ABB Comp-AC

User's Manual

ACS 400 AC Drives for Speed Control
of 3 to 50 Hp (2.2 to 37 kW)
AC Induction Motors

ACS 400 AC Drives for Speed Control of AC Induction Motors

User's Manual

ACS400-US-04

3AUA489002B5310 R0101 Rev A

Effective: 2/1/99

Safety

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

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

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

Warning! Even when power is removed from the input terminals of the 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 broken 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 ACS100/140/400 units are connected in parallel, the auxiliary voltage for these control connections must be taken from a single source which can either be one of the units or an external supply.

Warning! The heat sink may reach a high temperature. See Section **R**.

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

Table of Contents

Installation

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

Preparation before installation

To install the 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 parameters and write them down: supply voltage, nominal current, nominal frequency, and nominal speed.

Unpacking the unit

The ACS 400 is packed with this User's Manual, Conduit Plate, 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. Tear the lid off 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.

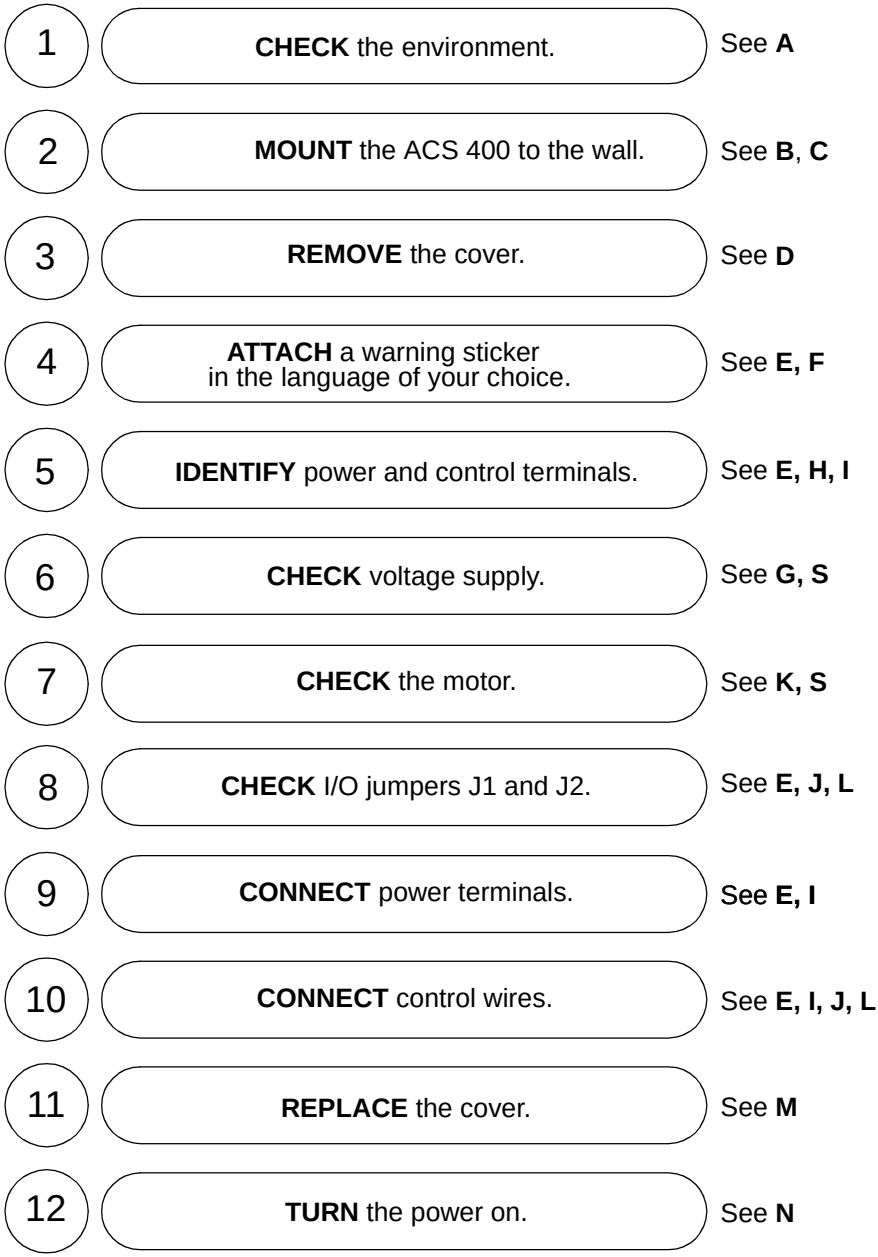


Figure 1 Step by step instructions for installing the ACS 400. The references after each step refer to one or more of the Reference Sections on the following pages in this manual.

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 I_2 derated to 90%
- Installation altitude 0…3300 ft (1000 m) if P_N and I_2 100%
- Installation altitude 3300…6600ft (1000...2000 m) if P_N and I_2 derated 1% every 330 ft (100 m) above 3300 ft (1000 m)
- Relative humidity less than 95% (non-condensing)

The 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/NEMA1 or an IP54/NEMA12 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/NEMA12 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 1 Enclosures

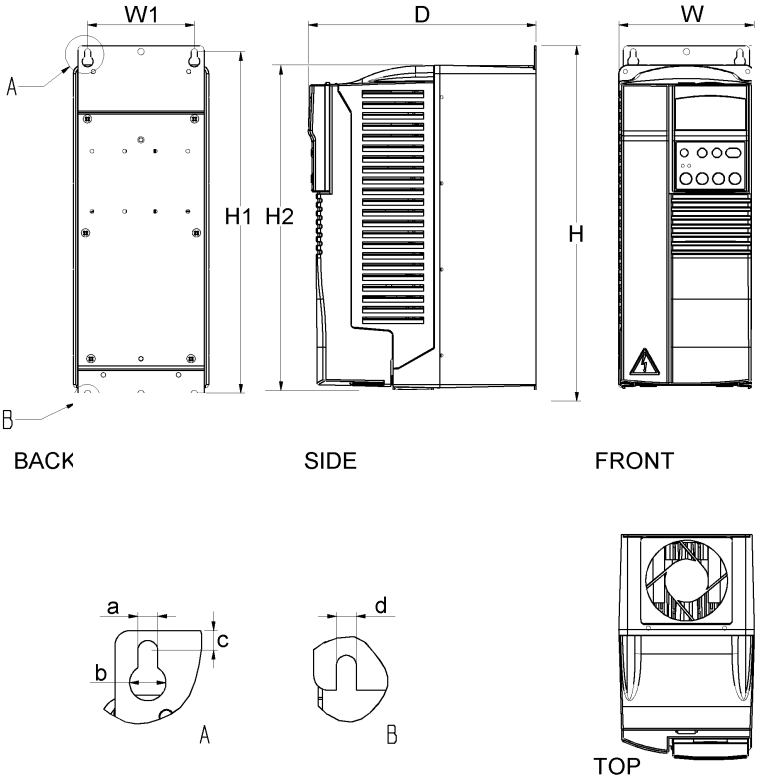


Figure 2 IP 21/NEMA 1 enclosures

Table 1 Dimensions of units with IP 21/NEMA 1 enclosures

Dimension Reference (in/mm)	Frame Size, IP21/NEMA 1 (See Paragraph S for frame size assignments of type codes)			
	R1	R2	R3	R4
W	4.92/125	4.92/125	7.99/203	7.99/203
W1	3.86/98	3.86/98	3.86/98	3.86/98
H	12.99/330	16.93/430	21.46/545	25.04/636
H1	12.52/318	16.42/417	20.79/528	24.37/619
H2	11.81/300	15.75/400	19.69/500	23.62/600
D	8.23/209	8.70/221	9.72/247	11.02/280
a	0.217/5.5	0.217/5.5	0.256/6.5	0.256/6.5
b	0.394/10	0.394/10	0.512/13	0.512/13
c	0.217/5.5	0.217/5.5	0.256/6.5	0.256/6.5
Mass (lb/kg)	12.76/5.8	19.80/9.0	40.70/18.5	59.40/27

Units with IP 54/NEMA 12 Enclosures

The IP 54/NEMA 12 protection class has a different outer plastic cover. The IP 54/NEMA 12 enclosure uses 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.

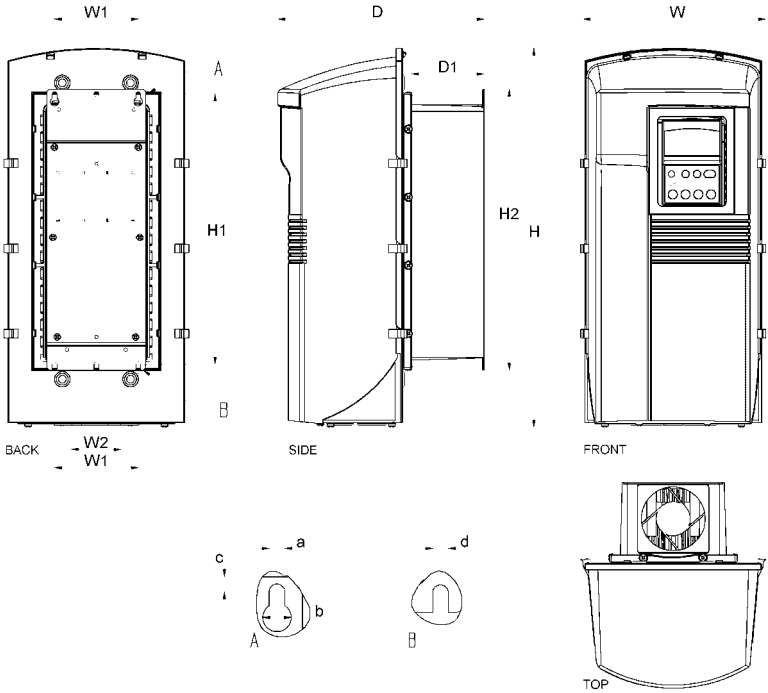


Figure 3 IP 54/NEMA 12 enclosures

Table 2 Dimensions of units with IP 54/NEMA 12 enclosures.

Dimension Reference (in/mm)	Frame Size, IP54/NEMA 12 (See Paragraph S for frame size assignments of type codes)			
	R1	R2	R3	R4
W	8.46/215	8.46/215	10.12/257	10.12/257
W1	3.86/98	3.86/98	3.86/98	3.86/98
H	17.72/450	21.65/550	25.28/642	29.21/742
H1	12.52/318	16.42/417	20.79/528	24.37/619
H2	12.49/330	16.93/430	21.46/545	25.04/636
D	9.49/241	9.96/253	10.98/279	12.28/312
a	0.217/5.5	0.217/5.5	0.256/6.5	0.256/6.5
b	0.394/10	0.394/10	0.512/13	0.512/13
c	0.217/5.5	0.217/5.5	0.256/6.5	0.256/6.5
Weight (lb/kg)	12.76/5.8	19.80/9.0	40.70/18.5	61.60/28

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.

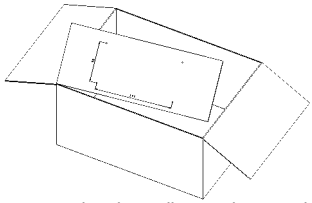


Figure 4 Removing the wall mounting template.

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).

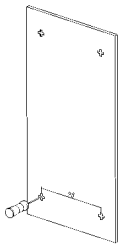


Figure 5 Marking and drilling the mounting holes.

3

IP 21

Position the ACS 400 onto the fixings and securely tighten in all four corners.

Note! Lift the ACS 400 by its metal chassis.

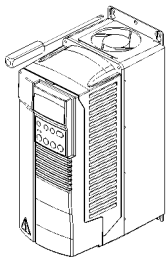


Figure 6 Mounting type IP21 drives.

IP 54

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

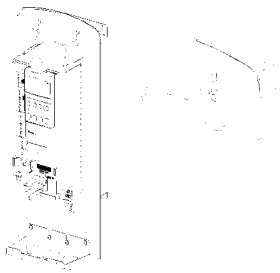


Figure 7 Mounting type IP54 drives.

D Removing the Cover

Opening frame size R1 and R2 units.

See Paragraph S for frame size assignments of type codes.

1 Remove the control panel.
2 In the control panel slot there is a small hole. Press the retaining lever inside the hole.
3 Remove the cover.

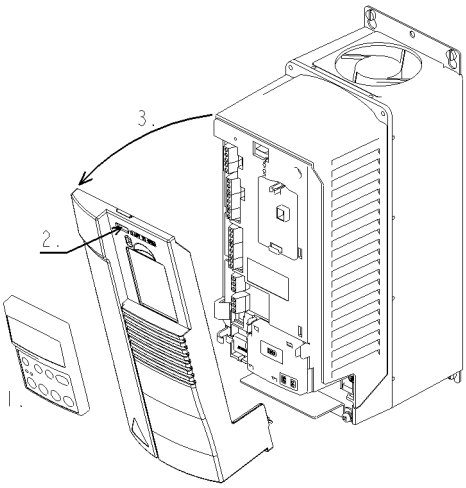


Figure 8 Opening the frame size R1 and R2 drives of type IP 21/ NEMA 1.

Opening frame size R3 and R4 units.

See Paragraph S 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 e.g. 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.

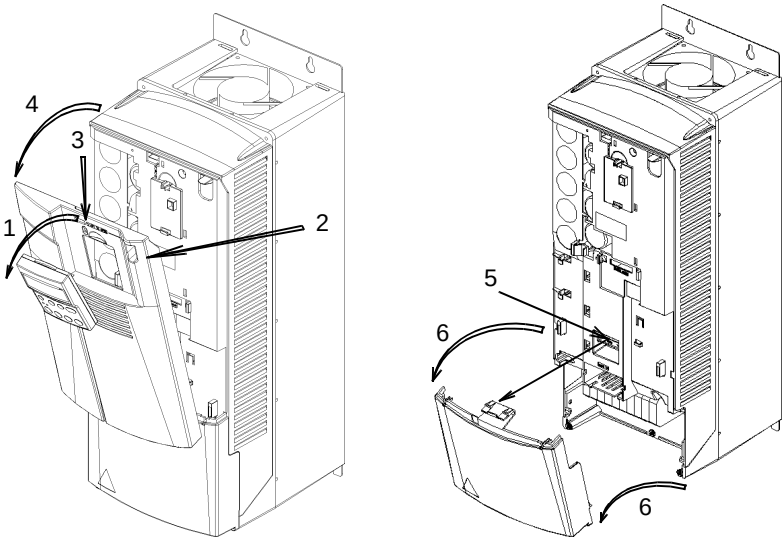


Figure 9 Opening the frame size R3 and R4 size drives of type IP 21/ NEMA 1.

IP 54/NEMA 12

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

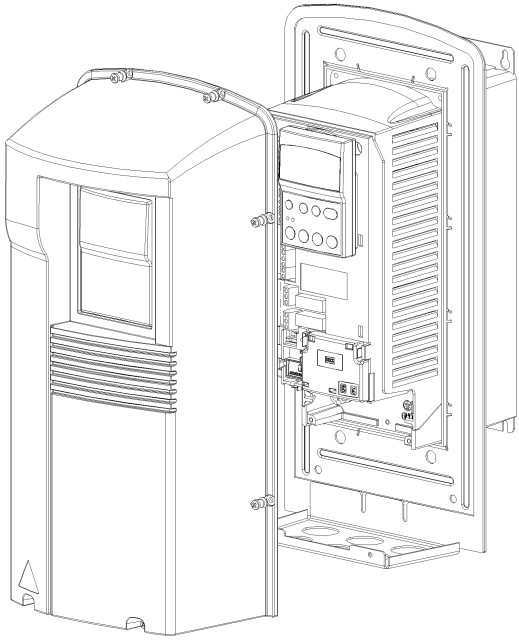


Figure 10 Opening type IP 54 / NEMA 12 drives.

E Terminal Interface

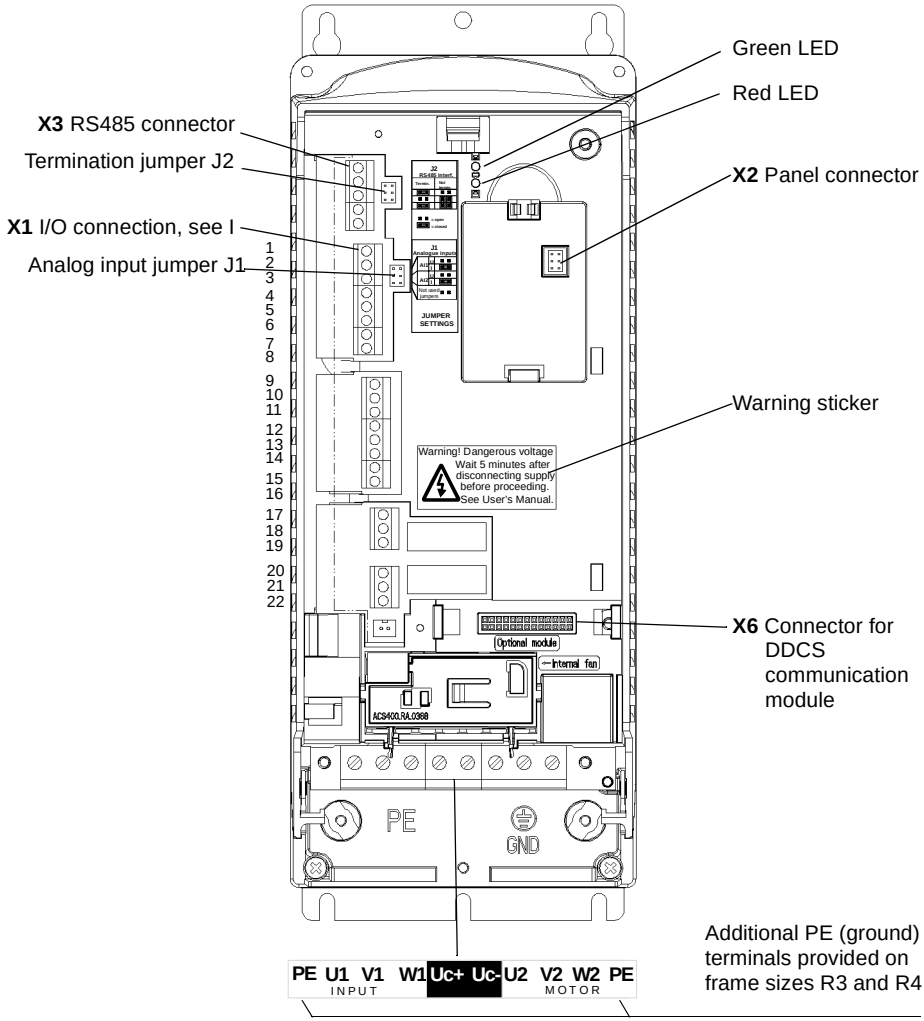


Figure 11 Terminal Interface.

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 Manual	
Type	**ACS401000432**	**U2**	3 0 - 380...480 V	LISTED 45Y1	
Code	**63996611**	**I1n/I1nnd**	4.7 / 6.2 A	c UL us	
		I2n/I2nnd	4.9 / 6.6 A	IND. CONT. EQ	
Ser.no.	*1982800001*	**f1**	48...63 Hz	CE	
		f2	0...250Hz		

Figure 12 ACS 400 type designation label.

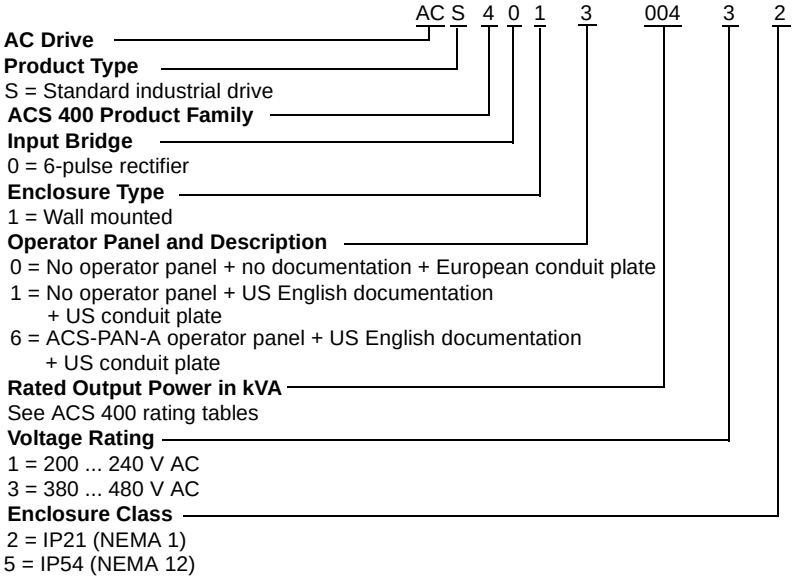


Figure 13 Type code key.

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

Type	**ACS401000432**		
Code	**63996611**	**Ser.no.**	***1982800001***

Figure 14 Serial number label.

H Installation of ACS 400 Gland Plates or Conduit Plates

A package, containing three screws and two gland plates and/or one conduit plate, is included with the ACS 400.

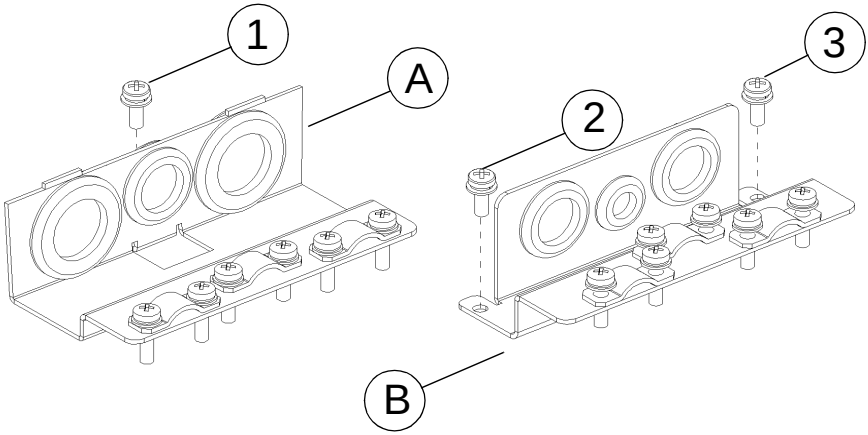


Figure 15 Gland plate for power cables (A) and for control cables (B). The conduit plate is a single piece with two blank spaces for punching holes for power and control conduits. The conduit plate does not have cable clamps.

A package, containing five screws and two cable clamp brackets, is included with the type IP 54 / NEMA 12 ACS 400 drives. These are required only for IEC installations. Gland plates are used for IEC installations and conduit plates are used for US installations. Contact your local ABB representative for additional information regarding IEC installations.

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

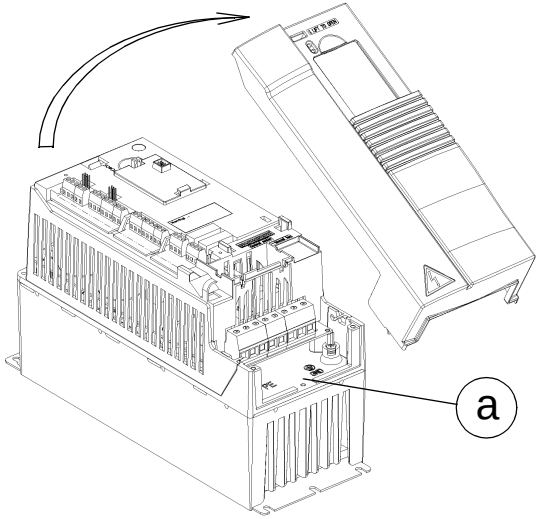


Figure 16 Removing the front cover.

Connect the gland plate for power cables with one screw. The threaded hole for the screw is located in the middle of the heat sink, at the bottom end (see Figure 17, point marked with **a**)

IP 21 / NEMA 1.

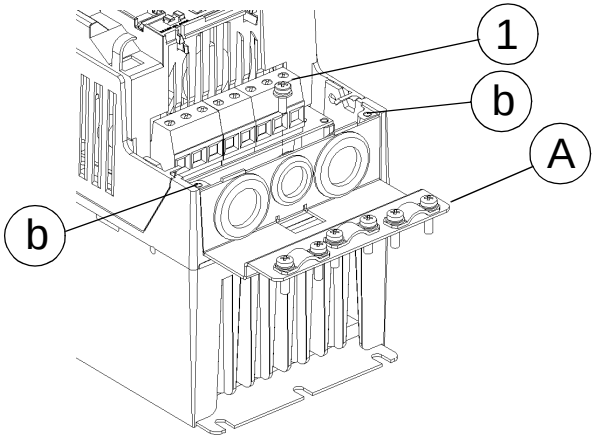


Figure 17 Installing the gland plate for power cables (A), type IP 21 / NEMA 1 drives.

The gland plate for control cables (**B**), is attached with two screws into threaded holes, marked **b** in Figure 18. This gland plate is located on top of the power cable gland plate, marked **A.**

IP 21 / NEMA 1

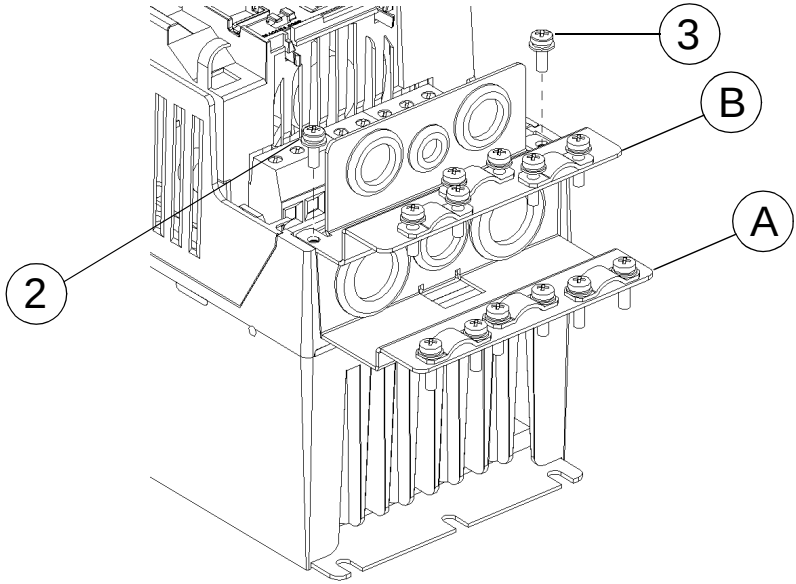


Figure 18 Installing the gland plate for control cables (B), type IP 21 / NEMA 1 drives.

The conduit plate is attached with three screws into threaded holes marked **a** in Figure 16 and **b** in Figure 17.

I 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 S.
Uc+, Uc–	DC bus	For optional ACS-BRK braking unit.
X1 1 to 16	Control Wiring	Low voltage control – use shielded cable
X1 17 to 22	Control Wiring	Low voltage or 115VAC
X3	RS485 Communications	Use shielded cable

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

Use shielded cable for control wiring.

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

Refer to Section **S** Specifications 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.

Note! 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.

J Control Terminals

Main I/O terminal X1

The analog input signal is selected with V/I jumper J1: AI open = V and AI connected = I.

X1	Identification	Description	
1	SCR	Terminal for signal cable screen. (Connected internally to frame ground.)	
2	AI 1	Analog input channel 1, programmable. Default: 0 - 10 V (R_i = 200 kΩ) (J1:AI1 open) <=> 0 - f_{nom} frequency reference 0 - 20 mA (R_i = 500 Ω) (J1:AI1 closed) <=> 0 - f_{nom} frequency reference Resolution 0.1 % accuracy ±1 %.	
3	AGND	Analog input circuit common. (Connected internally to frame ground through 1 MΩ.)	
4	10 V	10 V/10 mA reference voltage output for analog input potentiometer, accuracy ±2 %,.	
5	AI 2	Analog input channel 2, programmable. Default: 0 - 20 mA (R_i = 500 Ω) (J1:AI2 closed) <=> 0 - f_{nom} frequency reference 0 - 10 V (R_i = 200 kΩ) (J1:AI2 open) <=> 0 - f_{nom} frequency reference Resolution 0.1 % accuracy ±1 %.	
6	AGND	Analog input circuit common. (Connected internally to frame ground through 1 MΩ.)	
7	AO1	Analog output, programmable. Default: 0-20 mA (load < 500 Ω) <=>0-f_{nom} output frequency	
8	AGND	Common for DI return signals.	
9	24 V	Auxiliary voltage output 24 V DC / 250 mA (reference to AGND). Short circuit protected.	
10	DCOM1	Digital input common for DI1, DI2 and DI3. To activate a digital input, there must be ≥+10 V (or ≤-10 V) between that input and DCOM1. The 24 V may be provided by the ACS 400 (X1:9) using the connection examples (see Section L) or by an external 12-24 V source of either polarity.	
DI Configuration		**Factory (0)** (f_{nom} = 50 Hz)	**Factory (1)** (f_{nom} = 60 Hz)
11	DI 1	**Start.** Close to start. Motor will ramp up to frequency reference. Open to stop. Motor will coast to stop.	**Start.** If DI 2 is closed, momentary closing of DI 1 starts the ACS 400.
12	DI 2	**Reverse.** Close to reverse rotation direction.	**Stop.** Momentary opening stops the ACS 400.
13	DI 3	**Jog.** Close to set output frequency to jogging frequency (default: 5 Hz).	**Reverse.** Close to reverse rotation direction.
14	DI 4	Must be closed for Factory (0).	Must be open for Factory (1).
15	DI 5	Accel/Decel selection (ACC1/DEC1 or ACC2/DEC2).	
16	DCOM2	DCOM2 digital input common for DI4, DI5	
17	RO1C		Relay output 1, programmable (default: fault => 17 connected to 18). 12 - 250 V AC / 30 V DC, 10 mA - 2 A
18	RO1A		
19	RO1B		
20	RO2C		Relay output 2, programmable (default: running => 20 connected to 22). 12 - 250 V AC / 30 V DC, 10 mA - 2 A
21	RO2A		
22	RO2B		

Digital input impedance 1.5 kΩ.

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

Note! DI 4 is read only when powered-up (Factory macro (0) and (1)).

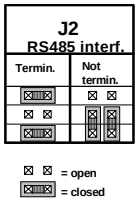
Note! For safety reasons the fault relay signals a "fault" when the ACS 400 is powered down.

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 L 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



K Motor

Check for motor compatibility. The motor must be a three-phase induction motor, with V_N from 200 to 240 V for ACS401-XXXX-1-X or 380 to 480 V for ACS401-XXXX-3-X and f_N either 50 Hz or 60 Hz.

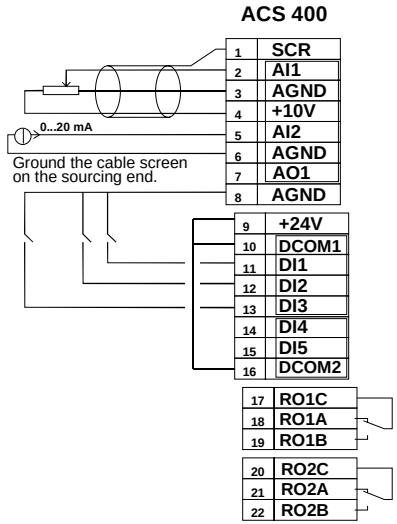
The motor nominal current, I_N, must be less than the nominal output current of the ACS 400, I_2 (See Sections **G** and **S**).

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.**

L Connection Examples

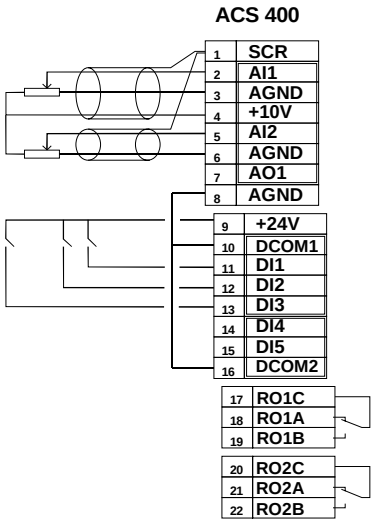
DI configuration for

NPN connection (sink)

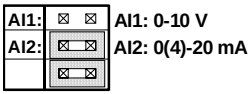


DI configuration for

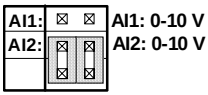
PNP connection (source)



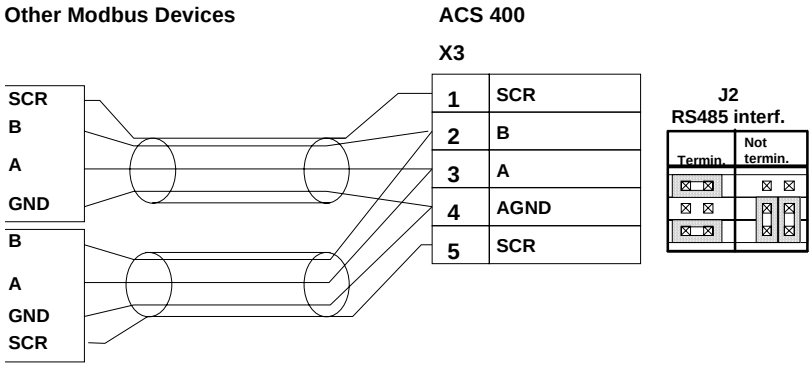
J1 Analog inputs



J1 Analog inputs



RS485 Multidrop application

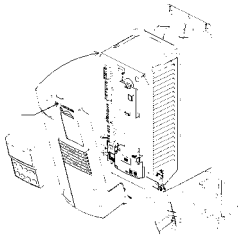


M Replacing the Cover

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

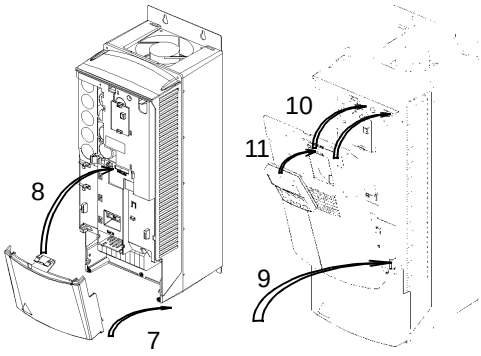
Replacing the front cover for IP21 / NEMA 1:

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



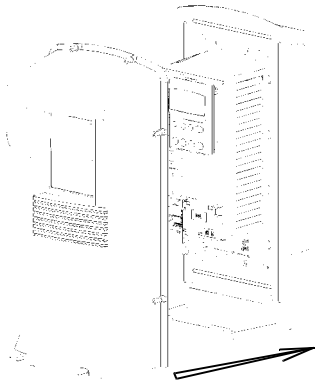
Replacing the front cover to IP 21/ NEMA 1 units from size ACS401-x016-3-x and up.

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



Replacing the front cover for IP54 / NEMA 12:

1. Replace the control panel.
2. Replace the front cover.



N 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.

O Environmental Information

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

P 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 **Q**)
- Output overload protection (see Section R)
- Stall protection
- Underload

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

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

Red LED: off **Green LED: blinking**	**ABNORMAL CONDITION**
ABNORMAL CONDITION: • ACS 400 cannot fully follow control commands. • Blinking lasts 15 seconds.	**POSSIBLE CAUSES:** • 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: • 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: • Transient overcurrent • Over-/undervoltage • Overtemperature CHECK: • the supply line for disturbances. • the drive for mechanical problems that might cause overcurrent. • that the heat sink is clean.

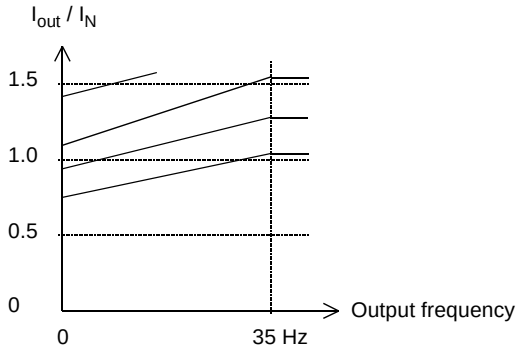
Red LED: blinking **Green LED: on**	**FAULT**
ACTION: • Turn the power off. • Wait for the LED's to turn off. • Turn the power back on. **Caution!** This action may start the drive.	POSSIBLE CAUSE: • Output ground fault • Short circuit • DC bus ripple too large CHECK: • the insulation in the motor circuit.

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.

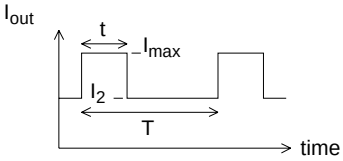
Q Motor Overload Protection

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”.

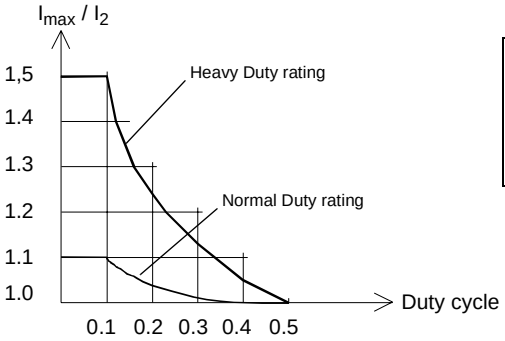


R Drive Overload Protection



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%.

S Specifications

200 V series								
3~ Input V_1 208V - 240V ±10 % 50/60 Hz	**ACS401-**	**X006-1**	**X009-1**	**X011-1**	**X016-1**	**X020-1**	**X030-1**	**X041-1**
Frame size		R1	R2		R3		R4	
Nominal ratings (See **G**)	Unit							
Nominal motor P_N Normal Duty	**Hp**	**3.0**	**5.0**	**7.5**	**10**	**15**	**20**	**25**
Input current I_{1NND}	A	10.9	14.4	21.6	28.2	35.7	55.5	67.7
Output current I_{2NND}	A	11.6	15.3	23	30	38	59	72
Max. output current $I_{2NNDmax}$ *	A	12.8	16.8	25.3	33.0	41.8	64.9	79.2
Nominal motor P_N Heavy Duty	**Hp**	**2.0**	**3.0**	**5.0**	**7.5**	**10**	**15**	**20**
Input current I_{1N}	A	8.3	11.0	14.5	21.8	28.4	41.6	55.8
Output current I_{2N}	A	8.8	11.6	15.3	23	30	44	59
Max. output current* I_{2Nmax}	A	13.2	17.4	22.9	34.5	45	66	88.5
Output voltage V_2	V	0 - V_1						
Switching frequency	kHz	4 (Standard) 8 (Low noise **)						
Protection limits	(See **P**)							
Overcurrent (peak)	A	37	48	64	76	99	145	195
Overvoltage: Running Start inhibit	 V DC V DC	 420 (corresponds to 295 VAC input) 390 (corresponts to 276 V input)						
Undervoltage: Running Start inhibit	 V DC V DC	 200 (corresponds to 142 VAC input) 230 (corresponds to 162VAC input)						
Overtemperature	°C	95 (heat sink)						
Power Terminals***	mm^2	10, AWG6 (stranded) Torque 1.3-1.5Nm			16, AWG4 (stranded) Torque 1.5-1.8Nm		35, AWG2 (stranded) Torque 3.2-3.7Nm	
Control Terminals	mm^2	0.5 - 1.5 (AWG22...AWG16)/Torque 0.4 Nm						
LIne fuse ****3~	A	16	16	25	35	50	63	80
Power Losses								
Power Circuit	W	79.2	108	144	198	270	396	540
Control Circuit	W	6	6	6	6	6	6	6

400 V series											
3~ Input V_1 380V - 480V ±10 % 50/60 Hz	**ACS401-**	**X004-3-2**	**X005-3-2**	**X006-3-2**	**X009-3-2**	**X011-3-2**	**X016-3-2**	**X020-3-2**	**X025-3-2**	**X030-3-2**	**X041-3-2**
Frame size		R1			R2		R3		R4		
Nominal ratings (See **G**)	Unit										
Nominal motor P_N Normal Duty	**Hp**	**3.0**	**5.0**	**7.5**	**10**	**15**	**20**	**25**	**30**	**40**	**50**
Input current I_{1NND}	A	6.2	8.3	11.1	14.8	21.5	29	35	41	56	68
Output current I_{2NND}	A	6.6	8.8	11.6	15.3	23	30	38	44	59	72
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	**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	8.8	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	(See **P**)										
Overcurrent (peak)	A	20.3	27.5	37	48	64	76	99	125	145	195
Overvoltage: Running Start inhibit	 V DC V DC	 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	 V DC V DC	 333 (corresponds to 247 VAC input) 436 (in input voltage range 380-415 VAC) 505 (in input voltage range 440-480 VAC)									
Overtemperature	°C	95 (heat sink)									
Max. cable length f_{SW} = 4 kHz *****	m	100			200		200		200		

* 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 **R**.

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

***** 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.

400 V series											
3~ Input V_1 380V - 480V ±10 % 50/60 Hz	**ACS401-**	**X004-3-2**	**X005-3-2**	**X006-3-2**	**X009-3-2**	**X011-3-2**	**X016-3-2**	**X020-3-2**	**X025-3-2**	**X030-3-2**	**X041-3-2**
Max. wire sizes and screw torque of connectors											
Power terminals ***	mm^2	10, AWG6 (stranded)/ Torque 1.3-1.5 Nm					16, AWG4 (stranded) / Torque 1.5-1.8 Nm		35, AWG2 (stranded) / Torque 3.2-3.7 Nm		
Control terminals	mm^2	0.5 - 1.5 (AWG22...AWG16) / Torque 0.4 Nm									
Line fuse 3~ **** ACS401-	A	10	10	16	16	25	35	50	50	63	80
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

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

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

T Product Conformity

The ACS 400 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.

U Accessories

ACS 100-PAN
Control panel for use with the ACS 100 / ACS 140 / ACS 400.

ACS-PAN-A
Control panel for use with the ACS 400.

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

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

ACS-BRK-
Braking units.

RS485/232 Adapter

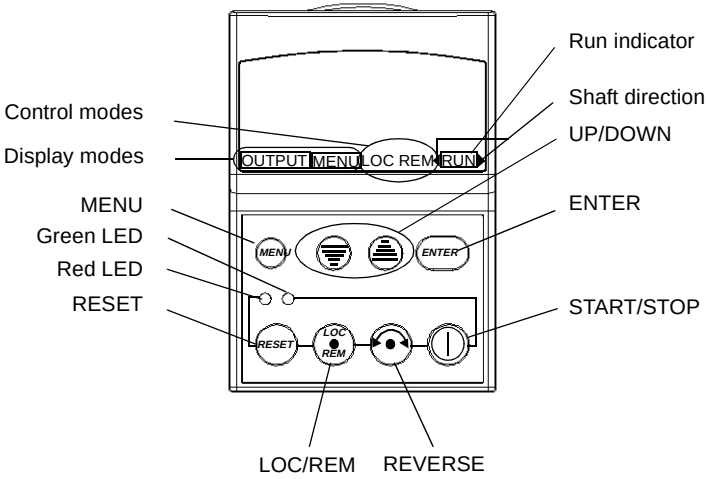
DDCS Communication Module

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

PROGRAMMING

ACS-PAN-A Control Panel

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



Control Modes

The first time the drive is powered up, it is controlled from the Control Terminal Strip 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 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 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.

Direction

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

Output Display

When the control panel is powered up, it displays a selection of actual values, as in Figure 19. Whenever the MENU button is pressed and held, the control panel resumes this **OUTPUT** display.

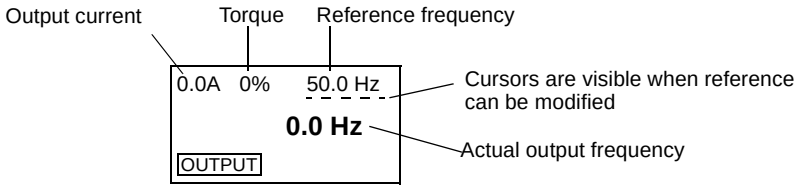


Figure 19 Output display variables.

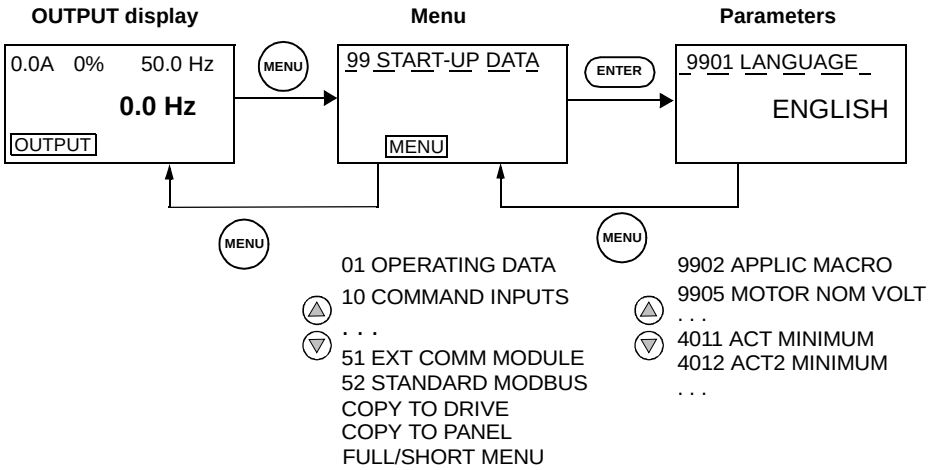
The frequency reference can be modified using UP/DOWN buttons when it is underlined. Pressing UP or DOWN buttons changes the output immediately.

The reference can be modified in local control mode or in remote control mode depending on programming.

Menu Structure

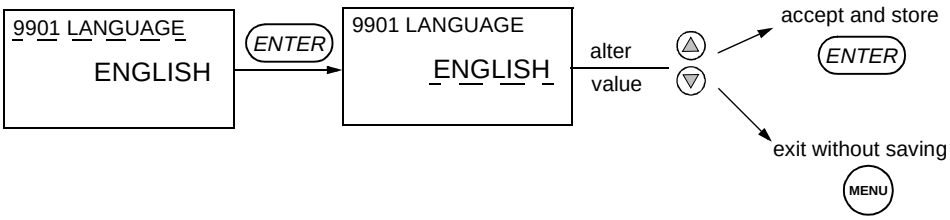
The ACS 400 has a large number of parameters. Of these, only the **basic parameters** are initially visible. See “Selecting Full Parameter Set” on page 28 for details on specifying the full parameter set.

The menu consists of parameter groups and menu functions.



Setting Parameter Value

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



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

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

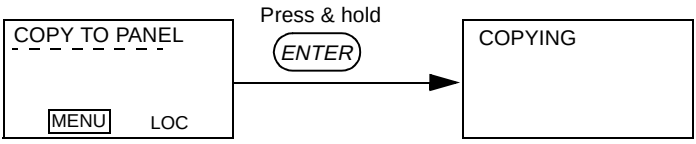
Adjust the Panel Display Contrast

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

Menu Functions

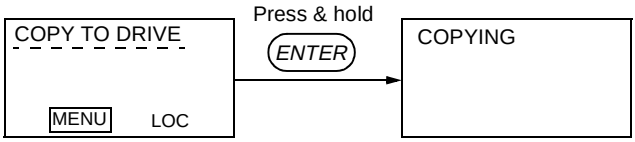
Use the UP/DOWN arrows to scroll through the Menu for the desired menu function, then press and hold ENTER down until the display blinks to start the operation.

Copy Parameters from Drive to Panel (upload)



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

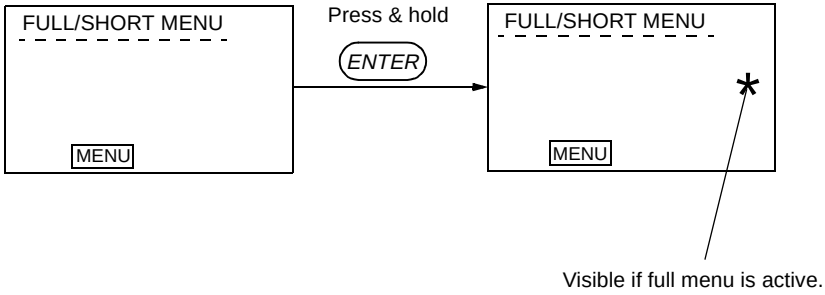
Copy Parameters from Panel to Drive (download)



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

Selecting Full Parameter Set

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



LED Indicators

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

Resetting the Drive from the Control Panel

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

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

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

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

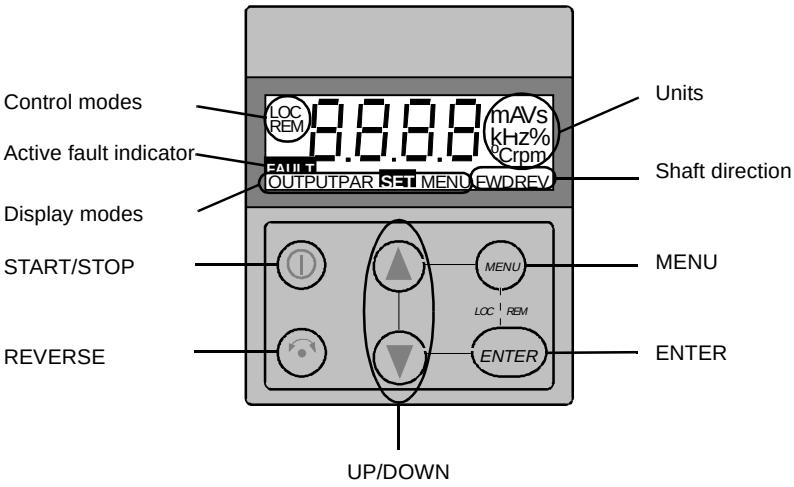
You can “clear” the display without resetting the fault by pressing any button.

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

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

ACS100-PAN Control Panel

The control panel can be connected to and detached from the drive at any time. The ACS100-PAN panel cannot be used to copy parameters between two ACS400 drives.



Control Modes

The first time the drive is powered up, it is controlled from the Control Terminal strip (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 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.

Direction

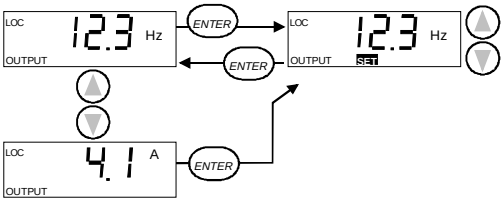
FWD / REV Visible	• Shaft direction is forward / reverse • Drive is running and at set point
FWD / REV Blinking rapidly	Drive is accelerating / decelerating.
FWD / REV Blinking slowly	Drive is stopped.

Output Display

When power is applied to the control panel, it displays the actual output frequency. Whenever the MENU button is pressed and held, the control panel resumes this **OUTPUT** display.

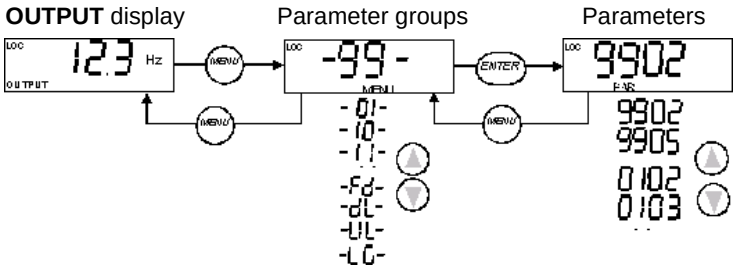
To toggle between output frequency and output current, press the UP or DOWN button.

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



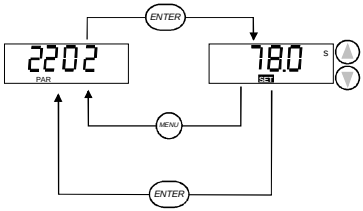
Menu Structure

ACS 400 has a large number of parameters. Of these, only the **basic parameters** are initially visible. The menu function -LG- is used to make the full parameter set visible. See “Select between basic and full menu” on page 33.



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.

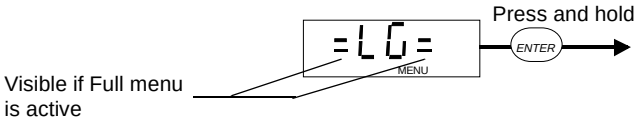
Note! To view the parameter default value, press the UP/DOWN buttons simultaneously.

Menu Functions

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

Note! The ACS100-PAN upload and download functions are not operational with ACS 400. Relatively small permanent memory of the ACS100-PAN cannot store all the ACS 400 parameter values.

Select between basic and full menu



Resetting the Drive from the Control Panel

When the red LED of the ACS 400 is on or blinking, a fault is active.

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

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

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

You can “clear” the display without resetting the fault by pressing any button. The word FAULT will be displayed.

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

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

Diagnostics

The ACS 400 alarms and faults are described in Table 5 and Table 6 respectively. The ACS100-PAN control panel displays only the alarm and fault codes. The alarm and fault messages are displayed only by the ACS-PAN-A control panel.

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

Table 5 Alarms.

Code	Message	Description
AL 1	OPERATION FAILED	Parameter upload/download failed.
AL 2	START ACTIVE	Operation not allowed while start is active.
AL 3	LOCAL/REMOTE	Operation not allowed in current control mode (Local or Remote).
AL 5	BUTTON DISABLED	Start/Stop/Direction or reference from control panel is not followed. Possible causes: • Remote mode: parameters disable the buttons (see APPENDIX). • Local mode: START/STOP button interlocked from digital inputs. • Local mode: Shaft direction is fixed by parameter 1003 DIRECTION.
AL 6	PARAMETER LOCK	Operation not allowed. Parameter 1602 PARAMETER LOCK or 1605 LOCAL LOCK is active.
AL 7	FACTORY MACRO	Use of factory macro disables operation.
AL10	OVERCURRENT	Overcurrent controller active.
AL11	OVERVOLTAGE	Overvoltage controller active.
AL12	DC UNDERVOLTAGE	Undervoltage controller active.
AL13	DIRECTION LOCK	Direction lock. See parameter 1003 DIRECTION.
AL14	SERIAL COMM LOSS	Serial communication loss alarm.
AL15	MODBUS EXCEPTION	Modbus exception response is sent through serial communication.
AL16	AI1 LOSS	Analog input 1 loss. Analog input 1 value is less than MINIMUM AI1 (1301). See parameter 3001 AI<MIN FUNCTION.
AL17	AI2 LOSS	Analog input 2 loss. Analog input 2 value is less than MINIMUM AI2 (1306). See parameter 3001 AI<MIN FUNCTION.
AL18	PANEL LOSS	Panel loss. Panel is disconnected when Start/Stop/Dir or reference is coming from panel. See parameter 3002 and APPENDIX.
AL19	ACS400 OVERTEMP	Hardware overtemperature (at 95 % of the trip limit).
AL20	MOTOR OVERTEMP	Motor overtemperature (at 95 % of the trip limit).
AL21	UNDERLOAD	Motor underload alarm.
AL22	MOTOR STALL	Stall alarm.
AL23	DDCS COMM LOSS	DDCS link loss alarm.
AL24		Reserved.
AL25	MANUAL OFF	Reference is not followed (1605 LOCAL LOCK=1).
AL26	OUTPUT OVERLOAD	If the load is not reduced, the drive will soon trip due to OUTPUT OVERLOAD fault (FL5).
AL27	AUTOMATIC RESET	The drive has stopped due to a fault but will attempt to restart automatically. See parameter Group 31.
AL28	PID SLEEP ACTIVE	The PID sleep feature has stopped the drive. The drive will restart automatically if the PID wake-up conditions are satisfied.

Table 6 Faults.

Code	Message	Description
FL 1	OVERCURRENT	Overcurrent: • Possible mechanical problem. • Acceleration and/or deceleration times may be too short. • Power supply disturbances.
FL 2	DC OVERVOLTAGE	DC overvoltage: • Input voltage too high. • Deceleration time may be too short.
FL 3	ACS400 OVERTEMP	ACS 400 overtemperature: • Ambient temperature too high. • Severe overload.
FL 4 *	SHORT CIRCUIT	Fault current: • Short circuit. • Power supply disturbances.
FL 5	OUTPUT OVERLOAD	Output overload.
FL 6	DC UNDERVOLTAGE	DC undervoltage.
FL 7	ANALOG INPUT 1	Analog input 1 fault. Analog input 1 value is less than MINIMUM AI1 (1301). See also parameter 3001 AI<MIN FUNCTION.
FL 8	ANALOG INPUT 2	Analog input 2 fault. Analog input 2 value is less than MINIMUM AI2 (1304). See also parameter 3001 AI<MIN FUNCTION.
FL 9	MOTOR OVERTEMP	Motor overtemperature. See parameters 3004-3008.
FL10	PANEL LOSS	Panel loss. Panel is disconnected when Start/Stop/Dir or reference is coming from panel. See parameter 3002 and APPENDIX. **Note!** If FL10 is active when the power is turned off, the ACS 400 will start in remote control (REM) when the power is turned back on.
FL11	PARAMETERING	Parameters inconsistent. Possible fault situations: • MINIMUM AI1 > MAXIMUM AI1 (parameters 1301 and 1302) • MINIMUM AI2 > MAXIMUM AI2 (parameters 1304 and 1305) • MINIMUM FREQ > MAXIMUM FREQ (parameters 2007 and 2008)
FL12	MOTOR STALL	Motor stall. See parameter 3009 STALL FUNCTION.
FL13	SERIAL COMM LOSS	Serial communication loss.
FL14	EXTERNAL FAULT SIGNAL	External fault is active. See parameter 3003 EXTERNAL FAULT.
FL15 *	OUTPUT EARTH FAULT	Output ground fault.
FL16 *	DC BUS RIPPLE	DC bus ripple too high. Check power supply for phase loss or imbalance.
FL17	UNDERLOAD	Underload.
FL18		Reserved.
FL19	DDCS LINK	DDCS link fault.
FL20 - FL28 *	HARDWARE ERROR	Hardware error. Contact the factory.
Full display blinking (ACS100-PAN) “COMM LOSS” (ACS-PAN) Serial link failure. Bad connection between the control panel and the ACS 400.		

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

ACS 400 Basic Parameters

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

Setting up only a few basic parameters is sufficient for applications where the preprogrammed application macros of the ACS 400 can provide all desired functionality. For a full description of programmable features provided by the ACS 400, see “ACS 400 Complete Parameter List”, starting on page 51.

The following table lists the basic parameters.

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

Code	Name	User	S
Group 99 START-UP DATA			
9901	**LANGUAGE** Language selection. 0 = ENGLISH (UK) 4 = SPANISH 8 = DANISH 12 = (reserved) 1= ENGLISH (US) 5 = PORTUGUESE 9 = FINNISH 2 = GERMAN 6 = DUTCH 10 = SWEDISH 3 = ITALIAN 7 = FRENCH 11 = RUSSIAN		
9902	**APPLIC MACRO** Selects application macro.Sets parameter values to their default values. Refer to “Application Macros”, starting on page 41 for detailed description of each macro. 0 = FACTORY 1= ABB STANDARD 2 = 3-WIRE 3 = ALTERNATE 4 = MOTOR POT 5 = HAND/AUTO 6 = PID CONTROL 7 = PREMAGN Default value: 0 (FACTORY MACRO)		✓
9905	**MOTOR NOM VOLT** Nominal motor voltage from motor nameplate. Range of this parameter depends on the type of the ACS 400. Default value for 400 V unit: 400 or 480 V depending on application macro selected. Default value for 200 V unit: 200 or 240 V depending on application macro selected.		✓
9906	**MOTOR NOM CURR** Nominal motor current from motor nameplate. Values for this parameter range from 0.5* I_N - 1.5* I_N, where I_N is nominal current of the ACS 400. Default value: I_N		✓
9907	**MOTOR NOM FREQ** Nominal motor frequency from motor nameplate. Range: 0 - 250 Hz Default: 50 Hz or 60 Hz depending on macro selected.		✓

Code	Name	User	S
9908	**MOTOR NOM SPEED** Nominal motor speed from motor nameplate. Range 0 - 3600 rpm Default: 1440 or 1720 rpm depending on application macro selected.		✓
9909	**MOTOR NOM POWER** Nominal motor power from nameplate. Range: 1 - 100 kW (1.5 - 125 Hp) Default: 1 kW (1.5 Hp)		✓
9910	**MOTOR COS PHI** Nominal motor cos phi from nameplate. Range: 0.50 - 0.99 Default: 0.83		✓
Group 01 **OPERATING DATA**			
0128	**LAST FAULT** Last recorded fault (0 = no fault). See “Diagnostics”, starting on page 35. Can be cleared with the control panel by pressing UP and DOWN buttons simultaneously when in parameter set mode.		
Group 10 **COMMAND INPUTS**			
1003	**DIRECTION** Rotation direction lock. 1 = FORWARD 2 = REVERSE 3 = REQUEST If you select REQUEST, the direction is set according to the given direction command. Default: 3 (REQUEST) or 1 (FORWARD) depending on the application macro selected.		✓
Group 11 **REFERENCE SELECT**			
1105	**EXT REF1 MAX** Maximum frequency reference in Hz. Range: 0 -250 Hz Default value: 50 Hz or 60 Hz depending on the application macro selected.		
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: 50.0 Hz or 60.0 Hz depending on the application macro selected. **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" starting on page 51.**		
Group 20 **LIMITS**			
2003	**MAX CURRENT** Maximum output current. Range: 0.5* I_N - 1.66* I_N, where I_N is nominal current of the ACS 400. Default value: 1.5 * I_N		
2008	**MAXIMUM FREQ** Maximum output frequency. Range: 0 - 250 Hz Default value: 50 Hz or 60 Hz depending on the application macro selected.		✓

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 parameter 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 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). Range is 0.1 - 1800 s. Default value: 5.0 s		
2204	**ACCELER TIME 2** Ramp 2: time from zero to maximum frequency (0 - MAXIMUM FREQ). Range is 0.1 - 1800 s. Default value: 60.0 s		
2205	**DECELER TIME 2** Ramp 2: time from maximum to zero frequency (MAXIMUM FREQ - 0). Range is 0.1 - 1800 s. Default value: 60.0 s		
Group 26 **MOTOR CONTROL**			
2606	**V/f RATIO** V/f below field weakening point. 1 = LINEAR 2 = SQUARE LINEAR is used for constant torque applications. SQUARE is used 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 which 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. 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 parameter values that are determined by the digital input DI4 cannot be modified.

Parameter Values

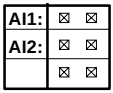
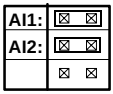
Selecting an application macro with parameter 9902 APPLIC MACRO will set all other parameters (except the language selection 9901, the parameter lock 1602 and groups 50 and 52 serial communication parameters) to their default values.

Default values of certain parameters depend on the selected macro. These are listed with the description of each macro. Default values for other parameters are given in “ACS 400 Complete Parameter List” starting on page 51.

Connection Examples

Please note the following in the examples below:

- All the digital inputs are connected using negative (NPN) logic.
- The signal type of analog input is selected with V/I jumper J1.

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

- If the frequency reference is provided with a voltage signal from both AI1 and AI2, keep the jumpers positioned according to the picture below.

0 - 10 V
0 - 10 V

Application Macro Factory (0)

This macro is intended for applications where there is no control panel available. It provides a general purpose I/O configuration that is typically used in Europe.

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

Input signals

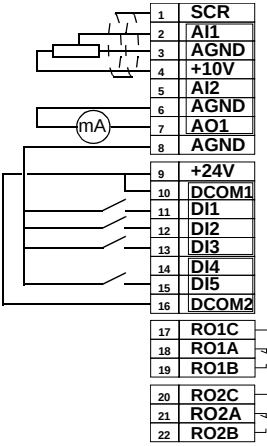
- Start, stop and direction (DI1,2)
- Analog reference (AI1)
- Constant speed 1 (DI3)
- Ramp pair 1/2 selection (DI5)

Output signals

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

V/I jumper S1

AI1:	⊠ ⊠	0 -10 V
AI2:	⊠ ⊠	0 -10 V
	⊠ ⊠	



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/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 ouput 1, programmable
Default: **Fault** =>17 connected to 18

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

***Note! DI 4 is used to configure ACS 400. It is read only once when power is connected. When DI 4 is open (0) the following applies:**

- **All parameters marked * are determined by the DI4 input.**
- **Motor nominal values are 400 V and 50 Hz and 1440 rpm.**
- **Input and output signals are scaled according to 50 Hz.**
- **Maximum frequency is 50 Hz.**

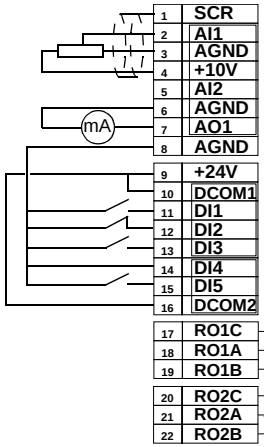
Factory (0) parameter values:

*9905 MOTOR NOM VOLT	400 V	*1105 EXT REF1 MAX	50 Hz
*9907 MOTOR NOM FREQ	50 Hz	1106 EXT REF2 SELECT	0 (KEYPAD)
*9908 MOTOR NOM SPEED	1440 rpm	*1201 CONST SPEED SEL	3 (DI3)
*1001 EXT 1 COMMANDS	2 (DI1,2)	*1503 AO CONTENT MAX	50 Hz
1002 EXT 2 COMMANDS	0 (NOT SEL)	1601 RUN ENABLE	0 (NOT SEL)
1003 DIRECTION	3 (REQUEST)	1604 FAULT RESET SEL	6 (START/STOP)
1102 EXT1/EXT2 SEL	6 (EXT1)	*2008 MAXIMUM FREQ	50 Hz
1103 EXT REF1 SELECT	1 (AI1)	2105 PREMAGN SEL	0 (NOT SEL)
		2201 ACC/DEC 1/2 SEL	5 (DI5)

Application Macro Factory (1)

This macro is intended for applications where there is no control panel available. It provides a general purpose I/O configuration that is typically used in North America.

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



External Reference 1: 0...10 V <=> 0...60 Hz

Reference voltage 10 VDC
Not used

Output frequency 0...20 mA <=> 0...60 Hz

+24 VDC

Momentary activation with DI2 activated: **Start**
Momentary deactivation: **Stop**
Fwd/Rev: activate to reverse rotation direction
Must be connected!*
Ramp pair selection. Activate to select ramp pair 2.

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

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

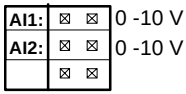
Input signals

- 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

V/I jumper S1



***Note! DI 4 is used to configure ACS 400. It is read only once when power is connected. When DI 4 is connected (1) the following applies:**

- **All parameters marked * are determined by the DI4 input.**
- **Motor nominal values are 480 V and 60 Hz and 1720 rpm.**
- **Input and output signals are scaled according to 60 Hz.**
- **Maximum frequency is 60 Hz.**

Note! Remote stop signal must be present to activate start/stop in local mode.

Factory (1) parameter values:

*9905 MOTOR NOM VOLT	480 V	*1105 EXT REF1 MAX	60 Hz
*9907 MOTOR NOM FREQ	60 Hz	1106 EXT REF2 SELECT	0 (KEYPAD)
*9908 MOTOR NOM SPEED	1720 rpm	*1201 CONST SPEED SEL	0 (NOT SEL)
*1001 EXT 1 COMMANDS	4 (DI1P,2P,P)	*1503 AO CONTENT MAX	60 Hz
1002 EXT 2 COMMANDS	0 (NOT SEL)	1601 RUN ENABLE	0 (NOT SEL)
1003 DIRECTION	3 (REQUEST)	1604 FAULT RESET SEL	6 (START/STOP)
		*2008 MAXIMUM FREQ	60 Hz
1102 EXT1/EXT2 SEL	6 (EXT1)	2105 PREMAGN SEL	0 (NOT SEL)
1103 EXT REF1 SELECT	1 (AI1)	2201 ACC/DEC 1/2 SEL	5 (DI5)

Application Macro ABB Standard

This general purpose macro provides two more preset speeds compared to Factory Macro (0).

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

Input signals

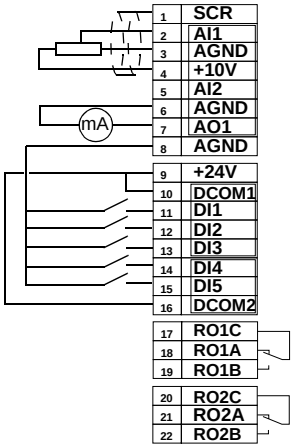
- Start, stop and direction (DI1,2)
- Analog reference (AI1)
- Preset speed selection (DI3,4)
- Ramp pair 1/2 selection (DI5)

Output signals

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

V/I jumper S1

AI1:	☒ ☒	0 -10 V
AI2:	☒ ☒	0 -10 V
	☒ ☒	



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/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 ouput 1, programmable
Default: **Fault** => 17 connected to 18

Relay ouput 2, programmable
Default: **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:

9905 MOTOR NOM VOLT	400 V	1105 EXT REF1 MAX	50 Hz
9907 MOTOR NOM FREQ	50 Hz	1106 EXT REF2 SELECT	0 (KEYPAD)
9908 MOTOR NOM SPEED	1440 rpm	1201 CONST SPEED SEL	7 (DI3,4)
1001 EXT 1 COMMANDS	2 (DI1,2)	1503 AO CONTENT MAX	50 Hz
1002 EXT 2 COMMANDS	0 (NOT SEL)	1601 RUN ENABLE	0 (NOT SEL)
1003 DIRECTION	3 (REQUEST)	1604 FAULT RESET SEL	0 (KEYPAD)
		2008 MAXIMUM FREQ	50 Hz
1102 EXT1/EXT2 SEL	6 (EXT1)	2105 PREMAGN SEL	0 (NOT SEL)
1103 EXT REF1 SELECT	1 (AI1)	2201 ACC/DEC 1/2 SEL	5 (DI5)

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.

Note! The default frequency is 60 Hz.

Note! 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)

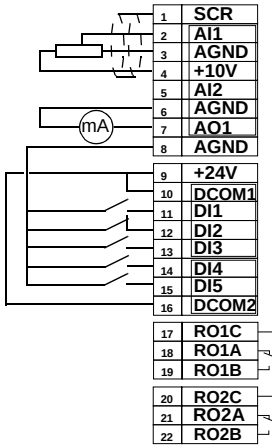
Output signals

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

V/I jumper S1

AI1:	⊠	⊠
AI2:	⊠	⊠
	⊠	⊠

0 -10 V
0 -10 V



External Reference 1: 0...10 V <=> 0...60 Hz

Reference voltage 10 VDC
Not used

Output frequency 0...20 mA <=> 0...60 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 ouput 1, programmable
Default: fault => 17 connected to 18

Relay ouput 2, programmable
Default: 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! Deactivation of stop signal interlocks panel START/STOP button in local control mode.
Application Macro 3-wire parameter values:

9905 MOTOR NOM VOLT	480 V	1105 EXT REF1 MAX	60 Hz
9907 MOTOR NOM FREQ	60 Hz	1106 EXT REF2 SELECT	0 (KEYPAD)
9908 MOTOR NOM SPEED	1720 rpm	1201 CONST SPEED SEL	8 (DI4,5)
1001 EXT 1 COMMANDS	4 (DI1P,2P,3)	1503 AO CONTENT MAX	60 Hz
1002 EXT 2 COMMANDS	0 (NOT SEL)	1601 RUN ENABLE	0 (NOT SEL)
1003 DIRECTION	3 (REQUEST)	1604 FAULT RESET SEL	0 (KEYPAD)
		2008 MAXIMUM FREQ	60 Hz
1102 EXT1/EXT2 SEL	6 (EXT1)	2105 PREMAGN SEL	0 (NOT SEL)
1103 EXT REF1 SELECT	1 (AI1)	2201 ACC/DEC 1/2 SEL	0 (NOT SEL)

Application Macro Alternate

This macro offers an I/O configuration that uses a sequence of DI control signals to alternate the direction of drive rotation.

Note! 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)

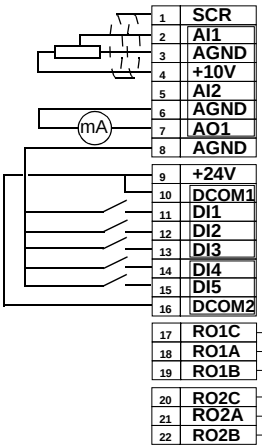
Output signals

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

V/I jumper S1

AI1:	☒	☒
AI2:	☒	☒
	☒	☒

0 -10 V
0 -10 V



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

Relay ouput 2, programmable
Default: **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:

9905 MOTOR NOM VOLT	400 V	1105 EXT REF1 MAX	50 Hz
9907 MOTOR NOM FREQ	50 Hz	1106 EXT REF2 SELECT	0 (KEYPAD)
9908 MOTOR NOM SPEED	1440 rpm	1201 CONST SPEED SEL	7 (DI3,4)
1001 EXT 1 COMMANDS	9 (DI1F,2R)	1503 AO CONTENT MAX	50 Hz
1002 EXT 2 COMMANDS	0 (NOT SEL)	1601 RUN ENABLE	0 (NOT SEL)
1003 DIRECTION	3 (REQUEST)	1604 FAULT RESET SEL	0 (KEYPAD)
		2008 MAXIMUM FREQ	50 Hz
1102 EXT1/EXT2 SEL	6 (EXT1)	2105 PREMAGN SEL	0 (NOT SEL)
1103 EXT REF1 SELECT	1 (AI1)	2201 ACC/DEC 1/2 SEL	5 (DI5)

Application Macro Motor Potentiometer

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

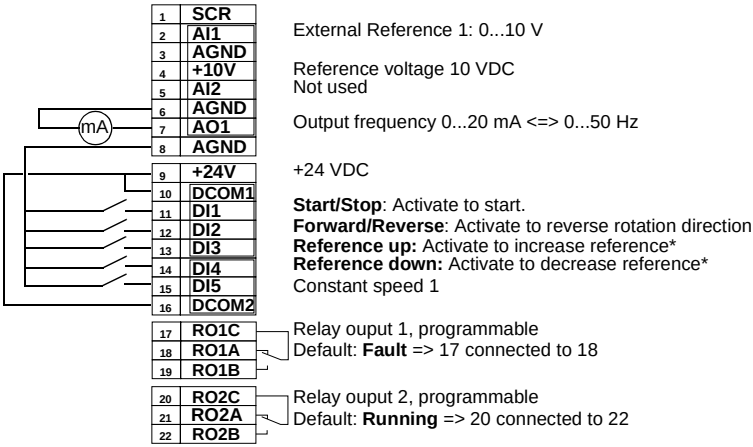
Note! The value of parameter 9902 is 4 (MOTOR POT).

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



***Note!**

- **If both DI 3 and DI 4 are active or inactive, reference is kept fixed.**
- **Reference is stored during stop or power down condition.**
- **Analog reference is not followed when motor potentiometer is selected.**

Motor potentiometer parameter values:

9905 MOTOR NOM VOLT	400 V	1105 EXT REF1 MAX	50 Hz
9907 MOTOR NOM FREQ	50 Hz	1106 EXT REF2 SELECT	0 (KEYPAD)
9908 MOTOR NOM SPEED	1440 rpm	1201 CONST SPEED SEL	5 (DI5)
1001 EXT 1 COMMANDS	2 (DI1,2)	1503 AO CONTENT MAX	50 Hz
1002 EXT 2 COMMANDS	0 (NOT SEL)	1601 RUN ENABLE	0 (NOT SEL)
1003 DIRECTION	3 (REQUEST)	1604 FAULT RESET SEL	0 (KEYPAD)
		2008 MAXIMUM FREQ	50 Hz
1102 EXT1/EXT2 SEL	6 (EXT1)	2105 PREMAGN SEL	0 (NOT SEL)
1103 EXT REF1 SELECT	6 (DI3U,4D)	2201 ACC/DEC 1/2 SEL	0 (NOT SEL)

Application Macro Hand - Auto

This macro offers an I/O configuration that is typically used for fan or pump applications.

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

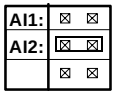
Input signals

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

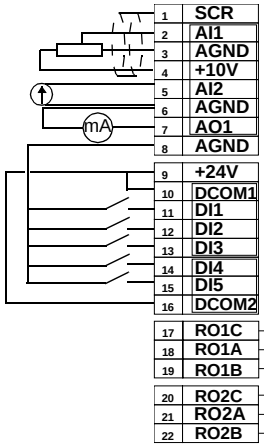
Output signals

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

V/I Jumper S1



0 -10 V
0(4) -20 mA



External Reference 1: 0...10 V <=> 0...50 Hz (**Hand Control**)

Reference voltage 10 VDC
External reference 2: 0...20 mA <=> 0...50 Hz (**Auto Control**)

Output frequency 0...20 mA <=> 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 ouput 1, programmable
Default: **Fault** => 17 connected to 18

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

Note! Parameter 2107 (Start Inhibit) must be disabled (off) to permit simultaneous closure of DI3 and DI5.

Hand-Auto parameter values:

9905 MOTOR NOM VOLT	400 V	1105 EXT REF1 MAX	50 Hz
9907 MOTOR NOM FREQ	50 Hz	1106 EXT REF2 SELECT	2 (AI2)
9908 MOTOR NOM SPEED	1440 rpm	1201 CONST SPEED SEL	0 (NOT SEL)
1001 EXT 1 COMMANDS	2 (DI1,2)	1503 AO CONTENT MAX	50 Hz
1002 EXT 2 COMMANDS	7 (DI5,4)	1601 RUN ENABLE	0 (NOT SEL)
1003 DIRECTION	3 (REQUEST)	1604 FAULT RESET SEL	0 (KEYPAD)
		2008 MAXIMUM FREQ	50 Hz
1102 EXT1/EXT2 SEL	3 (DI3)	2105 PREMAGN SEL	0 (NOT SEL)
1103 EXT REF1 SELECT	1 (AI1)	2201 ACC/DEC 1/2 SEL	0 (NOT SEL)

Application Macro PID Control

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

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

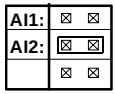
Input signals

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

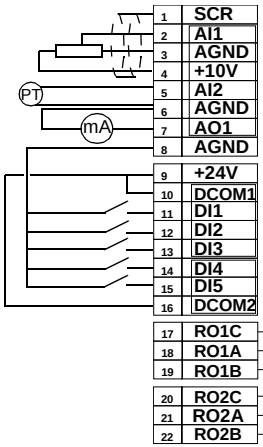
Output signals

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

V/I Jumper S1



0 -10 V
0(4) -20 mA



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

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

Output frequency 0...20 mA <=> 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 ouput 1, programmable
Default: **Fault** => 17 connected to 18

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

Note!
**** Constant speed is not used while in PID control (PID).**

PID control parameters (group 40) are not contained in the Basic parameter set.

PID Control parameter values:

9905 MOTOR NOM VOLT	400 V	1105 EXT REF1 MAX	50 Hz
9907 MOTOR NOM FREQ	50 Hz	1106 EXT REF2 SELECT	1 (AI1)
9908 MOTOR NOM SPEED	1440 rpm	1201 CONST SPEED SEL	3 (DI3)
1001 EXT 1 COMMANDS	1 (DI1)	1503 AO CONTENT MAX	50 Hz
1002 EXT 2 COMMANDS	6 (DI5)	1601 RUN ENABLE	4 (DI4)
1003 DIRECTION	1 (FORWARD)	1604 FAULT RESET SEL	0 (KEYPAD)
		2008 MAXIMUM FREQ	50 Hz
1102 EXT1/EXT2 SEL	2 (DI2)	2105 PREMAGN SEL	0 (NOT SEL)
1103 EXT REF1 SELECT	1 (AI1)	2201 ACC/DEC 1/2 SEL	0 (NOT SEL)

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. Using the Premagnetize Macro will minimize this delay.

The value of parameter 9902 is 7 (PREMAGN).

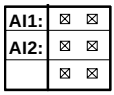
Input signals

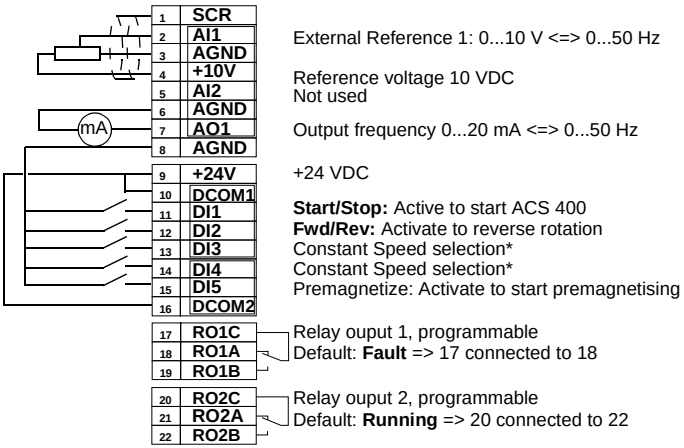
- Start, stop and direction (DI1,2)
- Analog reference (AI1)
- Preset speed selection (DI3,4)
- Premagnetize (DI5)

Output signals

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

V/I Jumper S1





*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)

Premagnetize parameter values:

9905 MOTOR NOM VOLT	400 V	1105 EXT REF1 MAX	50 Hz
9907 MOTOR NOM FREQ	50 Hz	1106 EXT REF2 SELECT	0 (KEYPAD)
9908 MOTOR NOM SPEED	1440 rpm	1201 CONST SPEED SEL	7 (DI3,4)
1001 EXT 1 COMMANDS	2 (DI1,2)	1503 AO CONTENT MAX	50 Hz
1002 EXT 2 COMMANDS	0 (NOT SEL)	1601 RUN ENABLE	0 (NOT SEL)
1003 DIRECTION	3 (REQUEST)	1604 FAULT RESET SEL	0 (KEYPAD)
		2008 MAXIMUM FREQ	50 Hz
1102 EXT1/EXT2 SEL	6 (EXT1)	2105 PREMAGN SEL	5 (DI5)
1103 EXT REF1 SELECT	1 (KEYPAD)	2201 ACC/DEC 1/2 SEL	0 (NOT SEL)

ACS 400 Complete Parameter List

Initially, only the basic parameters (shaded grey in Table 7) are visible. See “Selecting Full Parameter Set” on page 28 for menu function to select full parameter set.

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

Table 7 Full parameter set.

Code	Name	Range	Resolution	Default	User	S	M
Group 99 START-UP DATA							
9901	LANGUAGE	0 - 12	1	0 (ENGLISH (UK))			
9902	APPLIC MACRO	0 - 7	1	0 (FACTORY)		✓	
9905	MOTOR NOM VOLT	200, 208, 220, 230, 240, 380, 400, 415, 440, 460, 480 V	-	*		✓	✓
9906	MOTOR NOM CURR	$0.5*I_N$ - $1.5*I_N$	0.1 A	$1.0*I_N$		✓	
9907	MOTOR NOM FREQ	0 - 250 Hz	1 Hz	*		✓	✓
9908	MOTOR NOM SPEED	0 - 3600 rpm	1 rpm	*		✓	✓
9909	MOTOR NOM POWER	1 - 100	1 kW	1 kW		✓	
9910	MOTOR COS PHI	0.50 - 0.99	0.01	0.83		✓	
Group 01 OPERATING DATA							
0102	SPEED	0 - 9999 rpm	1 rpm	-			
0103	OUTPUT FREQ	0 - 250 Hz	0.1 Hz	-			
0104	CURRENT	-	0.1 A	-			
0105	TORQUE	-	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 - 150 °C	0.1 °C	-			
0111	EXTERNAL REF 1	0 - 250 Hz	0.1 Hz	-			
0112	EXTERNAL REF 2	0 - 100 %	0.1 %	-			
0113	CTRL LOCATION	0 - 2	1	-			
0114	RUN TIME (R)	0.00 - 9999 kh	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	1	-			
0118	AI1	0 - 100 %	0.1 %	-			
0119	AI2	0 - 100 %	0.1 %	-			
0121	DI5 & RELAYS	0000 - 0111	1	-			
0122	AO	0 - 20 mA	0.1 mA	-			
0124	ACTUAL VALUE 1	0 - 100 %	0.1 %	-			
0125	ACTUAL VALUE 2	0 - 100 %	0.1 %	-			
0126	CONTROL DEV	-100 - 100 %	0.1 %	-			
0127	PID ACTUAL VALUE	0 - 100 %	0.1 %				

Code	Name	Range	Resolution	Default	User	S	M
0128	LAST FAULT	0 - 26	1	0			
0129	PREVIOUS FAULT	0 - 26	1	0			
0130	OLDEST FAULT	0 - 26	1	0			
0131	SERIAL LINK DATA 1	0 - 255	1				
0132	SERIAL LINK DATA 2	0 - 255	1				
0133	SERIAL LINK DATA 3	0 - 255	1				
0134	PROCESS VAR 1	0 - 65535 or -32768 - 32767	1				
0135	PROCESS VAR 2	0 - 65535 or -32768 - 32767	1				
0136	RUN TIME	0.00 - 99.99 kh	0.01 kh				
0137	MWh COUNTER	0.0 - 999.9 MWh	0.1 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 - 10	1	*		✓	✓
1103	EXT REF1 SELECT	0 - 10	1	*		✓	✓
1104	EXT REF1 MIN	0 - 250 Hz	1 Hz	0 Hz			
1105	EXT REF1 MAX	0 - 250 Hz	1 Hz	*			✓
1106	EXT REF2 SELECT	0 - 10	1	*		✓	✓
1107	EXT REF2 MIN	0 - 100 %	1 %	0 %			
1108	EXT REF2 MAX	0 - 500 %	1 %	100 %			
Group 12 CONSTANT SPEEDS							
1201	CONST SPEED SEL	0 - 10	1	*		✓	✓
1202	CONST speed 1	0 - 250 Hz	0.1 Hz	5 Hz			
1203	CONST speed 2	0 - 250 Hz	0.1 Hz	10 Hz			
1204	CONST speed 3	0 - 250 Hz	0.1 Hz	15 Hz			
1205	CONST speed 4	0 - 250 Hz	0.1 Hz	20 Hz			
1206	CONST speed 5	0 - 250 Hz	0.1 Hz	25 Hz			
1207	CONST speed 6	0 - 250 Hz	0.1 Hz	40 Hz			
1208	CONST speed 7	0 - 250 Hz	0.1 Hz	50 Hz			
Group 13 ANALOG INPUTS							
1301	MINIMUM AI1	0 - 100 %	1 %	0 %			
1302	MAXIMUM AI1	0 - 100 %	1 %	100 %			
1303	FILTER AI1	0 - 10 s	0.1 s	0.1 s			
1304	MINIMUM AI2	0 - 100 %	1 %	0 %			
1305	MAXIMUM AI2	0 - 100 %	1 %	100 %			

Code	Name	Range	Resolution	Default	User	S	M
1306	FILTER AI2	0 - 10 s	0.1 s	0.1 s			
Group 14 RELAY OUTPUTS							
1401	RELAY OUTPUT 1	0 - 27	1	3 (FAULT (-1))			
1402	RELAY OUTPUT 2	0 - 27	1	2 (RUN)			
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)			
Group 20 LIMITS							
2003	MAX CURRENT	$0.5*I_N$ - $1.66*I_N$	0.1 A	$1.5*I_N$			
2005	OVERVOLT CTRL	0 - 1	1	1 (ENABLE)			
2006	UNDERVOLT CTRL	0 - 2	1	1 (ENABLE TIME)			
2007	MINIMUM FREQ	0 - 250 Hz	1 Hz	0 Hz			
2008	MAXIMUM FREQ	0 - 250 Hz	1 Hz	*		✓	✓
Group 21 START/STOP							
2101	START FUNCTION	1 - 4	1	1 (RAMP)		✓	
2102	STOP FUNCTION	1 - 2	1	1 (COAST)			
2103	TORQ BOOST CURR	$0.5*I_N$ - $1.8*I_N$	0.1 A	$1.2*I_N$		✓	
2104	STOP DC INJ TIME	0 - 250 s	0.1; 1 s	0 s			
2105	PREMAGN SEL	0 - 6	1	*		✓	✓
2106	PREMAGN MAX TIME	0.0 - 25.0 s	0.1 s	2.0 s			
2107	START INHIBIT	0 - 1	1	1 (ON)			

Code	Name	Range	Resolution	Default	User	S	M
Group 22 ACCEL/DECEL							
2201	ACC/DEC 1/2 SEL	0 - 5	1	*		✓	✓
2202	ACCELER TIME 1	0.1 - 1800 s	0.1; 1 s	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 - 30 V	1	10 V		✓	
2604	IR COMP RANGE	0 - 250 Hz	1 Hz	50 Hz		✓	
2605	LOW NOISE	0 - 1	1	0 (OFF)		✓	
2606	V/f RATIO	1 - 2	1	1 (LINEAR)		✓	
2606	SLIP COMPENSATION	0-150%	1	0%			
Group 30 FAULT FUNCTIONS							
3001	AI<MIN FUNCTION	0 - 3	1	1 (FAULT)			
3002	PANEL LOSS	1 - 3	1	1 (FAULT)			
3003	EXTERNAL FAULT	0 - 5	1	0 (NOT SEL)			
3004	MOT THERM PROT	0 - 2	1	1 (FAULT)			
3005	MOT THERM TIME	256 - 9999 s	1 s	500 s			
3006	MOT LOAD CURVE	50 - 150 %	1 %	100 %			
3007	ZERO SPEED LOAD	25 - 150 %	1 %	70 %			
3008	BREAK POINT	1 - 250 Hz	1 Hz	35 Hz			
3009	STALL FUNCTION	0 - 2	1	0 (NOT SEL)			
3010	STALL CURRENT	$0.5*I_N$ - $1.66*I_N$	0.1 A	$1.2* I_N$			
3011	STALL FREQ HI	0.5 - 50 Hz	0.1 Hz	20 Hz			
3012	STALL TIME	10...400 s	1 s	20 s			
3013	UNDERLOAD FUNC	0 - 2	1	0 (NOT SEL)			
3014	UNDERLOAD TIME	10...400 s	1 s	20 s			
3015	UNDERLOAD CURVE	1 - 5	1	1			

Code	Name	Range	Resolution	Default	User	S	M
Group 31 AUTOMATIC RESET							
3101	NR OF TRIALS	0 - 5	1	0			
3102	TRIAL TIME	1.0 - 180.0 s	0.1 s	30 s			
3103	DELAY TIME	0.0 - 3.0 s	0.1 s	0 s			
3104	AR OVERCURRENT	0 - 1	1	0 (DISABLE)			
3105	AR OVERVOLTAGE	0 - 1	1	0 (DISABLE)			
3106	AR UNDERVOLTAGE	0 - 1	1	0 (DISABLE)			
3107	AR AI<MIN	0 - 1	1	0 (DISABLE)			
Group 32 SUPERVISION							
3201	SUPERV 1 PARAM	102 - 137	1	103			
3202	SUPERV 1 LIM LO	0 - 65535	-	0			
3203	SUPERV 1 LIM HI	0 - 65535	-	0			
3204	SUPERV 2 PARAM	102 - 137	1	103			
3205	SUPERV 2 LIM LO	0 - 65535	-	0			
3206	SUPERV 2 LIM HI	0 - 65535	-	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			
34011	P VAR 2 UNIT	0 - 31	1	3 (Hz)			

Code	Name	Range	Resolution	Default	User	S	M
Group 40 PID-CONTROL							
4001	PID GAIN	0.1 - 100	0.1	1.0			
4002	PID INTEG TIME	0.1 - 320 s	0.1 s	60 s			
4003	PID DERIV TIME	0 - 10 s	0.1 s	0 s			
4004	PID DERIV FILTER	0 - 10 s	0.1 s	1 s			
4005	ERROR VALUE INV	0 - 1	1	0 (NO)			
4006	ACTUAL VAL SEL	1 - 9	1	1 (ACT1)		✓	
4007	ACT1 INPUT SEL	1 - 2	1	2 (AI2)		✓	
4008	ACT2 INPUT SEL	1 - 2	1	2 (AI2)		✓	
4009	ACT1 MINIMUM	0 - 1000 %	1 %	0 %			
4010	ACT1 MAXIMUM	0 - 1000 %	1 %	100 %			
4011	ACT2 MINIMUM	0 - 1000 %	1 %	0 %			
4012	ACT2 MAXIMUM	0 - 1000 %	1 %	100 %			
4013	PID SLEEP DELAY	0.0 - 3600 s	0.1; 1 s	60 s			
4014	PID SLEEP LEVEL	0.0 - 120 Hz	0.1 Hz	0 Hz			
4015	WAKE-UP LEVEL	0.0 - 100 %	0.1 %	0 %			
Group 50 COMMUNICATION							
5001	DDCS BIT RATE	1, 2, 4, 8	-	1		✓	
5002	DDCS NODE NR	1 - 254	1	1		✓	
5003	COMM FAULT TIME	0.1 - 60 s	0.1 s	1 s			
5004	COMM FAULT FUNC	0 - 3	1	0 (NOT SEL)			
5005	PROTOCOL SEL	0 - 3	1	0 (NOT SEL)		✓	
5006	COMM COMMANDS	0 - 2	1	0 (NOT SEL)		✓	
Group 51 EXT COMM MODULE							
5101-5115	FIELDBUSPAR1 - 15	-	-	-			
Group 52 STANDARD MODBUS							
5201	STATION ID	1 - 247	1	1			
5202	COM 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 99: Start-up Data

Note! Start-up Data parameters are used for setting up the ACS 400.

Code	Description
9901	**LANGUAGE** Language selection for ACS-PAN-A control panel. 0 = ENGLISH (UK) 3 = ITALIAN 6 = DUTCH 9 = FINNISH 12 = (reserved) 1= ENGLISH (US) 4 = SPANISH 7 = FRENCH 10 = SWEDISH 2 = GERMAN 5 = PORTUGUESE 8 = DANISH 11 = RUSSIAN **Note! The ACS-100 PAN does not support Language selection.**
9902	**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”, starting page 41, for a list and description of available Application Macros. 0 = FACTORY 2 = 3-WIRE 4 = MOTOR POT 6 = PID CONTROL 1= ABB STANDARD 3 = ALTERNATE 5 = HAND/AUTO 7 = PREMAGN
9905	**MOTOR NOM VOLT** Nominal motor voltage from motor nameplate. This parameter sets the maximum output voltage supplied to motor by 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 voltage. See Figure 20.
9906	**MOTOR NOM CURR** Nominal motor current from nameplate. The allowed range is $0.5 \cdot I_N$ ... $1.5 \cdot I_N$ of ACS 400.
9907	**MOTOR NOM FREQ** Nominal motor frequency from nameplate (field weakening point). See Figure 20.
9908	**MOTOR NOM SPEED** Nominal motor speed from nameplate.
9909	**MOTOR NOM POWER** Nominal motor power from nameplate.
9910	**MOTOR COS PHI** Nominal motor cos phi from nameplate.

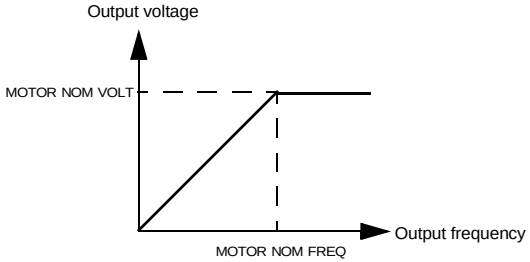
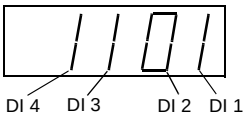
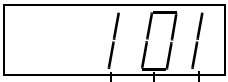


Figure 20 Output voltage as a function of output frequency.

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. (The same value that is shown by the OUTPUT display mode.)
0105	**TORQUE** Output torque. Calculated value of torque on 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 centigrade.
0111	**EXT REF 1** The value of external reference 1 in Hz.
0112	**EXT 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", starting page 115, for description of different control locations.
0114	**RUN TIME (R)** Shows the total run time of the ACS 400 in thousands of hours. Can be reset by pressing UP and DOWN buttons simultaneously when in parameter set mode.
0115	**kWh COUNTER (R)** Shows the ACS 400 operating hours. Can be reset by pressing UP and DOWN buttons simultaneously when in parameter set mode.
0116	**APPL BLK OUTPUT** The reference value in per cent received from the application block (PID control block). This value has significance only when the PID Control macro is used.
0117	**DI1-DI4 STATUS** Status of the four digital inputs. Status is displayed as 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 000001101BIN

Code	Description
0118	**AI1** Relative value of analog Input 1 displayed in %.
0119	**AI2** Relative value of analog input 2 displayed in %.
0121	**DI5 & RELAYS** Status of digital input 5 and relay outputs. 1 indicates that the relay is energized and 0 indicates that the relay is de-energized. ACS100-PAN  ACS-PAN 000000101BIN DI 5 Relay 2 status Relay 1 status
0122	**AO** Value of analog output signal in milliamperes.
0124	**ACTUAL VALUE 1** PID Controller actual value 1 (ACT1), displayed in per cent.
0125	**ACTUAL VALUE 2** PID Controller actual value 2 (ACT2), displayed in per cent.
0126	**CONTROL DEV** Displays the difference between the reference value and the actual value of the PID process controller.
0127	**PID ACTUAL VALUE** Feedback signal for PID controller.
0128	**LAST FAULT** Last recorded fault (0=no fault). See “Diagnostics”, starting 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”, starting 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”, starting page 35. Can be cleared with the control panel by pressing UP and DOWN buttons simultaneously when in parameter set mode.
0131	**SERIAL LINK DATA 1** Free data location that can be written from serial link.
0132	**SERIAL LINK DATA 2** Free data location that can be written from serial link.
0133	**SERIAL LINK DATA 3** Free data location that can be written from serial link.
0134	**PROCESS VAR 1** Process variable 1, as selected by parameters in group 34.
0135	**PROCESS VAR 2** Process variable 2, as selected by 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”, starting page 115.

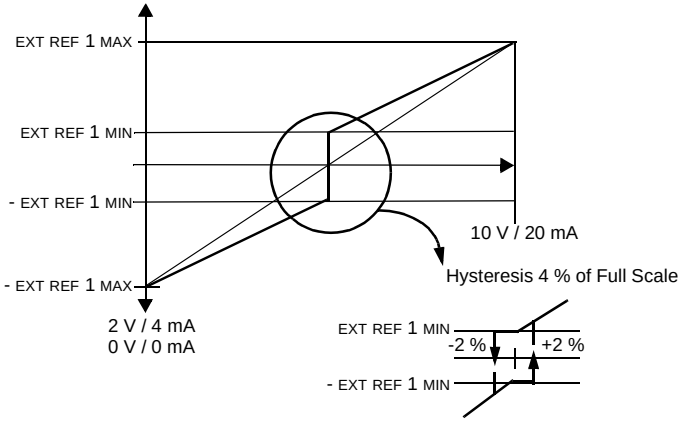
Code	Description
1001	**EXT1 COMMANDS** Defines the connections and the source of Start/Stop/Direction commands for External control location 1 (EXT1). 0 = NOT SEL No Start/Stop/Direction command source for EXT1 is selected. 1 = DI1 Two-wire Start/Stop connected to digital input DI1. DI1 deactivated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

1002	**EXT2 COMMANDS** Defines the connections and the source of Start, Stop and Direction commands for external control location 2 (EXT2). Refer to parameter 1001 EXT1 COMMANDS above.
1003	**DIRECTION** 1 = FORWARD 2 = REVERSE 3 = REQUEST Rotation direction lock. This parameter allows you to fix the 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.

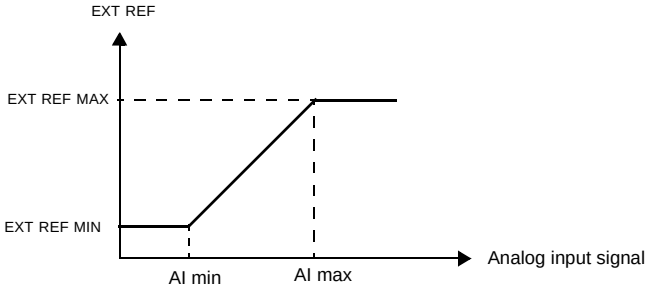
Group 11: Reference Select

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”, starting page 115.

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

1103	**EXT REF1 SELECT** This parameter selects the signal source of external reference 1. 0 = KEYPAD Reference is given from the control panel. 1 = AI 1 Reference is given through analog input 1. 2 = AI 2 Reference is given through analog input 2. 3 = AI1/JOYST; 4 = AI2/JOYST Reference is given through analog input 1 (or 2 accordingly) configured for a joystick. The minimum input signal runs the drive at maximum reference in the reverse direction. The maximum input signal runs the drive at maximum reference in the forward direction (See Figure 21). 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 1301 MINIMUM AI1 to a value 0.3 V or higher, and parameter 3001 AI<MIN FUNCTION to 1 (FAULT), and the ACS 400 will stop in case the control signal is lost.  *Figure 21 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 , see chapter “Standard Serial Communication” on page 95.

1104	**EXT REF1 MIN** Sets the minimum frequency reference for external reference 1 in Hz. When analog input signal is at minimum, external reference 1 equals to EXT REF1 MIN. See Figure 22 on page 65.
1105	**EXT REF1 MAX** Sets the maximum frequency reference for external reference 1 in Hz. When analog input signal is at maximum, external reference 1 equals to EXT REF1 MAX. See Figure 22 on page 65.
1106	**EXT REF2 SELECT** This parameter selects the signal source for external reference 2. The alternatives are the same as with external reference 1.
1107	**EXT REF2 MIN** Sets the minimum reference in %. When analog input signal is at minimum value external reference 2 equals to EXT REF2 MIN. See Figure 22. • If the PID Control macro is selected, this parameter sets the minimum process reference. • If any other macro than PID is selected, this parameter sets the minimum frequency reference. This value is given as a percentage of the maximum frequency.
1108	**EXT REF2 MAX** Sets the maximum reference in %. When analog input signal is at maximum, external reference 2 equals to EXT REF2 MAX. See Figure 22. • If the PID Control macro is selected, this parameter sets the maximum process reference. • If any other macro than PID Control is selected, this parameter sets the maximum frequency reference. This value is given as percentage of maximum frequency.



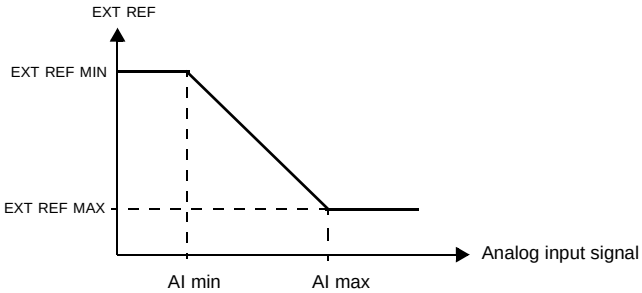


Figure 22 Setting EXT REF MINIMUM and EXT REF MAXIMUM. The range of the analog input signal is set by parameters 1301 and 1302 or parameters 1304 and 1305, depending on the analog input used.

Example: For 4 to 20 mA input, set 1301 = 20% and 1302 = 100%.

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 drive is in local mode or if the process PID reference is followed (see PID Control Macro).

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

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

0 = NOT SEL
Constant speed function disabled.

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

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

Table 8 Constant Speed selection with digital inputs DI1,2.
<table>
<tr><th>DI 1</th><th>DI 2</th><th>Function</th></tr>
<tr><td>0</td><td>0</td><td>No constant speed</td></tr>
<tr><td>1</td><td>0</td><td>Constant speed 1 (1202)</td></tr>
<tr><td>0</td><td>1</td><td>Constant speed 2 (1203)</td></tr>
<tr><td>1</td><td>1</td><td>Constant speed 3 (1204)</td></tr>
</table>
0 = DI deactivated, 1 = DI activated

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

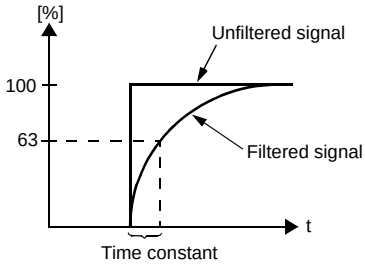
8 = DI4,5
Three Constant Speeds (1 ... 3) are selected with two digital inputs as in DI1,2.

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

Table 9 Constant Speed selection with digital inputs DI1,2,3.
<table>
<tr><th>DI 1</th><th>DI 2</th><th>DI 3</th><th>Function</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>No constant speed</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>Constant speed 1 (1202)</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>Constant speed 2 (1203)</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>Constant speed 3 (1204)</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>Constant speed 4 (1205)</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>Constant speed 5 (1206)</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>Constant speed 6 (1207)</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>Constant speed 7 (1208)</td></tr>
</table>
0 = DI deactivated, 1 = DI activated

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

Group 13: Analog Inputs

Code	Description
1301	**MINIMUM AI1** Relative minimum value of AI1 (%). Value corresponds to minimum reference set by parameter 1104 EXT REF1 MIN or 1107 EXT REF2 MIN. See Figure 22 on page 65.
1302	**MAXIMUM AI1** Maximum value of AI1 (%). Value corresponds to maximum reference set by parameter 1105 EXT REF1 MAX or 1108 EXT REF2 MAX. See Figure 22 on page 65.
1303	**FILTER AI1** Filter time constant for analog input AI1. As the analog input value changes, 63 % of the change takes place within the time specified by this parameter. **Note! If you select 0 s for the filter time constant, the signal is still filtered with a time constant of 25 ms due to the signal interface hardware. This cannot be changed by any parameters!**.  *Figure 23 Filter time constant for analog input AI1.*
1304	**MINIMUM AI2** Minimum value of AI2 (%). Value corresponds to minimum reference set by parameter 1104 EXT REF1 MIN or 1107 EXT REF2 MIN.
1305	**MAXIMUM AI2** Maximum value of AI2 (%). Value corresponds to maximum reference set by parameter 1105 EXT REF1 MAX or 1108 EXT REF2 MAX.
1306	**FILTER AI2** Filter time constant for AI2. Refer to parameter 1303 FILTER AI1.

Group 14: Relay Outputs

Code	Description
1401	**RELAY OUTPUT 1** Relay output 1 content. Selects which information is indicated with relay output 1. 0 = NOT SEL Relay is not used and is de-energized. 1 = READY The 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. 2 = RUN Relay energized when the ACS 400 is running. 3 = FAULT (-1) Relay energized when power is applied, and de-energized upon a fault trip. 4 = FAULT Relay energized when a fault is active. 5 = ALARM Relay energized when an alarm is active, except AL1-AL7, AL15 and AL 27-AL28. 6 = REVERSED Relay energized when motor rotates in reverse direction. 7 = SUPRV1 OVER Relay energized when first supervised parameter (3201) exceeds the limit (3203). See “Group 32: Supervision”, starting page 82. 8 = SUPRV1 UNDER Relay energized when first supervised parameter (3201) drops below the limit (3202). See “Group 32: Supervision”, starting page 82. 9 = SUPRV2 OVER Relay energized when second supervised parameter (3204) exceeds the limit (3206). See “Group 32: Supervision”, starting page 82. 10 = SUPRV2 UNDER Relay energized when second supervised parameter (3204) drops below the limit (3205). See “Group 32: Supervision”, starting page 82. 11 = AT SET POINT Relay energized when output frequency is equal to reference frequency. 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). 13 = FLT/ALARM Relay is energized if any fault or alarm occurs, except AL1-AL7, AL15 and AL 27-AL28. 14 = EXT CONTROL Relay is energized if external control is selected. 15 = REF 2 SEL Relay is energized if EXT2 is selected. 16 = CONST FREQ Relay is energized when a constant speed is selected. 17 = REF LOSS Relay is energized when reference or active control place is lost. 18 = OVERCURRENT Relay is energized when overcurrent alarm or fault appears. 19 = OVERVOLTAGE Relay is energized when overvoltage alarm or fault appears. 20 = ACS400 TEMP Relay is energized when ACS 400 overtemperature alarm or fault exists.

Parameter 1401 continues on the next page.

Code	Description
	21 = ACS OVERLOAD Relay is energized when ACS 400 overload alarm or fault exists. 22 = UNDERVOLTAGE Relay is energized when undervoltage alarm or fault exists. 23 = AI1 LOSS Relay is energized when AI1 signal is lost. 24 = AI2 LOSS Relay is energized when AI2 signal is lost. 25 = MOT OVER TEMP Relay is energized when motor overtemperature alarm or fault exists. 26 = STALL Relay is energized when stall alarm or fault exists. 27 = UNDERLOAD Relay is energized when underload alarm or fault exists. 28 = PID SLEEP Relay is energized when the drive is stopped by the PID sleep function.
1402	**RELAY OUTPUT 2** Relay output 2 content. Refer to parameter 1401 RELAY OUTPUT 1.
1403	**RELAY 1 ON DELAY** Switch-on delay for relay 1.
1404	**RELAY 1 OFF DELAY** Switch-off delay for relay 1
1405	**RELAY 2 ON DELAY** Switch-on delay for relay 2.
1406	**RELAY 2 OFF DELAY** Switch-off delay for relay 2.

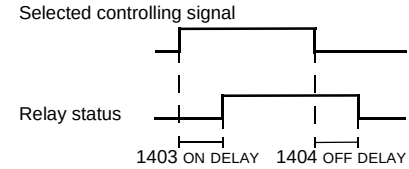


Figure 24

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.

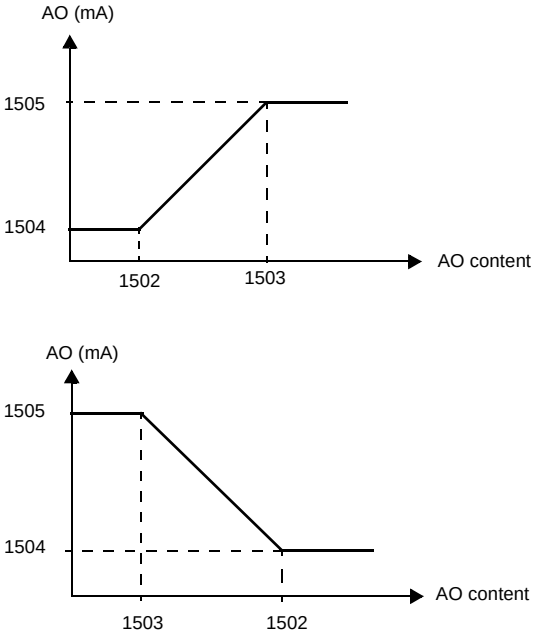


Figure 25 Analog output scaling.

Group 16: System Controls

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

Group 20: Limits

Code	Description
2003	**MAX CURRENT** Maximum output current. The maximum output current that the ACS 400 will supply to the motor. The default value is 1.5 * I_N .
2005	**OVERVOLT CTRL** DC overvoltage controller enable. Fast braking of a high inertia load causes the DC bus voltage to rise to the overvoltage control limit. To prevent the DC voltage from exceeding the limit, the overvoltage controller automatically decreases the braking torque. **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. 0 = DISABLE 1 = ENABLE
2006	**UNDERVOLT CTRL** DC undervoltage controller enable. If the DC bus voltage drops due to loss of input power, the undervoltage controller will decrease the motor speed in order to keep the DC bus voltage above the lower limit. By decreasing the motor speed, 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. 0 = DISABLE 1 = ENABLE (TIME) Enable with 500 ms time limit for operation. 2 = ENABLE Enable without time limit for operation.
2007	**MINIMUM FREQ** Operating range minimum output frequency. **Note! Keep MINIMUM FREQ ≤ MAXIMUM FREQ.**
2008	**MAXIMUM FREQ** Operating range maximum output frequency.

Group 21: Start/Stop

The ACS 400 supports several start and stop modes, including flying start and torque boost at start. DC current can be injected either before the start command (PREMAGN SEL = DI1...DI5) or right after the start command (PREMAGN SEL = CONST).

DC hold can be used when stopping the drive in ramp mode. If stopping by coast mode is selected, DC braking can be used.

Code	Description
2101	**START FUNCTION** Conditions during motor acceleration. 1 = RAMP Ramp acceleration as defined by the active acceleration time 2202 ACCELER Time1 or 2204 ACCELER Time2. 2 = FLYING START Flying start. Use this setting if the motor is already rotating and the drive will start smoothly at the present frequency. **Note! Flying Start may cause an under-rated motor to ramp through its speed range.** 3 = TORQUE BOOST Automatic torque boost might be necessary for loads with high starting torque. Torque boost is only applied at start. Boost is stopped when output frequency exceeds 20 Hz or when output frequency is equal to reference. See also parameter 2103 TORQ BOOST CURR. 4 = FLY + BOOST Activates both the flying start and torque boost.
2102	**STOP FUNCTION** Conditions during motor deceleration. 1 = COAST Motor coasts to stop. 2 = RAMP Ramp deceleration as defined by the active deceleration time 2203 DECELER TIME 1 or 2205 DECELER TIME 2.
2103	**TORQ BOOST CURR** Maximum supplied current during torque boost. See parameter 2101 START FUNCTION.
2104	**STOP DC INJ TIME** DC injection time after modulation has stopped. If 2102 STOP FUNCTION is 1 (COAST), ACS 400 uses DC braking. If 2102 STOP FUNCTION is 2 (RAMP), ACS 400 uses DC hold after ramp. **Note! Excessive DC injection time may cause the motor to overheat.**
2105	**PREMAGN SEL** Options 1- 5 select source for premagnetizing command. Option 6 selects start with DC hold. 0 = NOT SEL Premagnetizing not used. 1...5 = DI1...DI5 Premagnetizing command is received through a digital input. 6 = CONST Constant premagnetizing time after start command. Time is defined by parameter 2106 PREMAGN MAX TIME.
2106	**PREMAGN MAX TIME** Maximum premagnetizing time.
2107	**START INHIBIT** Start inhibit control. Start inhibit means a pending start command is ignored when fault is reset or mode change takes place. Mode changes are from local to remote or from EXT1 to EXT2 or vice versa. 0 = OFF Start inhibit control disabled. Drive will start after fault is reset or mode is changed if there is a pending start command. 1 = ON Start inhibit control enabled. Drive will not start after fault is reset or mode changed.

Group 22: Accel/Decel

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

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

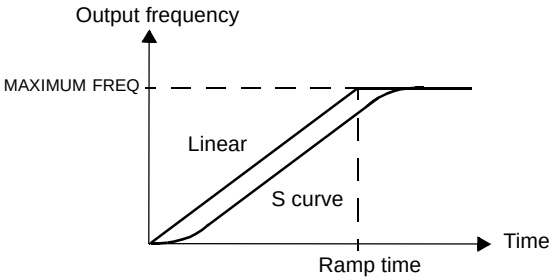


Figure 26 Definition of acceleration/deceleration ramp time.

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 occur.**
2503	**CRIT FREQ 1 HI** Critical frequency 1 end.
2504	**CRIT FREQ 2 LO** Critical frequency 2 start. **Note! If LOW > HI, no critical frequency lock-out will occur.**
2505	**CRIT FREQ 2 HI** Critical frequency 2 end.

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

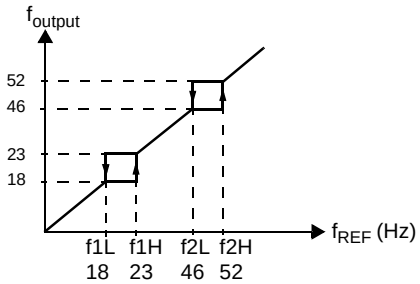


Figure 27 Example of critical frequencies setting in a fan system with bad vibrations at frequency ranges 18 Hz to 23 Hz and 46 Hz to 52 Hz.

Group 26: Motor Control

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>2603</td><td>IR COMPENSATION
IR compensation voltage at 0 Hz.
Note! IR compensation should be kept as low as possible to prevent overheating. Refer to Table 10.

Table 10 Typical IR compensation values.
<table><tr><th colspan="6">400 V Units</th></tr><tr><td>P_N / Hp</td><td>5</td><td>10</td><td>20</td><td>25</td><td>50</td></tr><tr><td>IR comp / V</td><td>21</td><td>18</td><td>15</td><td>12</td><td>10</td></tr></table></td></tr>
<tr><td>2604</td><td>IR COMP RANGE
IR compensation range. Defines frequency after which IR compensation is 0 V.</td></tr>
<tr><td>2605</td><td>LOW NOISE
Motor acoustical noise option

0 = OFF
standard (switching frequency 4 kHz).

1 = ON
Low noise (switching frequency 8 kHz).

Note! When the low noise setting is used, the maximum overload of the ACS 400 is I_2 at 30 °C ambient temperature or 0.9 * I_2 at 40 °C.</td></tr>
<tr><td>2606</td><td>V/f RATIO
V/f ratio below field weakening point.

1 = LINEAR
2 = SQUARE

Linear is used for constant torque applications and Square for centrifugal pump and fan applications. (Square is quieter for most operating frequencies.)</td></tr>
<tr><td>2607</td><td>SLIP COMP

Slip Compensation increases frequency slightly as motor load increases so that speed remains constant within 1/2%, even though slip increases from 0 to 3% as load increases from 0 to 100%. The amount of frequency boost is equal to the product of
$\left(9907\ \text{MOTOR NOM FREQ} - \frac{9908\ \text{MOTOR NOM SPEED} \times \text{MOTOR POLES}}{120}\right) \times \frac{0105\ \text{TORQUE}}{100} \times \frac{2607\ \text{SLIP COMP}}{100}$

Over compensation is possible by adjusting Parameter 2607 to greater than 100%.</td></tr>
</table>

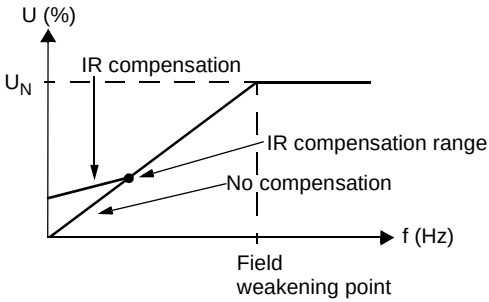


Figure 28 Operation of IR compensation

Group 30: Fault Functions

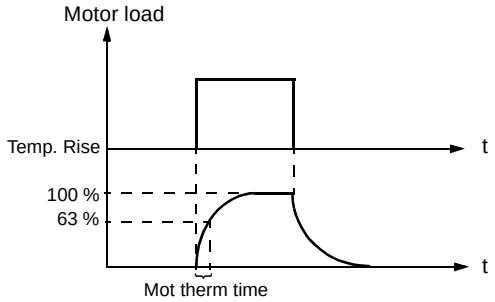
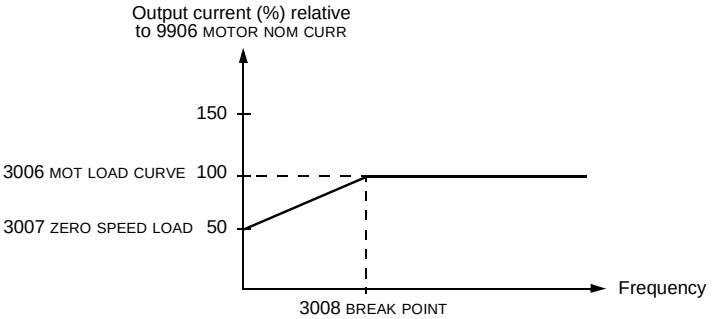
The ACS 400 can be configured to respond to certain abnormal external conditions: analog input fault, external fault signal and panel loss.

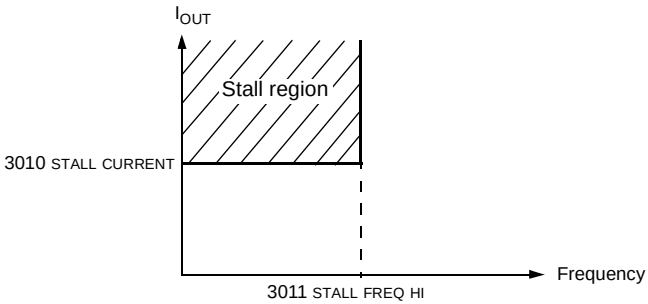
In these cases, the drive can either continue operation at current speed or at a set constant speed while showing an alarm, ignore the condition, or trip on a fault and stop.

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 an externally powered cooling fan.

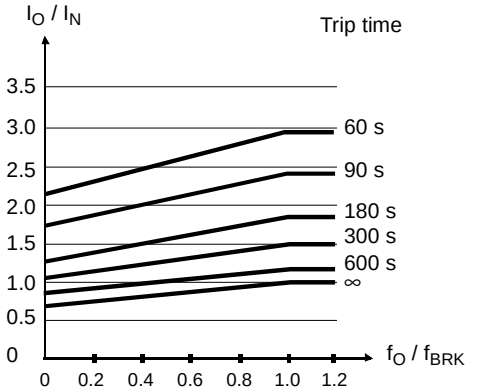
Stall protection (parameters 3009 - 3012) includes parameters for stall frequency, stall time and current.

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

Code	Description
3004	**MOT THERM PROT** Motor overtemperature function. This parameter defines the operation of the motor thermal protection function which protects the motor from overheating. 0 = NOT SEL 1 = FAULT Displays a warning indication at 95 % of the nominal value. Displays a fault indication when the motor temperature reaches 100 % level. The ACS 400 coasts to stop. 2 = WARNING A warning indication is displayed when the motor temperature reaches 95 % of the nominal value.
3005	**MOT THERM TIME** Time for 63 % temperature rise.This is the time within which the motor temperature reaches 63 % of the final temperature rise. Figure 29 shows motor thermal time definition. If thermal protection according to UL requirements for NEMA class motors is desired, use this rule of thumb - MOTOR THERM TIME equals 35 times t6 (t6 in seconds is the time that the motor can safely operate at six times its rated current, given by the motor manufacturer). The thermal time for a Class 10 trip curve is 350 s, for a Class 20 trip curve 700 s and for a Class 30 trip curve 1050 s.  *Figure 29 Motor thermal time.*
3006	**MOT LOAD CURVE** Motor current maximum limit. MOTOR LOAD CURVE sets the maximum allowable operating load of the motor. When set to 100 %, the maximum allowable load is equal to the value of Start-up Data parameter 9906 MOTOR NOM CURRENT. The load curve level should be adjusted if the ambient temperature differs from the nominal value.  *Figure 30 Motor load curve.*

Code	Description
3007	**ZERO SPEED LOAD** This parameter defines the maximum allowable current at zero speed relative to 9906 MOTOR NOM CURR. Refer to Figure 30.
3008	**BREAK POINT** Break point of motor load curve. Refer to Figure 30 for an example of a motor load curve. See Figure 32.
3009	**STALL FUNCTION** This parameter defines the operation of stall protection. The protection is activated if the output current becomes too high compared to output frequency, refer to Figure 31. 0 = NOT SEL Stall protection not used. 1 = FAULT When the protection is activated the ACS 400 coasts to stop. Fault indication is displayed. 2 = WARNING A warning indication is displayed. The indication disappears in half the time set by parameter 3012 STALL TIME.  *Figure 31 Motor stall protection.*
3010	**STALL CURRENT** Current limit for stall protection. Refer to Figure 31.
3011	**STALL FREQ HI** This parameter sets the frequency value for the stall function. Refer to Figure 31.
3012	**STALL TIME** This parameter sets the time value for the stall function.
3013	**UNDERLOAD FUNCTION** Removal of motor load may indicate a process malfunction. The protection is activated if: • The motor torque drops below the load curve selected by parameter 3015 UNDERLOAD CURVE. • This condition has lasted longer than the time set by parameter 3014 UNDERLOAD TIME. • Output frequency is higher than 10 % of the nominal frequency of the motor and higher than 5 Hz. 0 = NOT SEL Underload protection is not used. 1 = FAULT When the protection is activated the ACS 400 coasts to stop. Fault indication is displayed. 2 = WARNING A warning indication is displayed.
3014	**UNDERLOAD TIME** Time limit for underload protection.

Code	Description
3015	**UNDERLOAD CURVE** This parameter provides five selectable curves shown in Figure 33. If the load drops below the set curve for longer than the time set by parameter 3014, the underload protection is activated. Curves 1...3 reach maximum at the motor rated frequency set by parameter 9907 MOTOR NOM FREQ.



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

Figure 32 Thermal protection trip times when parameters 3005 MOT THERM TIME, 3006 MOT LOAD CURVE and 3007 ZERO SPEED LOAD have default values.

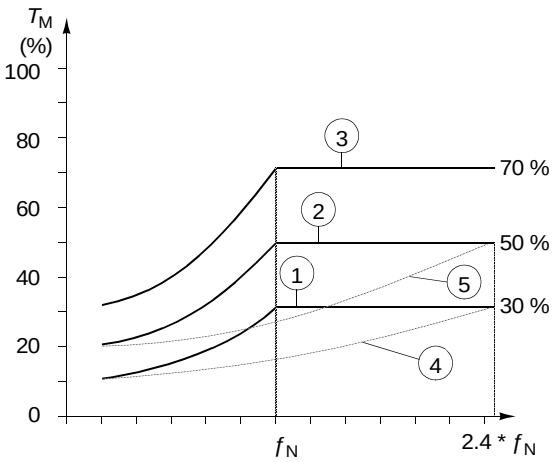


Figure 33 Underload curve types. T_M nominal torque of the motor, f_N nominal frequency of the motor.

Group 31: Automatic Reset

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

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

Code	Description
3101	**NR OF TRIALS** 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.

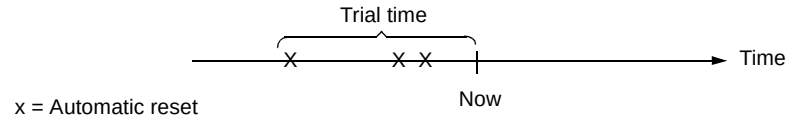
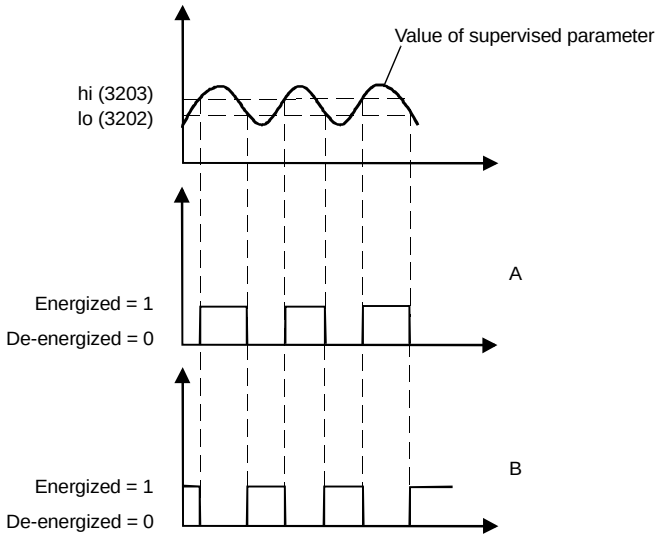


Figure 34 Operation of automatic reset function. In this example, if the fault occurs at the moment "Now", it is automatically reset if parameter 3101 NR OF TRIALS value is greater than or equal to 4.

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 within the Operating Data group (Group 1) can be supervised. Relays can be configured to be energized when the values of supervised parameters are either too low or too high.

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



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

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

Figure 35 Operating data supervision using relay outputs.

Group 33: Information

Code	Description
3301	**SW VERSION** Software version.
3302	**TEST DATE** Displays the test date of the ACS 400 (yy.ww).

Group 34: Process Variables

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

See example below.

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>3401</td><td>DISPLAY SEL
Selects displayed variable for the output display of the ACS-PAN control panel.

1 = STANDARD
Panel displays standard variables.

2 = PROCESS VAR
Panel displays process variables. See Figure 36.

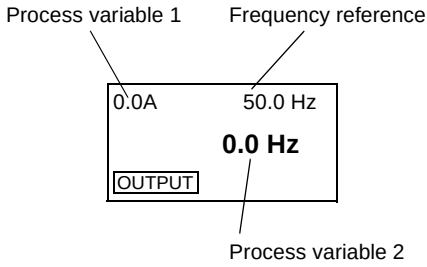
 

Figure 36 ACS-PAN output display when process variable display is selected.</td></tr>
<tr><td>3402</td><td>P VAR 1 SEL
Selection of process variable 1. Number of any parameter within Group 1 OPERATING DATA.</td></tr>
<tr><td>3403</td><td>P VAR 1 MULTIP
Process variable 1 multiplier.</td></tr>
<tr><td>3404</td><td>P VAR 1 DIVISOR
Process variable 1 divider.</td></tr>
<tr><td>3405</td><td>P VAR 1 SCALING
Decimal point location of process variable 1, when displayed. Refer to Figure 37.

<table><tr><th>Value</th><th>Display</th></tr><tr><td>0</td><td>125</td></tr><tr><td>1</td><td>12.5</td></tr><tr><td>2</td><td>1.25</td></tr><tr><td>3</td><td>0.125</td></tr></table>Figure 37 Display with different decimal point locations when calculated value is 125.</td></tr>
<tr><td>3406</td><td>P VAR 1 UNIT
Process variable unit.

0 = NO
1 = A
2 = V
3 = Hz
4 = %
5 = s
6 = h
7 = rpm
8 = kh
9 = C
10 = kHz
11 = mA
12 = mV
13 = kW
14 = W
15 = kWh
16 = F
17 = Hp
18 = MWh
19 = m/s
20 = m^3/s
21 = dm^3/s
22 = bar
23 = kPa
24 = gpm
25 = psi
26 = cFm
27 = ft
28 = Mgd
29 = inHg
30 = Cst2
31 = Fpm</td></tr>
</table>

Code	Description
3407	**P VAR 2 SEL** Selection of process variable 2. Number of any parameter within 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 of 0.1 m 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)

For a 2-pole motor, 1 Hz output equals 1 rev/s, equals PI * 0.1m/s line speed, or approximately 0.314 m/s, is:

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

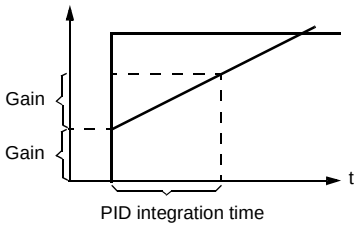
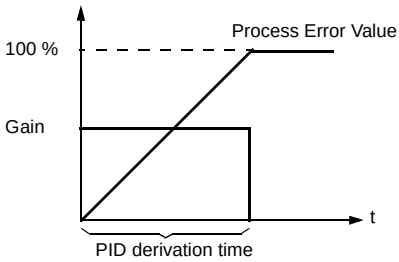
Select:

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

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

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. The control signal block diagram is show in figure 34 on page 118 of the Appendix.

Code	Description
4001	**PID GAIN** This parameter defines the gain of the PID Controller. The setting range is 0.1... 100. If you select 1, a 10 % change in error value causes the PID Controller output to change by 10 %. * Limited by parameter 2008 MAXIMUM FREQ.
4002	**PID INTEG TIME** PID controller integration time. Defined as the time in which the maximum output is achieved if a constant error value exists and the gain is 1. Integration time 1 s denotes that a 100 % change is achieved in 1 s. 
4003	**PID DERIV TIME** PID controller derivation time. If the process error value changes linearly, D part adds a constant value into the PID controller output. The derivative is filtered with a 1-pole filter. The time constant of the filter is defined by parameter 4004 PID DERIV FILTER. 
4004	**PID DERIV FILTER** Time constant for the filter of D part. By increasing the filter time constant it is possible to smooth the effect of the D part and suppress noise.
4005	**ERROR VALUE INV** Process error value inversion. Normally, a decrease in feedback signal causes an increase in drive speed. If a decrease in feedback signal is desired to cause a decrease in speed, set ERROR VALUE INV to 1 (YES). 0 = NO 1 = YES

Code	Description
4006	**ACTUAL VAL SEL** PID controller feedback (actual) signal selection. Feedback signal can be a combination of two actual values ACT1 and ACT2. Source for actual value 1 is selected by parameter 4007 and source for actual value 2 is selected by parameter 4008. 1 = ACT1 Actual value 1 is used as the feedback signal. 2 = ACT1-ACT2 Difference of actual values 1 and 2 is used as the feedback signal. 3 = ACT1+ACT2 Sum of actual values 1 and 2. 4 = ACT1*ACT2 Product of actual values 1 and 2. 5 = ACT1/ACT2 Quotient of actual values 1 and 2. 6 = MIN (A1, A2) Smaller of actual values 1 and 2. 7 = MAX (A1, A2) Greater of actual values 1 and 2. 8 = sq (A1-A2) Square root of difference of actual values 1 and 2. 9 = sqA1 + sqA2 Sum of square roots of actual values 1 and 2.
4007	**ACT1 INPUT SEL** Source for actual value 1 (ACT1). 1 = AI 1 Analog input 1 is used as actual value 1. 2 = AI 2 Analog input 2 is used as actual value 1.
4008	**ACT2 INPUT SEL** Source for actual value 2 (ACT2). 1 = AI 1 Analog input 1 is used as actual value 2. 2 = AI 2 Analog input 2 is used as actual value 2.

Code	Description
4009	**ACT1 MINIMUM** Minimum value for actual value 1 (ACT1). Refer to Figure 38 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 38 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.

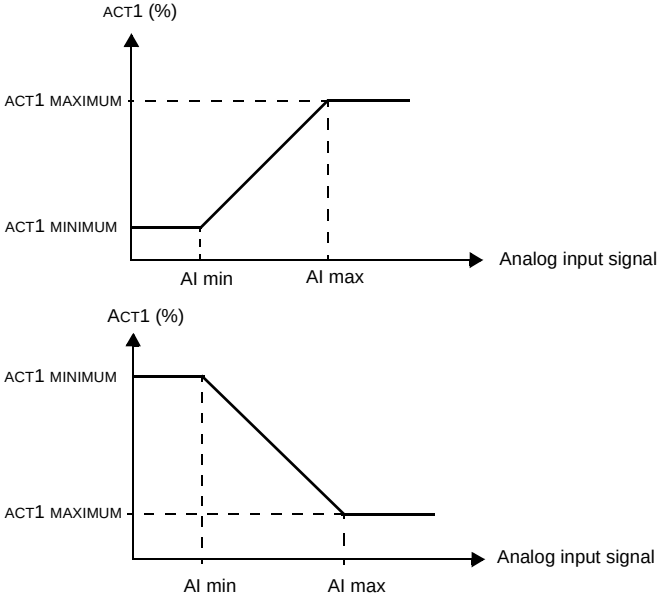


Figure 38 Actual value scaling. The range of the analog input signal is set by parameters 1301 and 1302 or parameters 1304 and 1305, depending on the analog input used.

Code	Description
4013	**PID SLEEP DELAY** Time delay for the sleep function, see Figure 39. If the ACS 400 output frequency is below a set level (parameter 4014 SLEEP LEVEL) longer than PID SLEEP DELAY, ACS 400 is stopped.
4014	**PID SLEEP LEVEL** Level for activation of sleep function, see Figure 39. 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.
4015	**WAKE-UP LEVEL** Level for deactivation of sleep function. This parameter sets a process actual value limit for the sleep function (see Figure 39). When the actual value falls below the limit, the sleep function is interrupted. Wake-up level = %Ref. x (Param 4015) / 100 **Note! Wake-up level comparison is also inverted when error value is inverted using parameter 4005 ERROR VALUE INV.**

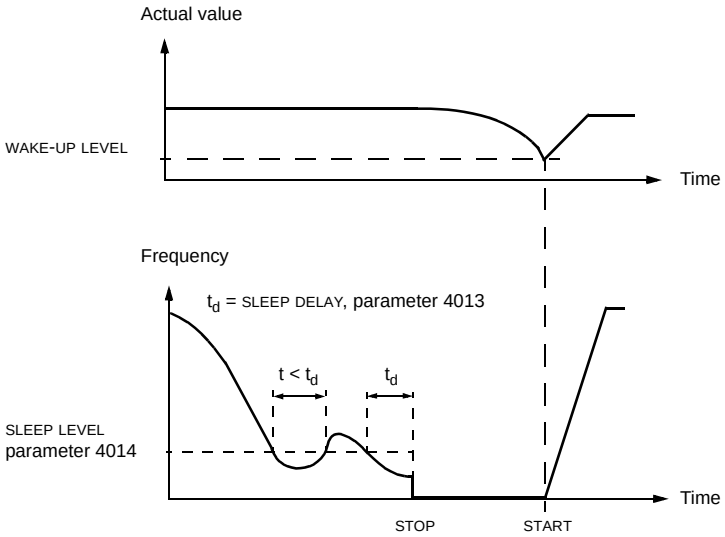


Figure 39 Sleep function.

Note! The proportional gain and integration time values are used to adjust the responsiveness of the system. A low value for proportional gain and a high value for integral time ensures stable operation, but provides sluggish response. Too large of a proportional gain value or too short of an integral time can cause the system to become unstable. To start, set Parameter 4001 PID Gain to 0.3. Set Parameter 4002 Integration Time to 20 seconds. Start the system and see if it reaches the set point quickly while maintaining stable operation. If not, increase PID Gain (4001) until the actual signal (or drive speed) oscillates constantly. It may be necessary to start and stop the drive to induce this oscillation. Reduce PID Gain (4001) until the oscillation stops. Set the value to 0.4 to 0.6 times this value. Decrease the Integration Time (4002) until the feedback signal (or drive speed) oscillates constantly. It may be necessary to start and stop the drive to induce this oscillation. Increase Integration Time (4002) until the oscillation stops. Set the value to 1.15 to 1.5 times this value. If the feedback signal contains high frequency noise, increase the value of Parameter 4004 Derivative Filter until the noise is filtered from the signal.

Group 50: Communication

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

Code	Description
5001	**DDCS BIT RATE** DDCS link baud rate in Mbits/s.
5002	**DDCS NODE NR** DDCS link node number.
5003	**COMM FAULT TIME** Communication time out delay. This applies both to standard Modbus and DDCS link.
5004	**COMM FAULT FUNC** Communication fault function. This applies both to standard Modbus and DDCS link. 0 = NOT SEL No operation. 1 = FAULT A fault indication is displayed and the ACS 400 coasts to stop. 2 = CONST SP 7 A warning indication is displayed and the speed is set according to parameter 1208 CONST SPEED7. 3 = LAST SPEED A warning indication is displayed and the speed is set to the level the ACS 400 was last operating at. This value is determined by the average speed over the last 10 seconds. **Caution:** If you select CONST SPEED 7 or LAST SPEED, make sure that it is safe to continue operation if communication is lost.
5005	**PROTOCOL SEL** Defines what communication protocols are used. Options 1 (DDCS) and 3 (STD MDB+DDCS) should be selected only if DDCS communication module is installed. 0 = NOT SEL No serial communication is active. 1 = DDCS DDCS serial communication is active. 2 = STD MODBUS Standard Modbus protocol is active. 3 = STD MDB+DDCS Both standard Modbus and DDCS are active.
5006	**COMM COMMANDS** This parameter controls 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. 0 = NOT SEL Controlling commands are not received via serial communication. 1 = STD MODBUS Controlling commands can be received through Channel 1 standard Modbus protocol. 2 = DDCS Controlling commands can be received through the DDCS link.

Group 51: Ext Comm Module

Parameters of this group need to be adjusted when a DDCS option module is installed. Refer to option module documentation for more information regarding these parameters.

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

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

Group 52: Standard Modbus

The ACS 400 can be connected to a Modbus fieldbus system. Parameters of this group are used to set up station number, communication speed and parity. Parameters 5206 - 5215 are diagnostic counters that can be used to debug the fieldbus system. Refer to “Standard Serial Communication” on page 95 for more information.

Code	Description
5201	**STATION ID** Sets the slave number for the ACS 400 in Modbus network. Range: 1 - 247 **Note! Modifications take effect only on the next power up.**
5202	**COM SPEED** Defines the communication speed of the ACS 400 in bits per second (bps). 3 = 300 bps 6 = 600 bps 12 = 1200 bps 24 = 2400 bps 48 = 4800 bps 96 = 9600 bps 192 = 19200 bps **Note! Modifications take effect only on the next power-up.**
5203	**PARITY** Defines the parity to be used with the Modbus communication. Parameter also defines the number of stop bits. With Modbus communication, the number of stop bits is 2 with no parity bit, and 1 with even or odd parity. 0 = NONE 1 = EVEN 2 = ODD **Note! Modifications take effect only on the next power-up.**
5206	**BAD MESSAGES** This diagnostics counter increases by one every time the ACS 400 finds any kind of communication error. During normal operation, this counter hardly ever increases.
5207	**GOOD MESSAGES** This diagnostics counter increases by one every time a valid Modbus message has been received by the ACS 140. During normal operation, this counter is increasing constantly.
5208	**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 is received and cannot be placed in the buffer.
5209	**FRAME ERRORS** This diagnostic counter increases by one every time when a character with a framing error is received from the bus. • Communication speed settings of the devices connected in the bus differ. • Ambient noise levels may be too high.
5210	**PARITY ERRORS** This diagnostic counter increases by one every time when a character with a parity error is received from the bus. • Parity settings of the devices connected in the bus differ. • Ambient noise levels may be too high.

Code	Description
5211	**CRC ERRORS** This diagnostic counter increases by one every time when a message with a CRC error is received. • Ambient noise levels may be too high. • CRC calculation is not performed correctly.
5212	**BUSY ERRORS** In Modbus network, only one device can transmit at any given time. 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.
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.

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 Drive*Window* PC tool.

Optional serial communication features

The ACS400 can also be connected to number of other fieldbuses using special fieldbus adapter modules. These adapters are connected using an optical DDCS link (DDCS=Distributed Drives Control System). For more information on these options, contact your local ABB sales office.

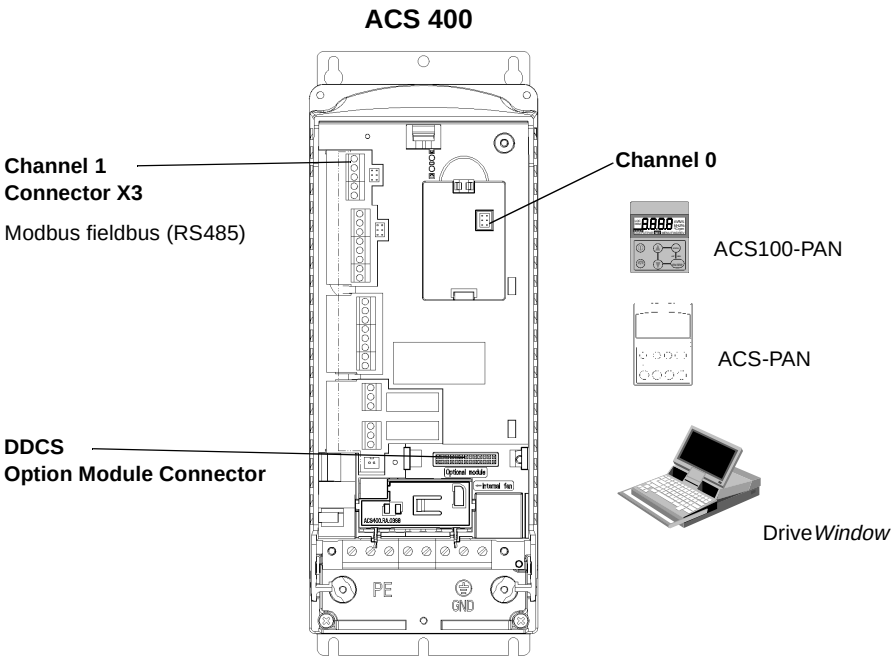


Figure 40 Standard serial communication features of the ACS 400.

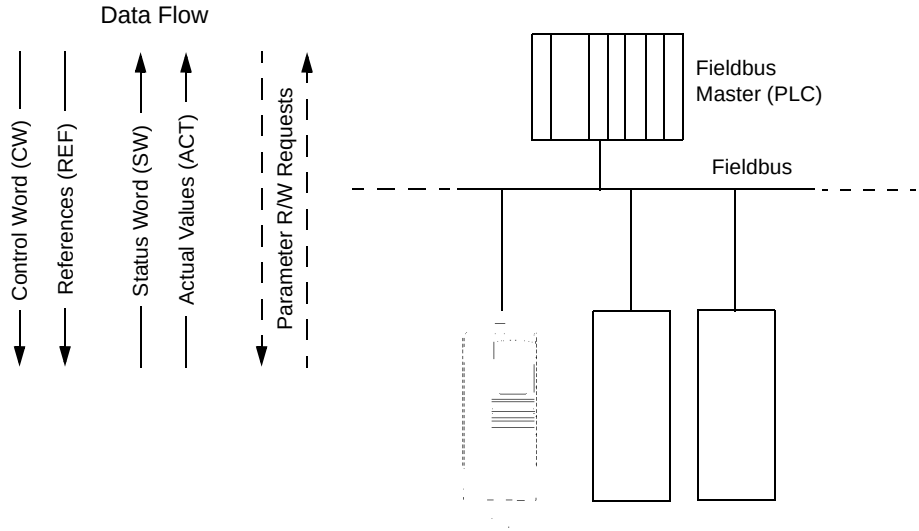


Figure 41 Structure of a fieldbus system.

Grounding and Termination

RS485 Bus

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

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

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

Termination should not be done on the intermediate stations. See Figure 42 for the proper method of termination.

Figure 42 Termination for the RS485 link.

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

Activating Modbus protocol

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

After this parameter change, the ACS400 is ready to communicate via Channel 1 using the default communication settings (given in Table 12), making parameter read and write possible.

The following sections describe how to configure the ACS400 for more sophisticated communication and control.

Table 12 Default communication settings of the Channel 1.

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

Communication settings

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

Default communication settings for Channel 1 are listed in Table 12. 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 parameters and their alternative settings is given in under “ACS 400 Complete Parameter List” on page 51.

Table 13 Communication parameters.

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

Control Locations

The 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. To accept control from serial communications, ACS 400 must be in remote control.

The necessary parameters and their usage are listed in Table 14. Before any control commands can be given through serial communication channel 1, parameter 5006 COMM COMMANDS value must be set to STD MODBUS.

Further information on all the parameters and their alternative settings can be found under “ACS 400 Complete Parameter List” on page 51.

Table 14 Parameters for control command source selection.

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

Code	Parameter Name	Alternative Settings	Setting for Standard Modbus	Function/Information
1106	EXT REF2 SELECT	KEYPAD AI1 ... COMM COMM+AI1 COMM*AI1	COMM, COMM+AI1 or 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	NOT SEL DI1...DI5 COMM	COMM	Selects the source of the run enable signal.
1604	FAULT RESET SEL	KEYPAD ONLY DI1...DI5 START/STOP COMM	COMM	Fault reset source **Note! Fault reset is always possible with conrol panel.**

Output signal source selection

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

Relay outputs can be controlled in the following way:

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

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

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

Refer to Table 15 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 16 for information on analog output control.

Table 15 Relay output control.

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

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

Table 16 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 analoque output.
Group 15 ANALOG OUTPUT				
1501	AO CONTENT	102 - 137	e.g. 133	Directs the contents of parameter 133 to the analog output.
1503	AO CONTENT MAX		255	Analog output scaling: upper limit (20 mA) reached when value 255 written to parameter 133.

Diagnostic Counters

Diagnostic counters can be used for debugging the Modbus system.

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

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

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

Table 17

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

Communication

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

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 local ABB sales office for a copy of 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 pre-defined 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).

Register Mapping

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

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

Register addresses 4GGPP are shown in Table 18. In this table GG is the group number, and PP is the parameter number within the group

Table 18 Parameter mapping.

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

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

Exception Codes

The ACS 400 supports the standard Modbus exception codes. These are shown in Table 19.

Table 19 Exception codes.

Code	Name	Meaning
01	ILLEGAL FUNCTION	The function code received in the query is not an allowable action for the slave. 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-max 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 20. If any other function codes are used ACS 400 returns an exception response with error code 01 (illegal function).

Table 20 Function codes.

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

The Control Word

Holding register: 40001

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

Note! In order to use Control Word the drive must be configured to receive control commands from the serial communication channel. Refer to "Control Locations" on page 100.

The contents of the Control Word is presented in the following table. The text in *italics* refers to the states in Figure 43.

Table 21 The Control Word.

Bit	Value	Description
0	1	Enter ***READY TO OPERATE***
	0	Emergency OFF. Ramp to stop according to parameter 2203 DECELER TIME 1. Enter ***OFF1 ACTIVE*;** proceed to ***READY TO SWITCH ON*** unless other interlocks (OFF2, OFF3) are active.
1	1	Continue operation (OFF2 inactive)
	0	Emergency OFF, coast to stop. 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

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

References

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

Reference 1

Holding Register: 40002

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

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

Reference 2

Holding Register: 40003

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

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

Fieldbus Reference Selection and Correction

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

The Status Word

Holding Register: 40004

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

The contents of Status Word is presented in the following table. The text in italics refers to the states in Figure 43.

Table 22 The Status Word.

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

Actual Values

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

Actual Value 1

Holding Register: 40005

Actual output frequency. Scaling: 5000 ≙ 50 Hz.

Actual Value 2

Holding Register: 40006

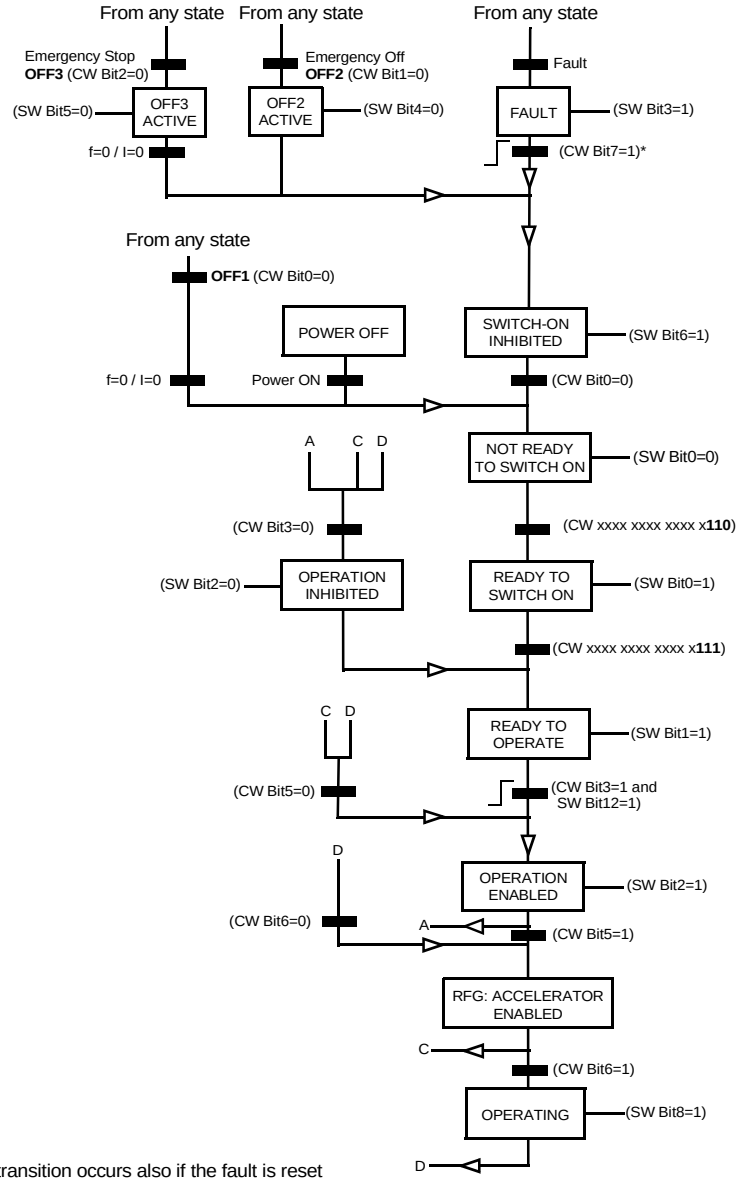
Actual output current. Scaling: 10 ≙ 1 A.

Example

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

Table 23 Using the Control Word.

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



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

State
CW = Control Word
SW = Status Word

I = Output current
f = Output frequency
RFG = Ramp Function Generator

Figure 43 The state machine for evaluation of start and stop signals.

Fault and Alarm Status

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

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

Registers 40301-40309 are generally read-only type; however, alarm words can be reset by writing zero into the register. Table 24 lists the fault and alarm words.

Table 24 Fault and alarm status words.

No	Name	Description
40301	MAIN CONTROL WORD	Read-only copy of the Control Word (40001). See page 108.
40302	MAIN STATUS WORD	Read-only copy of the Status Word (40004). See page 110.
40305	FAULT WORD 1	Fault information. When a fault is active corresponding bit is set. Bit descriptions are given in Table 25.
40306	FAULT WORD 2	Fault information. When a fault is active corresponding bit is set. Bit descriptions are given in Table 25.
40308	ALARM WORD 1	Alarm information. When an alarm is active corresponding bit is set. Bits remain set until whole alarm word is reset by writing 0 to it.See Table 26.
40309	ALARM WORD 2	Alarm information. When an alarm is active corresponding bit is set. Bits remain set until whole alarm word is reset by writing 0 to it.See Table 26.

Table 25 Bit descriptions for fault words 1 and 2.

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 26 ALARM WORD 1 bit descriptions.

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

APPENDIX

Local Control vs. Remote Control

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

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

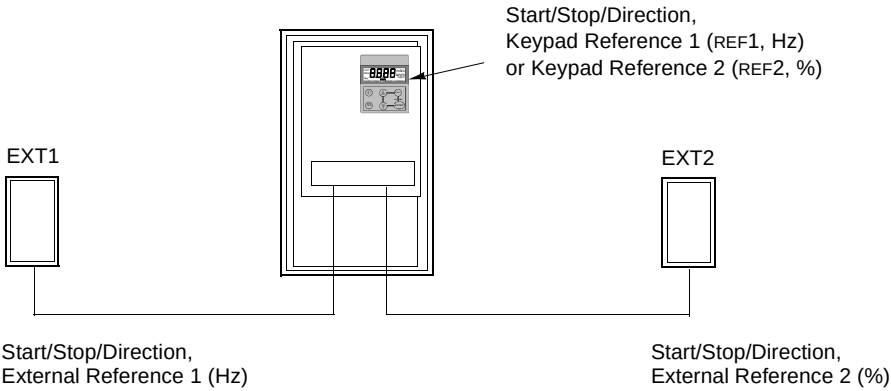


Figure 44 Control locations.

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 percent.

If PID Control 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 be given also 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).

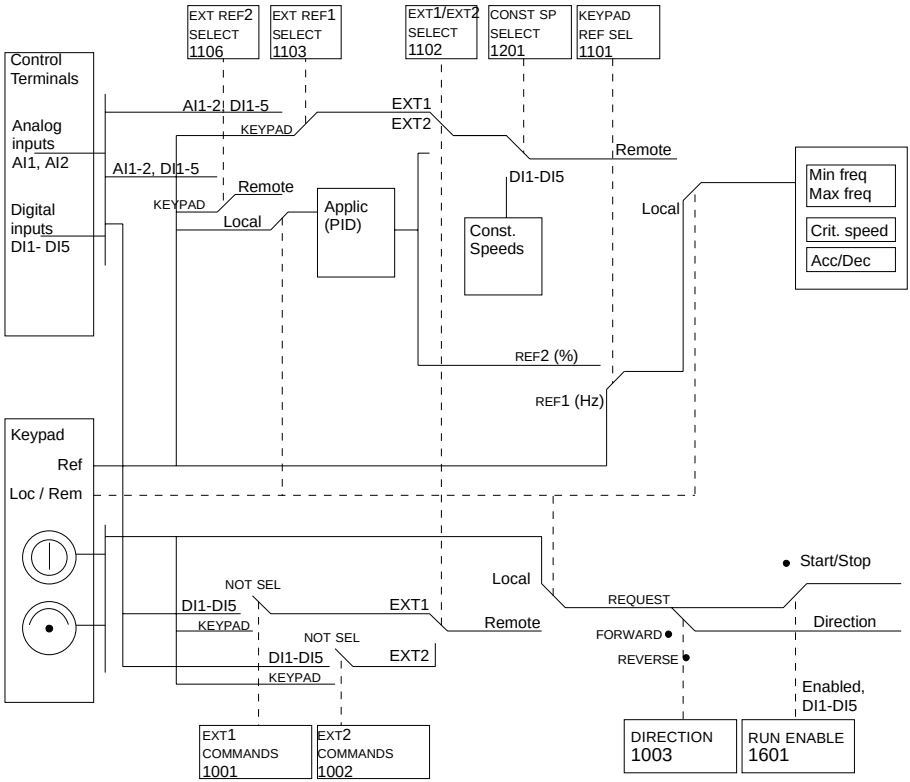


Figure 45 Selecting control location and control source.

Internal Signal Connections for the Macros

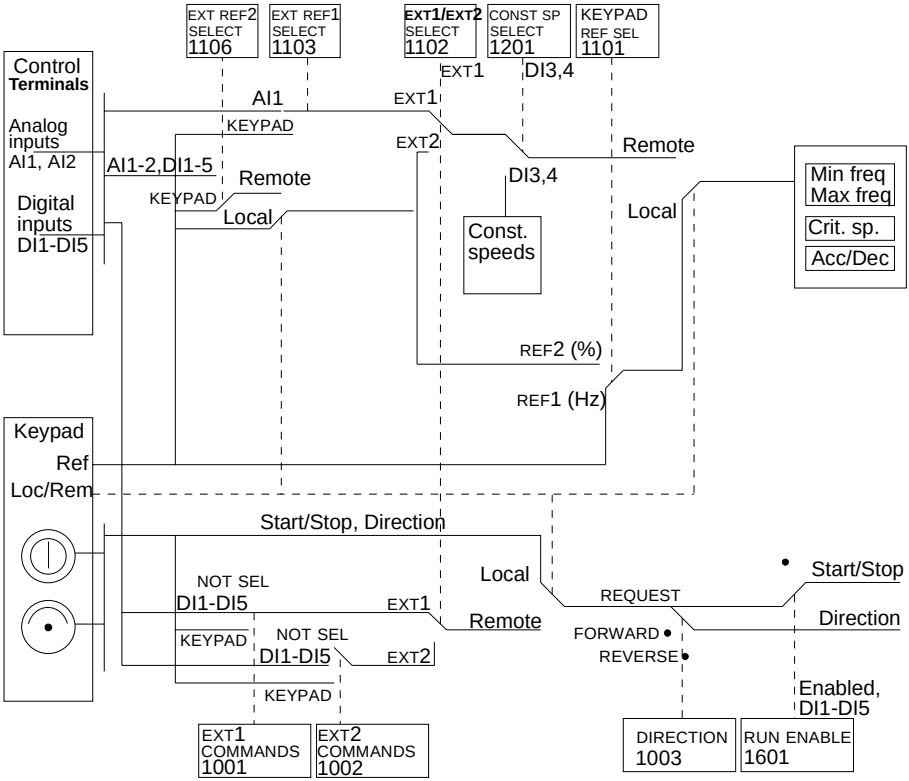


Figure 46 The control signal connections of the ABB Standard, Alternate and Premagnetize macros.

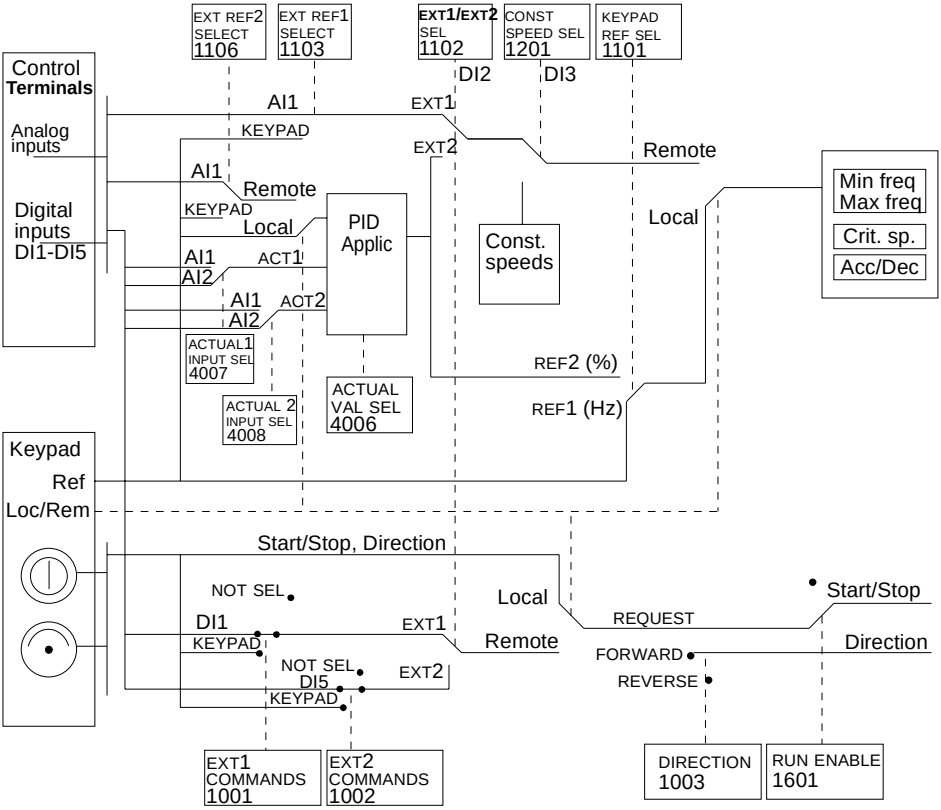


Figure 47 The control signal connections of the PID Control macro.

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