ACS 600 SingleDrive Frequency Converters

for Speed and Torque Control of
2.2 to 3000 kW Squirrel Cage Motors

Technical Catalogue

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Chapter 1 – Overview

Introduction

This Catalogue describes the hardware, features, and specifications of the ACS 600 SingleDrive frequency converter. It guides you in selecting the correct ACS 600 type and optional devices as well as planning the installation.

ACS 600 SingleDrive in Brief

ACS 600 SingleDrive is a new generation frequency converter that achieves the ultimate in AC motor control performance. The first AC drive to utilise Direct Torque Control (DTC), the ACS 600 accurately controls the speed and torque of any standard squirrel cage motor.

Suitable for Any Application

ACS 600 frequency converters meet the needs of any application - from the simplest to the most critical and highly demanding.

- Pumps - centrifugal, positive displacement, dosing
- Fans - forced draught, induced draught, centrifugal, axial
- Mixers
- Conveyors, bottling lines, palletisers and other materials handling applications
- Lifts, elevators, cranes, hoists
- Winders - films, paper, wire
- Centrifuges
- Extruders - melt pumps, pelletisers.

ACS 600 Drives for Specific Purposes

ACS 600 MotionControl, ACP 600

ACS 600 MotionControl provides state-of-the-art solution to a high-precision control applications, i.e. positioning, synchronising, torque control and speed control.

ACP 600 frequency converters belong to the ACS 600 product family. The same advanced motor control and hardware solutions are used. There are certain differences, however, due to a specific focus of design:

- special application program including Positioning, Synchronising, Speed Control and Torque Control Application Macros
- Advanced I/O Board with integrated incremental encoder interface
- add-on board for an absolute encoder
- Pulse Encoder Interface Module (NTACP-01) option

For more information, see the *Technical Data* appendix and *ACS 600 Product Catalogue*, code: 3BFE 64162021. The options are described in *Chapter 7 – Optional Equipment*.

ACS 600 CraneDrive, ACC 600

ACS 600 CraneDrive belongs to the ACS 600 product family. The same advanced motor control and hardware solutions are used.

The ACS 600 CraneDrive is equipped with a special application program that includes advanced functions for a standard crane system; torque memory, power optimisation, limit switch supervision, mechanical brake control, torque proving etc.

The special crane functions, together with the unique Direct Torque Control (DTC) technology, used in all ACS 600 family members, guarantee precise control in the most demanding crane applications.

For more information, see the *Technical Data* appendix and *ACS 600 Product Catalogue*, code: 3BFE 64162021. The options are described in *Chapter 7 – Optional Equipment*.

Product Type Designations Used in The Catalogue

See the inside of the backover.

Direct Torque Control

Direct Torque Control (DTC) is a unique motor control method for AC Drives. The inverter switching directly controls the motor core variables: the flux and the torque.

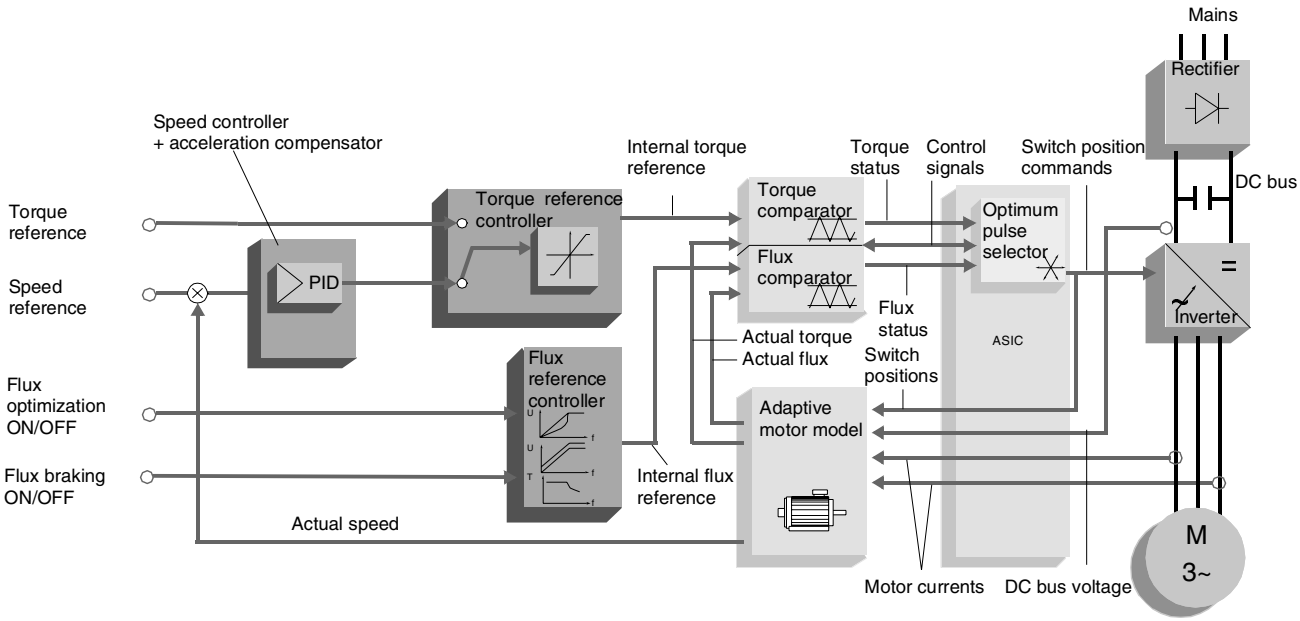


Figure 2-1 DTC block diagram.

The measured motor current and voltage are inputs to an adaptive motor model which produces an exact actual value of torque and flux every 25 microseconds. Motor torque and flux comparators compare actual values to the reference values produced by the torque and flux reference controllers. Depending on the outputs from the two-level controllers, the optimum pulse selector directly determines the optimum inverter switch positions.

Typical performance figures for the speed and torque control are given in *Chapter 6 – Standard Features*.

How Does DTC Differ from PWM Flux Vector Drives?

In DTC, every switching is determined separately based on the values of flux and torque, rather than switching in a predetermined pattern as in conventional PWM flux vector drives.

DTC	Flux Vector
Switching based on core motor variables Flux and Torque	Switching based on separate control of magnetising and torque producing components of current
Shaft speed and position typically not required	Mechanical speed is essential. Requires shaft speed and position (either measured or estimated)
Each inverter switching is determined separately (every 25 μs).	Inverter switching based on average references to a PWM modulator. This results in delays in response and wasted switchings.
Torque Step Rise Time (open loop) is 1 to 5 ms.	Torque Step Rise Time Closed Loop 10 to 20 ms. Sensorless 100 to 200 ms.

For more information on DTC, please refer to the *Technical Guide No. 1 Direct Torque Control* (3AFY 58056685).

Scalar Control

It is also possible to select scalar control as the motor control method. There are some special cases when scalar control should be selected, e.g. when running a multimotor application with variable motor configuration.

For more information on scalar control, see *Chapter 6 – Standard Features*.

Chapter 3 – Hardware Description

ACx 601

The ACx 601 hardware is arranged inside a wall-mountable metal frame. The ACx 601 series comprises six different frames (R2 to R7). The degree of protection of the frame housing is IP 22. IP 54 versions are available as an option, except R7. R7 is available as IP 54 in the ACx 607 series only.

The front section of the frame contains the electronics and the power and control cable terminals. The rear section forms a cooling channel. Two-section construction allows the unit to be installed protruding through a wall, placing the rear section in a cooling air duct (frames R2 to R6). In standard installations the converter is mounted directly onto the wall. The upward cooling air flow is provided by a fan or fans in the bottom part of the frame.

There is room for the Braking Chopper and for one Option Module in frames R4 to R7. Frames R2 and R3 need to have these devices installed outside the converter housing. For information on the optional devices available, see *Chapter 7 – Optional Equipment.*

For the degree of protection, materials etc. see the *Technical Data* appendix.

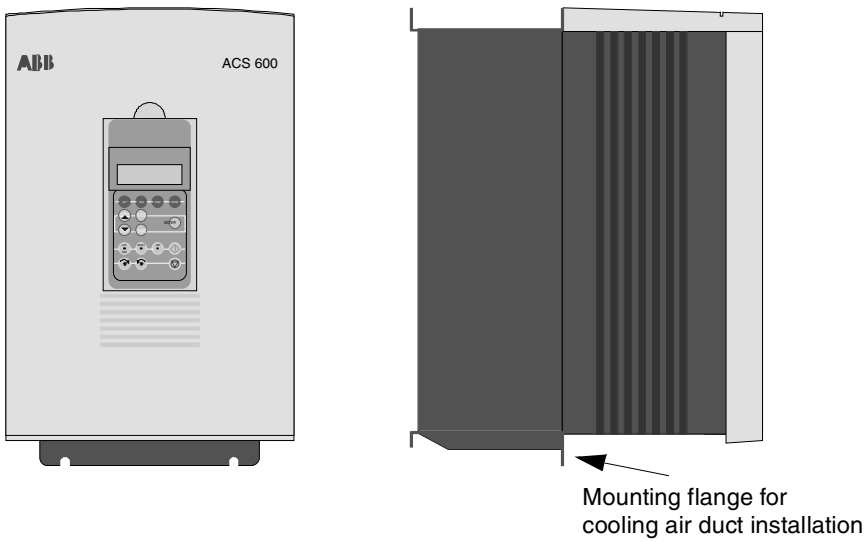


Figure 3-1 The ACx 601. The dimensions and weights are shown in Technical Data appendix.

ACx 604 / ACx 607 / ACS 617 / ACS 677

The ACx 604 is a converter module which is installed into a cabinet and equipped with accessories by the user. The ACx 607 is housed inside a Drives-MNS cabinet.

ACx 604

The ACx 604 hardware is arranged inside a metal frame. There are three frame sizes: R7, R8 and R9. The ACx 604 frame is to be fitted in a cabinet by the user. The degree of protection is IP 22 (ACx 604-0100-3, -0120-3, -0120-5, -0140-5, -0100-6 and -0120-6) or IP 00 (ACx 604-0140-3 to -0320-3 and -0170-5 to -0400-5 and -0140-6 to -400-6). The Control Panel mounting platform, the Control Panel and the other optional devices are supplied separately. Most optional devices are to be installed outside the unit. For more information on the Control Panel, Control Panel Mounting Platform and the other optional add-on kits, see *Chapter 7 – Optional Equipment*.

ACx 607 / ACS 617 / ACS 677

The cabinet of ACx 607 / ACS 617 / ACS 677 is equipped with a hinged front door(s) that holds the mains switch, the Control Panel mounting platform, and some optional devices. Cooling air intake and exhaust vents are covered with grates to keep out unwanted objects. As standard, the cabling is through the bottom of the unit. The mains and motor cable can also be lead in through the roof of the cabinet. See *Chapter 7 – Optional Equipment* for more information.

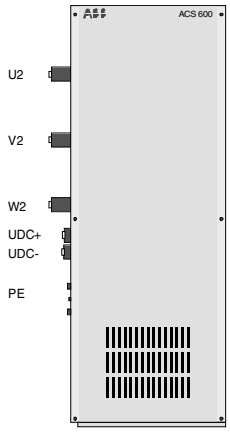
There is room inside the cabinet to allow connections and optional devices. The cabinet can be ordered as an extended version if more space is required.

ACx 607 types up to -0610-3, -0760-5 and -0760-6 use the ACx 604 converter modules/frames.

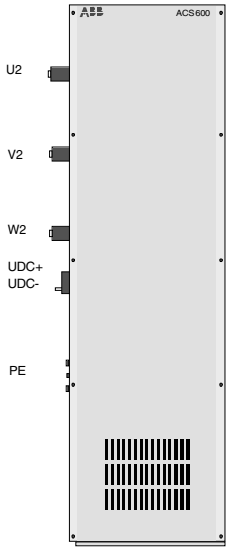
ACS/ACC 607 types -0760-3, -0930-5, -0900-6 or above, and ACS/ACC 617 and ACS/ACC 677 use the supply units and inverter modules/frames of the *ACS 600 MultiDrive*.

For the degree of protection, materials etc. see the *Technical Data* appendix.

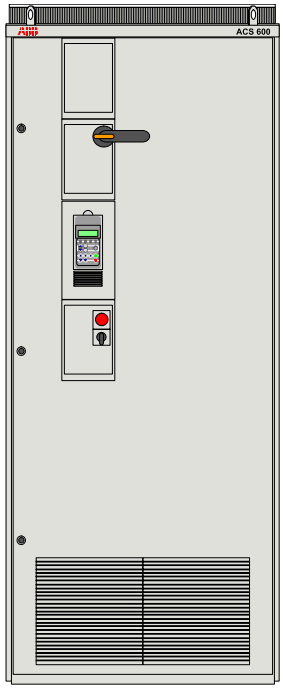
ACx 604-0140-3 to 0210-3
ACx 604-0170-5 to 0260-5
ACx 604-0140-6 to 0260-6



ACx 604-0260-3, 0320-3
ACx 604-0320-5, 0400-5
ACx 604-0320-6, 0400-6



ACx 607-0100-3 to 0320-3
ACx 607-0120-5 to 0400-5
ACx 607-0100-6 to 0400-6



ACx 607-0400-3 to 0610-3
ACx 607-0490-5 to 0760-5
ACx 607-0490-6 to 0760-6

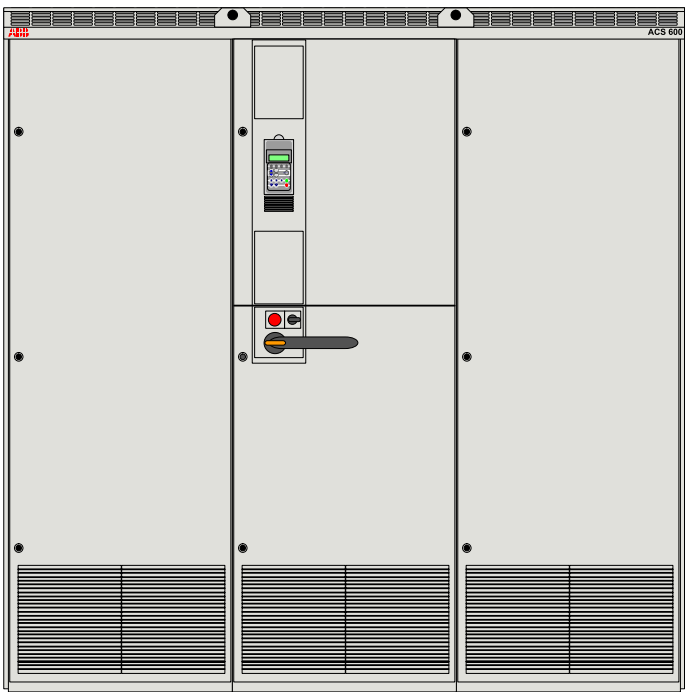


Figure 3-2 The ACx 604 and the ACx 607 (up to -0610-3, -0760-5 and -0760-6). The dimensions and weights are given in the Technical Data appendix.

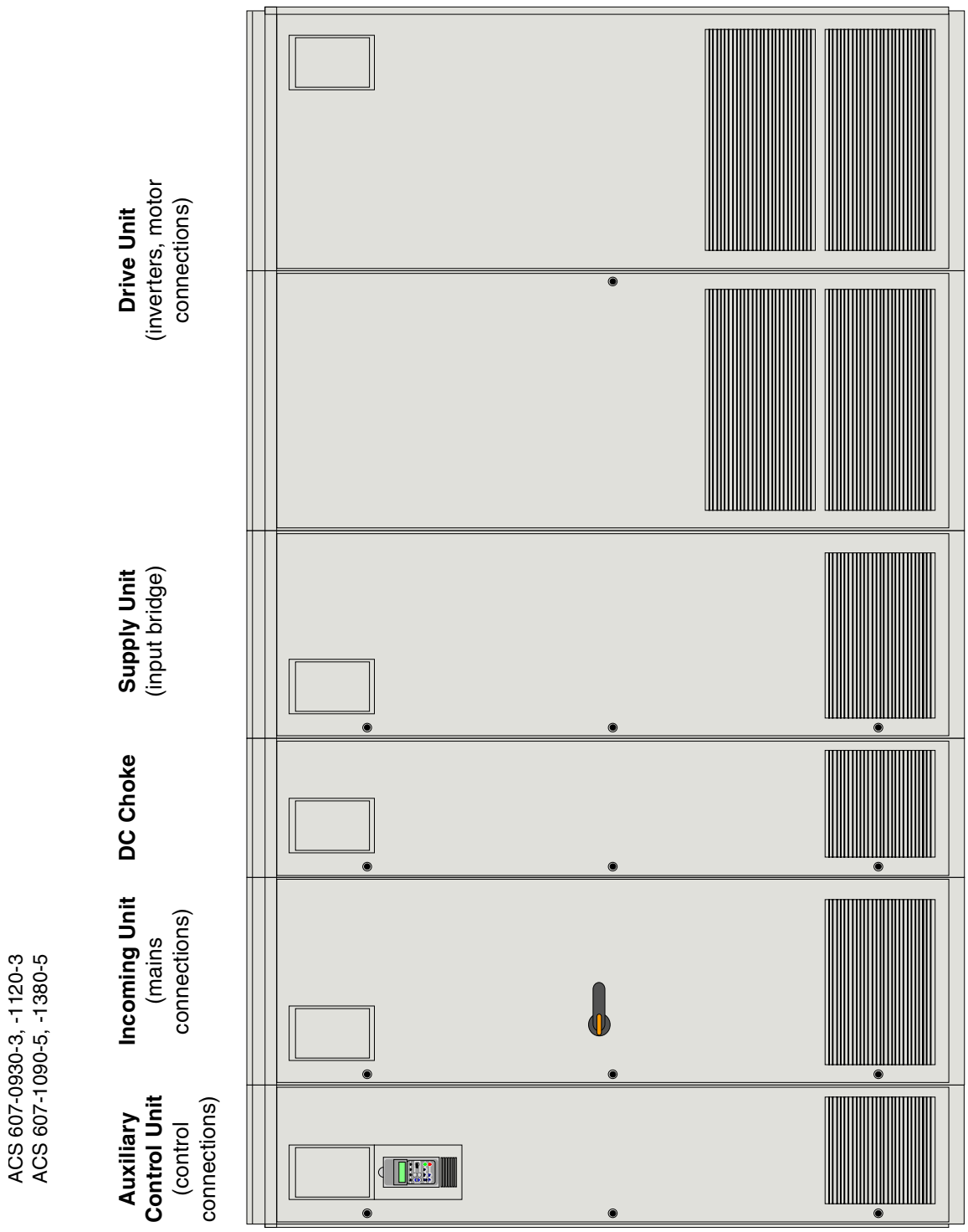


Figure 3-3 The ACS/ACC 607 (-0760-3, -0930-5, -0900-6 or above). The dimensions and weights are given in the Technical Data appendix.

Chapter 4 – User Interfaces

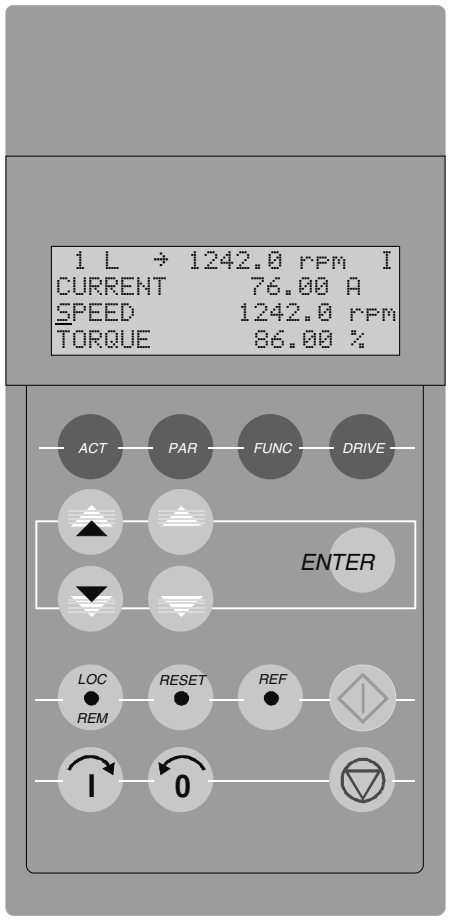
Overview

The ACS 600 can be controlled from several control locations:

- The detachable Control Panel which can be mounted on the ACS 600 enclosure or a remote control desk.
- External control devices that connect to the analogue and digital I/O terminals or Standard Modbus Link (serial RS 485 connection) on the Standard I/O Board, NIOC.
- External control devices that connect to the ACS 600 option modules (Analogue and Digital I/O Extension Modules and Fieldbus Adapter Modules).
- PC that connects via a PC adapter to the Application and Motor Control Board, NAMC.

Control Panel

The Control Panel is the user interface for monitoring, adjusting parameters and controlling the ACS 600 operation.



Control Panel Display

Control Panel Keypad

Degree of protection IP 54 when attached to the Control Panel Mounting Platform

Multilingual Alphanumeric Display (4 lines x 20 characters)
Plain text messages in 10 languages

Depending on the selection, four languages are loaded in the ACS 600.

Control Panel Mode Selection keys

Double Up Arrow, Up Arrow, Enter, Double Down Arrow, Down Arrow keys

Local/Remote, Reset, Reference and Start keys

Forward, Reverse and Stop keys

Figure 4-1 The Control Panel.

Using the panel it is possible to

- enter start-up data into the drive
- control the drive with a reference signal and with Start, Stop and Direction commands
- display the actual values (three values can be read simultaneously)
- display and adjust the parameters
- display information on faults
- upload and download complete parameter settings from one drive to another (this greatly simplifies the start-up procedure of several identical drives).

On the control panel mounting platform, there are two LEDs which indicate the status of the drive while the control panel is detached. The green LED indicates that the ACS 600 is powered, the red LED indicates that a fault is detected.

Standard I/O See the *Technical Data* appendix, subsection *Standard I/O*.

Standard ModBus Link See the *Technical Data* appendix, subsection *Standard I/O*.

I/O Extension Modules See *Chapter 7 – Optional Equipment*.

Fieldbus Adapter Modules See *Chapter 7 – Optional Equipment*.

PC Connection See *Chapter 7 – Optional Equipment*.

Chapter 5 – Parameters and Application Macros

This Chapter describes briefly the Parameters and Macros of the ACS 600 Standard Application Program.

Overview

Parameters are the Control Panel configurable operation instructions of the ACS 600.

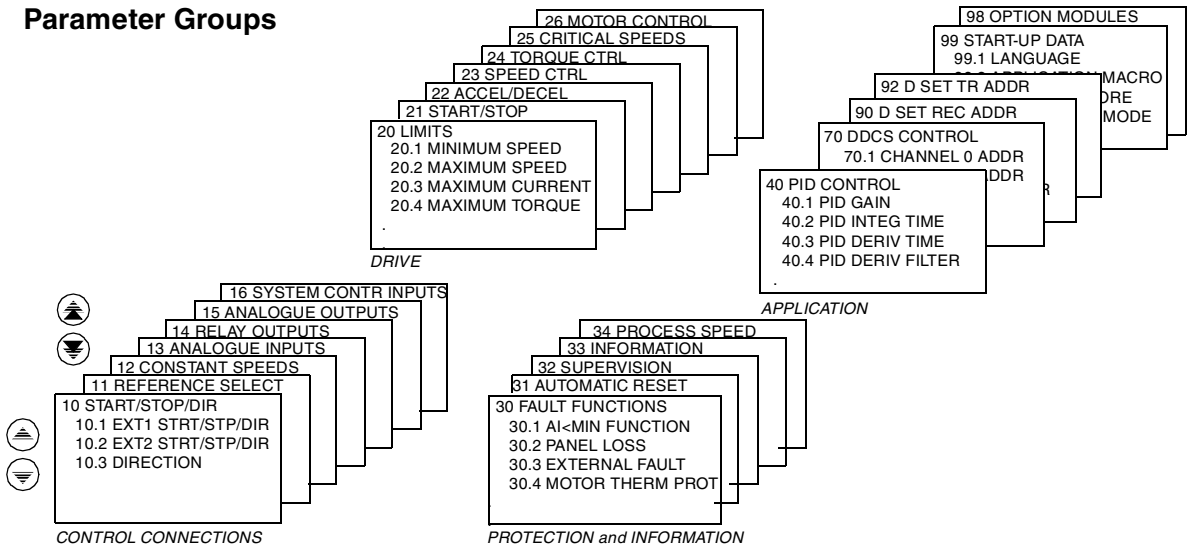
The built-in application macros can be selected at the touch of a button. The macro automatically takes care of configuration of inputs, outputs and signal processing as well as selections of the other parameters.

Available standard application macros:

- FACTORY SETTING for basic industrial applications
- HAND/AUTO CONTROL for local and remote operation
- PID CONTROL for closed loop processes
- TORQUE CONTROL for processes where torque control is required
- SEQUENTIAL CONTROL for operation at preset constant speeds
- USER MACRO 1 & 2 for saving the user's own parameter settings.

If further customisation is needed, the multilingual alphanumeric Control Panel allows quick parameter adjustment without the need to look up codes in a book.

Parameter Groups



The parameters in the ACS 600 are organised into functional groups, allowing the user to step through the groups, rather than having to step through all the parameters one by one. This makes the right parameter much easier and quicker to find.

I/O Settings in Macros

Preprogrammed use of digital inputs (DI), relay outputs (RO), analogue inputs (AI) and analogue outputs (AO) is shown below.

Factory Macro

Input Signals		Output Signals	
DI1,2:	Start, Stop, Direction	AO1:	Speed
AI1:	Speed reference	AO2:	Current
DI5,6:	Constant speed selection (3)	RO1:	Ready
DI4:	Accel/Decel ramp selection (2)	RO2:	Running
		RO3:	Fault (-1)

Hand/Auto Macro

Input Signals		Output Signals	
DI1,2:	Start,Stop,Direction (Hand)	AO1:	Speed
DI5,6:	Start,Stop,Direction (Auto)	AO2:	Current
DI3:	Control location selection (Hand/Auto)	RO1:	Ready
AI1:	Speed reference (Hand)	RO2:	Running
AI2:	Speed reference (Auto)	RO3:	Fault (-1)
DI4:	Constant speed selection		

PID Control Macro

Input Signals		Output Signals	
DI1:	Start, Stop (Speed Control)	AO1:	Speed
DI6:	Start, Stop (Process Control)	AO2:	Current
AI1:	Process reference/Speed Reference	RO1:	Ready
AI2:	Process actual value	RO2:	Running
DI3:	Speed/Process control selection	RO3:	Fault (-1)
DI4:	Constant speed selection		
DI5:	Run enable signal		

Torque Control Macro

Input Signals		Output Signals	
DI1,2:	Start, Stop	AO1:	Speed
AI1:	Speed reference	AO2:	Current
AI2:	Torque reference	RO1:	Ready
DI3:	Speed/Torque control selection	RO2:	Running
DI5:	Accel/Decel ramp selection (2)	RO3:	Fault (-1)
DI4:	Constant speed selection		
DI6:	Run enable signal		

Sequential Control Macro

Input Signals		Output Signals	
DI1,2:	Start, Stop, Direction	AO1:	Speed
AI1:	Speed reference	AO2:	Current
DI3:	Accel/Decel ramp selection (2)	RO1:	Ready
DI4,5,6:	Constant speed selection (7)	RO2:	Running
		RO3:	Fault (-1)

Chapter 6 – Standard Features

This Chapter describes features of the ACS 600 equipped with the Standard Application Program.

Overview

Based on the Direct Torque Control motor control technology, the ACS 600 offers highly advanced features as standard. As a default setting the ACS 600 operates in DTC. There are some special cases when scalar control should be selected, for example when running a multimotor application with variable motor configuration.

The following features are available in DTC mode. The standard features that are not available in the scalar control mode, and the features that are only available in the scalar control mode, are listed in section *Scalar Control* later in this chapter.

Motor Control Features

Motor Identification

The unbeatable performance of Direct Torque Control is based on an accurate motor model determined during the motor start-up.

A quick motor identification is automatically done the first time the Start command is given. During this first start-up the motor is magnetised at zero speed for several seconds to allow the motor model to be created. The First Start is the motor identification method suitable for most applications.

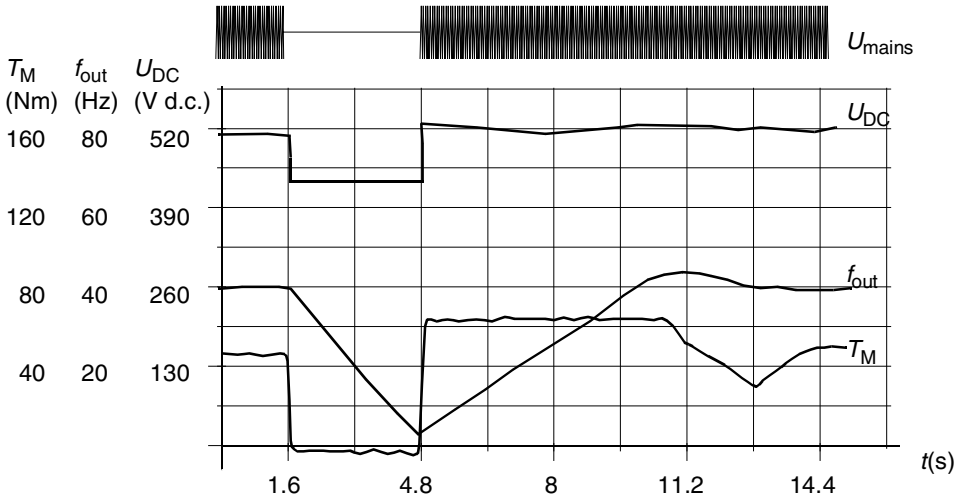
In demanding applications it is possible to perform an Identification Run. The Identification (ID) Run should be performed if:

- operation point is near zero speed
- operation at torque range above the motor nominal torque within wide speed range and without pulse encoder (i.e. without measured speed feedback) is required

There are two ID Run alternatives: the Standard ID Run and the Reduced ID Run. The motor must be uncoupled from the load during the Standard ID Run. The Reduced ID Run is to be used if the load cannot be disengaged from the motor or stator flux reduction is not allowed. Flux reduction is not allowed, for example, with a braking motor in which the brake is switched on if the motor voltage or flux reduces significantly. To achieve the most accurate motor model and the best possible motor control performance, the Standard ID Run should be selected.

Power Loss Ride-through

If the incoming supply voltage is cut off the ACS 600 will continue to operate by utilising the kinetic energy of the rotating motor. The ACS 600 will be fully operational as long as the motor rotates and generates energy to the ACS 600.



U_{DC} = ACS 600 intermediate circuit voltage, f_{out} = ACS 600 output frequency
T_M = Motor torque

Figure 6-1 Loss of supply voltage at nominal load (f_{out} = 40 Hz). The intermediate circuit DC voltage drops to the minimum limit. The controller keeps the voltage steady as long as the mains is switched off. The ACS 600 runs the motor in generator mode. The motor speed falls but the drive is fully operational as long as the motor has enough kinetic energy.

Note: In cabinet assembled units (ACS 607) with a main contactor option there is a “hold circuit” that keeps the contactor control circuit closed during a short main supply break.The allowed duration of the break is adjustable. The factory setting is five seconds.

Controlled Torque at Zero Speed

The ACS 600 can control motor torque at zero speed without any pulse encoder or tachogenerator feedback. E.g. a controlled change of rotation direction can be performed. The feature is essential in several applications including elevators and lifts. However, if long-term operation at zero speed is required, a pulse encoder is used.

DC Magnetizing

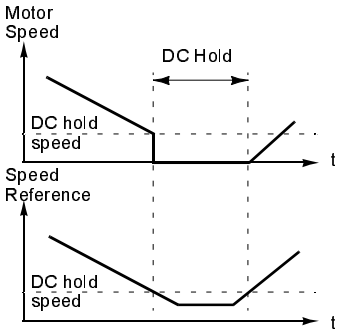
When DC Magnetizing is activated the ACS 600 automatically magnetises the motor before the start. This feature guarantees the highest possible breakaway torque, even 200 % of motor nominal torque. By adjusting the premagnetising time, it is possible to fix the motor start with a mechanical brake release, for example. The Automatic Start feature and DC Magnetizing cannot be activated at the same time.

Automatic Start

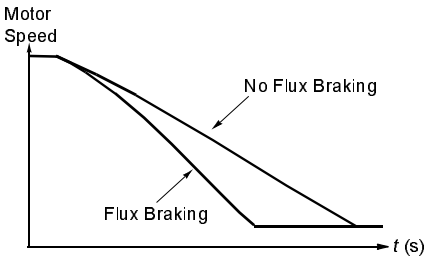
The Automatic Start feature of the ACS 600 outperforms the flying start and ramp start features normally found in frequency converters.

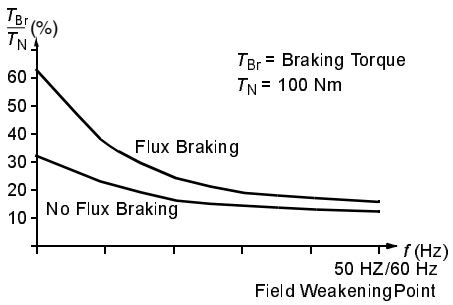
Because ACS 600 can detect the state of the motor within a few milliseconds, starting is immediate under all conditions. There is no restart delay. The starting of turbining pumps or windmilling fans is easy, for example.

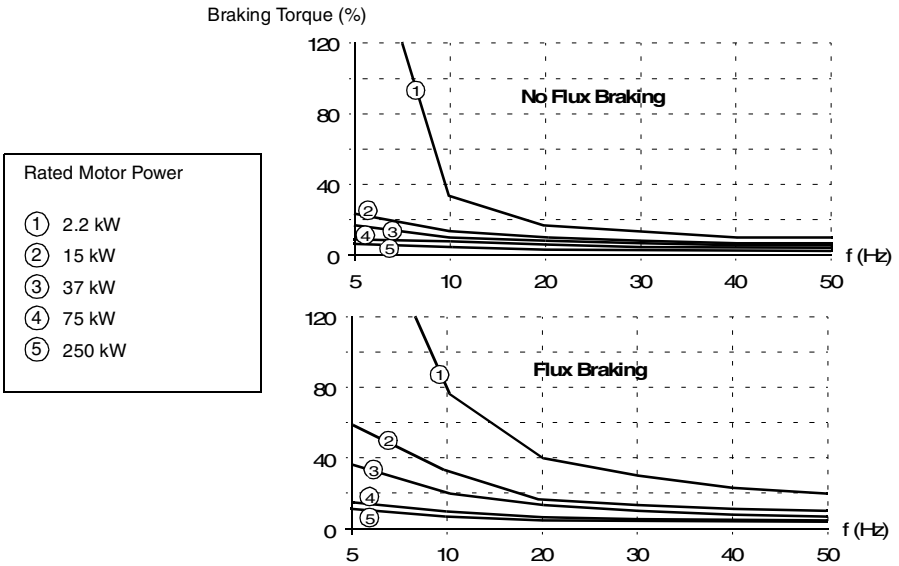
DC Hold By activating the motor DC Hold feature it is possible to lock the rotor at zero speed. When both the reference and the motor speed drop below the preset DC hold speed, the ACS 600 stops the drive and starts to inject DC into the motor. When the reference speed again rises above the DC hold speed, the normal ACS 600 operation resumes.



Flux Braking The ACS 600 can provide greater deceleration by raising the level of magnetisation in the motor. By increasing the motor flux, the energy generated by the motor during braking can be converted to motor thermal energy. The feature is useful in motor power range below 15 kW.







The ACS 600 monitors the motor status continuously, also during Flux Braking. Therefore, Flux Braking can be used both for stopping the motor and for changing from one speed to another. The latter is not possible with DC Injection Braking, which is offered in most frequency converters. The other benefits of Flux Braking compared to DC Injection Braking are:

- The braking starts immediately after the Stop command is given. In DC Injection Braking, there is typically a 500 ms delay after the Stop command before braking can be started. The delay is essential because DC Injection is possible only after the motor flux is sufficiently reduced.
- The cooling of the motor is more efficient.
  The stator current of the motor increases during Flux Braking. With DC Injection Braking the rotor current increases. The stator cools much more efficiently than the rotor.

Flux Optimization

Flux Optimization of the ACS 600 reduces the total energy consumption and motor noise level when the drive operates below the nominal load. The total efficiency (motor and the drive) can be improved by 1 % to 10 %, depending on the load torque and speed.

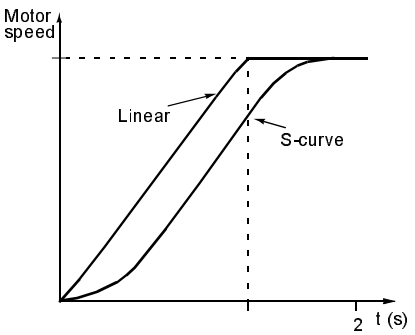
Acceleration and Deceleration Ramps

ACS 600 provides two user-selectable acceleration and deceleration ramps. It is possible to adjust the acceleration/deceleration times (0 to 1800 s) and the ramp shape. Switching between the two ramps can be controlled via a digital input.

The available ramp shape alternatives are linear and S curve.

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

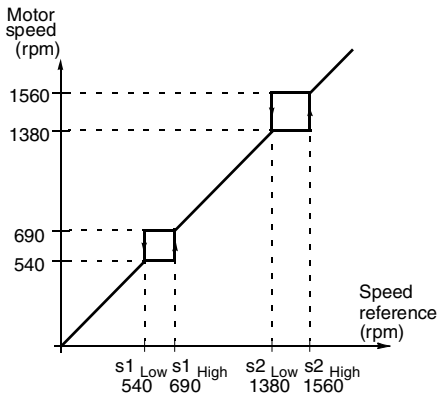
S-curve: Ideal for conveyors carrying fragile loads, or other applications where a smooth transition is required when changing from one speed to another.



Critical Speeds

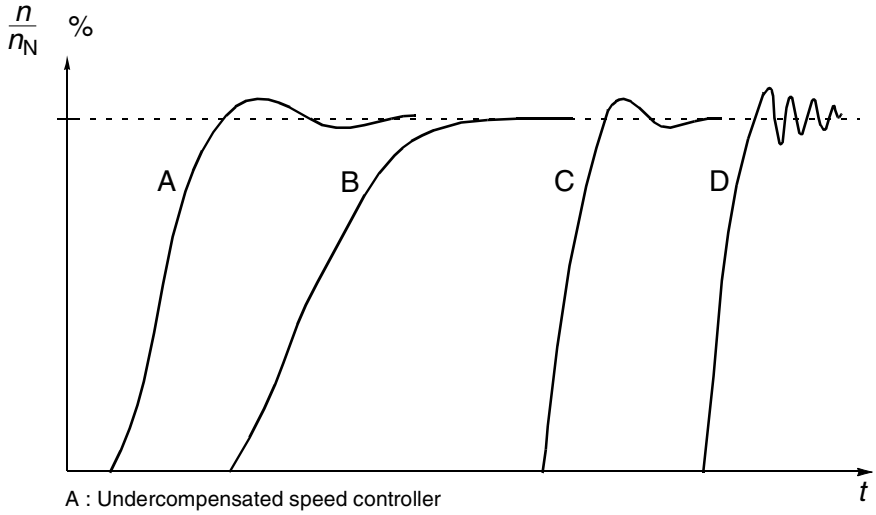
There is a Critical Speeds function available for applications where it is necessary to avoid certain motor speeds or speed bands due to e.g. mechanical resonance problems. The ACS 600 makes it possible to set up 3 different speeds or speed bands which will be avoided during operation.

Each critical speed setting allows the user to define a low and a high speed limit. If the speed reference signal requires the ACS 600 to operate within this speed range the Critical Speeds function will keep the ACS 600 operating at the low (or high) limit until the reference is out of the critical speed range. The motor is accelerated/decelerated through the critical speed band according to the acceleration or deceleration ramp.



Constant Speeds In the ACS 600 it is possible to predefine 15 constant speeds. Constant speeds are selected with digital inputs. Constant speed activation overrides the external speed reference.

Speed Controller Tuning During the motor Identification (ID) Run the ACS 600 speed controller is automatically tuned. However, it is possible to manually adjust the controller gain, integration time and derivation time, or let the ACS 600 perform a separate speed controller Autotune Run. In Autotune Run, the motor is driven through a series of movements and the speed controller is tuned based on the load and inertia of the motor and the machine.



A : Undercompensated speed controller
B : Normally tuned speed controller, autotuning
C : Normally tuned speed controller, manual tuning. Better dynamic performance than with B
D : Overcompensated speed controller

Figure 6-2 Examples of speed response at a speed reference step (typically, 1 to 20 %). Speed step response can be seen by monitoring the actual signal SPEED.

Accurate Speed Control The static speed control error is typically $\pm$ 0.1% to $\pm$ 0.5 % of motor nominal speed, which satisfies most industrial applications. If even more precise speed regulation is required, a pulse encoder can be

connected. With a pulse encoder, the static speed control error is typically ± 0.01% of motor nominal speed.

The dynamic speed control error is typically ± 0.4 %sec. at 100 % load torque step without a pulse encoder or tachogenerator. With a pulse encoder, dynamic speed control error is typically ± 0.1 %sec.

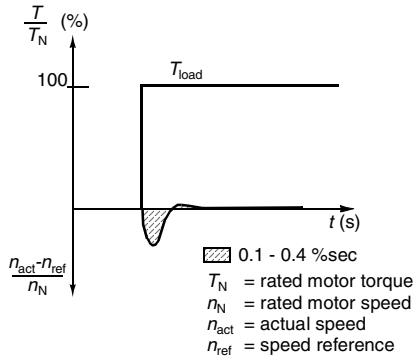


Table 6-1 Typical performance figures for speed control, when Direct Torque Control is used.

Speed Control	ACS 600 no Pulse Encoder	ACS 600 with Pulse Encoder
Static speed error, % of n_N	± 0.1 to 0.5 % (10 % of nominal slip)	± 0.01 %
Dynamic speed error	0.4 %sec.*	0.1 %sec.*

*Dynamic speed error depends on speed controller tuning.

Accurate Torque Control without Speed Feedback

The ACS 600 can perform precise torque control without any speed feedback from the motor shaft. With torque rise time less than 5 ms at 100 % torque reference step compared to over 100 milliseconds in frequency converters using sensorless flux vector control, the ACS 600 is unbeatable.

By applying a torque reference instead of a speed reference, the ACS 600 will maintain a specific motor torque value; the speed will adjust automatically to maintain the required torque.

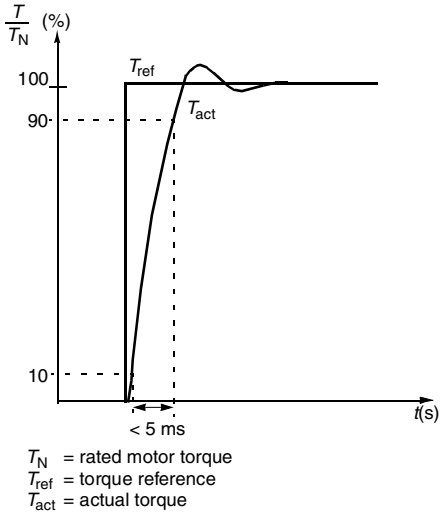


Table 6-2 Typical performance figures for torque control, when Direct Torque Control is used.

Torque Control	ACS 600 no Pulse Encoder	ACS 600 with Pulse Encoder
Linearity error	± 4 %*	± 3 %
Repeatability error	± 3 %*	± 1 %
Torque rise time	1 to 5 ms	1 to 5 ms

*When operated around zero frequency, the error may be greater.

Scalar Control

With the ACS 600 it is possible to select Scalar Control as the motor control method. In the Scalar Control Mode, the drive is controlled with a frequency reference. The outstanding performance of the default motor control method, Direct Torque Control, is not achieved in Scalar Control.

It is recommended to activate the Scalar Control mode in certain special applications:

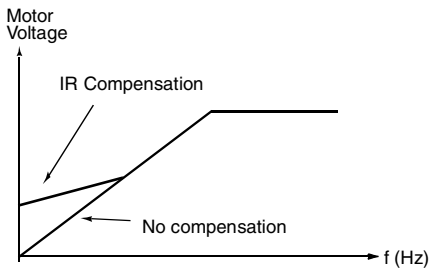
- In multimotor drives 1) if the load is not equally shared between the motors, 2) if the motors are of different sizes, or 3) if the motors are going to be changed after the motor identification.
- If the nominal current of the motor is less than 1/6 of the nominal output current of the ACS 600.
- If the ACS 600 is used without a motor connected (for test purposes, for example).
- If the ACS 600 is used in a step-up transformer application. (ACS 600 is running a medium voltage motor via a step-up transformer.)

In the Scalar Control Mode, the following ACS 600 standard features are not available: Motor ID Run, Automatic Start, Torque Control, DC Magnetizing, Flux Braking, Flux Optimization, DC Hold, Underload Function, Motor Phase Loss Function, Speed Limits, Torque Limits, Speed Controller Tuning, Stall Function.

The following features are available only in Scalar Control: Limits for Frequency (programmable), IR Compensation.

IR Compensation

When IR Compensation is activated, the ACS 600 gives an extra voltage boost to the motor at low speeds. IR Compensation can be used in e.g. Scalar Control applications that require high breakaway torque, for example.



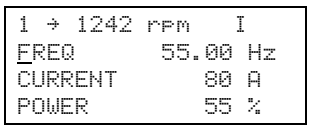
Diagnostics

Actual Signals

Several Actual Signals are available including:

- ACS 600 output frequency, current, voltage and power
- Motor speed and torque
- Mains voltage and intermediate circuit (DC) voltage
- Active control location (Local/External1/External 2)
- Reference values
- ACS 600 temperature
- Operating time counter (h), kWh counter
- DI/O and AI/O status
- PID controller actual values (if the PID Control Macro is selected)

Three signals can be read simultaneously from the control panel display.



Fault History

The Fault History contains information on 64 most recent events (faults or warnings) detected by the ACS 600 (16 remains in the memory over a power switch off). The events are displayed in words along with the total power-on time of the ACS 600.

Programmable Relay Outputs

The three programmable relay outputs can be used as potential free changeover contacts. With parameter setting it is possible to choose which information to indicate with the RO: ready, running, fault, warning, motor stall, motor temperature, ACS 600 temperature, reversed selected, external control selected, preset speed limits (2 pcs), intermediate circuit voltage limits, preset motor current limit, reference limits (2 pcs), loss of reference signal, ACS 600 started, motor operating at reference speed, process PID controller actual value limits (low, high) etc. It is also possible to control the relay outputs through a communication (e.g. fieldbus adapter) module.

Programmable Analogue Outputs

ACS 600 offers two programmable current outputs. Analogue output signals can be inverted and filtered. The minimum level can be adjusted to 0 mA or to 4 mA.

Depending on parameter selection, the analogue output signals can be proportional to motor speed, process speed (scaled motor speed), output frequency, output current, motor torque, motor power, DC bus voltage, output voltage, application block output (the process PID controller output), the active reference, or reference deviation (difference between the reference and the actual value of the process PID controller) etc.

Also, the output can be proportional to the process PID controller actual value of the ACS 600. The process PID controller actual values can be scaled, inverted and filtered.

It is also possible to control the analogue outputs through a communication (e.g. fieldbus adapter) module.

Input Signal Source Selections and Signal Processing

Two Programmable Control Locations

The ACS 600 (with no optional devices) can receive Start/Stop/Direction commands and reference from the control panel, through digital inputs and analogue inputs or through a serial RS 485 port (Standard Modbus Link).

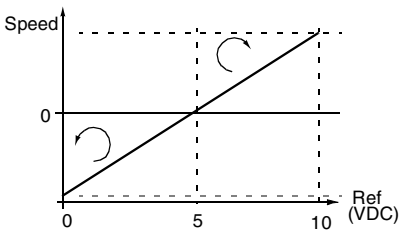
It is possible to predefine two separate External Control Locations (EXT1 and EXT2) for both the Start/Stop/Direction commands and the reference signal. The active External Control Location can be changed with the control panel, through a digital input or through the Standard Modbus Link.

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

Reference Signal Processing

The ACS 600 can accept a variety of speed references in addition to the conventional analogue input signal and control panel signals.

- The ACS 600 reference can be given with two digital inputs: One digital input increases the speed, the other decreases it.
- ACS 600 accepts a “joystick” analogue speed reference. This feature allows both the speed and direction to be controlled with a single analogue input. The minimum signal is full speed reversed and the maximum signal is full speed forward.



- The ACS 600 can form a reference out of two analogue input signals by using mathematical functions: Addition, Subtraction, Multiplication, Minimum selection, and Maximum selection.
- The ACS 600 can form a reference out of an analogue input signal and a signal received through a serial communication interface by using mathematical functions: Addition and Multiplication.

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

Programmable System Control Inputs

The programmable system control inputs include:

- Run enable signal
- Fault reset signal
- User Macro Selection

The system control input signals can be received through a digital input or from the control panel, except the Run enable signal which cannot be given with the panel.

Analogue Input Processing

The ACS 600 has three programmable analogue inputs: one voltage input and two current inputs. Each of these analogue inputs can be processed by adjusting the signal min/max levels, the filtering time constant, and the signal inversion selection.

Min/Max Setting

The minimum setting of 0V/0mA, 2V/4mA or the input tuning can be selected. The tuning allows the ACS 600 to read the value of the applied minimum signal.

The maximum setting of 10V/20 mA or the input tuning can be selected. The tuning allows the ACS 600 to read the value of the applied maximum signal.

Readable range in tuning is 0 mA / 0 V to 20 mA / 10 V.

Filtering

The analogue input signal filtering time constant is user-adjustable from 0.01 to 10 s.

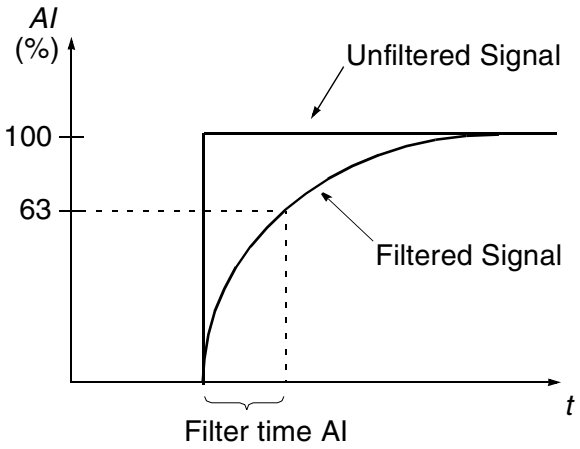


Figure 6-3 Analogue input filtering time constant.

Inversion

With inversion activated, the minimum level of the analogue input signal corresponds to the maximum reference and the maximum analogue input signal corresponds to the minimum reference.

Protection Functions

The ACS 600 offers several Programmable Fault Functions and other non-user adjustable Preprogrammed Protection Functions.

Programmable Fault Functions

AI<Min Function

AI< Min function defines the drive operation if an analogue input signal drops below the preset minimum limit. The options are:

- The drive is stopped and a fault message is displayed.
- The drive continues operation. No indication is given.
- A warning message is displayed and the motor will be run at a predefined continuous speed.
- A warning message is displayed and the motor will be run according to the last speed reference value received.

Panel Loss Function

Panel Loss function defines the operation of the ACS 600 if the control panel selected as control location for the ACS 600 stops communicating. The available selections are the same as with the AI< Min function except that the fault or warning message is always given.

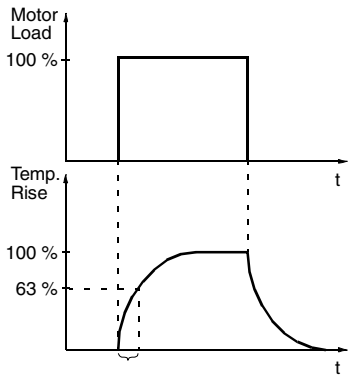
External Fault Function

With the External Fault function it is possible to supervise external faults by defining one digital input as a source for an external fault indication signal.

Motor Thermal Protection Function

The motor can be protected against overheating by activating the Motor Thermal Protection function and by selecting one of the Motor Thermal Protection Modes available.

The Motor Thermal Protection Modes are based either on a Motor Temperature Thermal Model or on Motor Thermistor Element overtemperature indication.

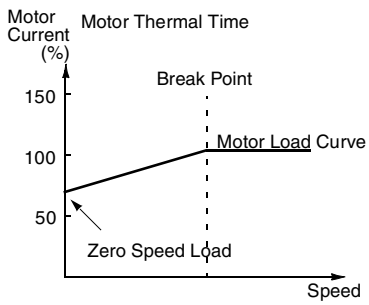


Motor Temperature Thermal Model

The ACS 600 calculates the temperature of the motor using the following assumptions:

1) The motor is in the ambient temperature of 30 °C when power is applied to the ACS 600.

2) Motor temperature is calculated using either the user-adjustable or automatically calculated Motor Thermal Time and Motor Load Curve (see the figures on the right). The load curve should be adjusted in case the ambient temperature is higher than 30 °C, for example.



Note: The user-adjustable model is to be used in ACS 607-0400-3, -0490-5, -0490-6 or above.

The thermal model provides protection equivalent to standard class 10, 20, or 30 overload relays by setting the Motor Thermal Time to 350, 700, or 1050 seconds respectively.

Usage of the Motor Thermistor Element

It is possible to detect motor overtemperature by connecting a motor thermistor (PTC) between the +24 VDC voltage supply offered by the ACS 600 and digital input DI6. In normal motor operation temperature, the thermistor resistance should be less than 1.5 kΩ (current 5 mA). The ACS 600 stops the motor and gives a fault indication if the thermistor resistance rises higher than 4 kΩ.

Note: According to IEC 664 the connection of the thermistor to the DI6 requires double or reinforced insulation between motor live parts and the thermistor.

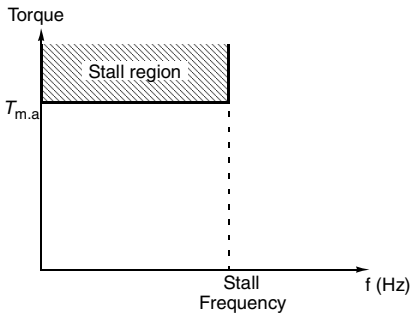
Stall Function

The ACS 600 protects the motor upon a stall situation. It is possible to adjust the supervision limits (frequency, time) and choose how the drive reacts to the motor stall condition (warning indication/fault indication & stop the drive/no reaction).

The protection is activated if all the following conditions are fulfilled at the same time:

1) The ACS 600 output frequency is below the Stall Frequency limit set by the user.

2) The motor torque has risen to the maximum allowed value (the value $T_{m.a}$ in the figure) calculated by the ACS 600 software. This limit is continuously changing depending on variables such as motor temperature calculated by the frequency converter software.



3) Conditions 1 and 2 have been on longer than the period set by the user (Stall Time Limit).

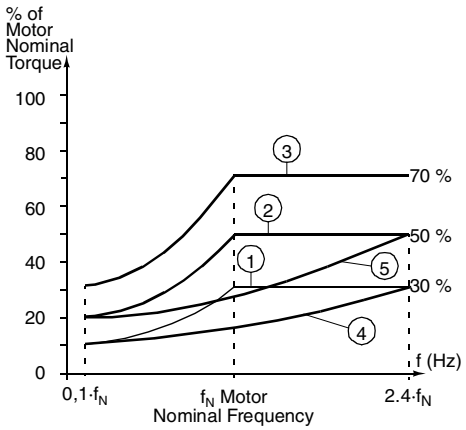
Underload Function

Loss of motor load may indicate a process malfunction. ACS 600 provides an Underload Function to protect the machinery and process in such a serious fault condition. The supervision limits: Underload Curve and Underload Time can be chosen as well as the drive operation in the underload condition (warning indication / fault indication & stop the drive / no reaction).

The protection is activated if all the following conditions are fulfilled at the same time:

1) The motor load is below the Underload Curve selected by the user (five options, see the figure on the right).

2) The motor load has been below the selected Underload Curve longer than the time set by the user (Underload Time).



Motor Phase Loss Function

The Phase Loss function monitors the status of the motor cable connection. The function is useful especially during the motor start: the ACS 600 detects if any of the motor phases has not been connected and refuses to start. The Phase Loss function also supervises the motor connection status during normal operation.

The user can define the drive operation during motor phase loss. The alternatives are either a fault indication and Stop, or no reaction.

Earth Fault Protection

The Earth Fault protection detects earth faults in the motor, the motor cable or the inverter.

In ACS 601, ACS 604, and the 6-pulse versions of ACS 607 up to -0610-3, -0760-5 and -0760-6, the Earth Fault protection is based on earth leakage current measurement with a summation current transformer at the input of the converter. Depending on the user's selection, the Earth Fault function stops the drive and gives a fault indication, or the drive continues operation, ignoring the detected earth fault.

- An earth fault in the mains does not activate the protection.
- In earthed mains, the protection activates in 200 μs.
- In floating mains, the mains capacitance should be 1 μF or more.
- The capacitive currents due to screened copper motor cables up to 300 metres do not activate the protection.

In the12-pulse versions, i.e. ACS 627-0400-3 to -0610-3, -0490-5 to -0760-5 and -0490-6 to -0760-5, the protection is based on the voltage measurement of the supply neutral point. For more information on the protection principle see *Chapter 7 – Optional Equipment.*

For ACS 6x7-0760-3, -0930-5, -0900-6 or above the Earth Fault protection is an optional feature. See *Chapter 7 – Optional Equipment*.

Communication Fault Function

The Communication Fault Function supervises the communication between ACS 600 and an external control device (e.g. a fieldbus adapter module).

The user can define the drive operation during communication loss, and set the time delay for the function. The user can also define the fault states for the ACS 600 relay or analogue outputs that are

controlled via the communication link.

Preprogrammed Protection Functions

The preprogrammed protection functions of the ACS 600 cannot be altered by the user.

Overcurrent

The overcurrent trip limit for the ACS 600 is 3.5 · I_{2hd} (rated output current, heavy-duty use rating).

DC Overvoltage

DC overvoltage trip limit is 1.3 · U_{1max}, where U_{1max} is the maximum value of the mains voltage range. For 400 V units, U_{1max} is 415 V. For 500 V units, U_{1max} is 500 V. For 690 V units, U_{1max} is 690 V. The actual voltage in the intermediate circuit corresponding to the mains voltage trip level is 728 V d.c for 400 V units, 877 V d.c. for 500 V units, and 1210 V d.c. for 690 V units.

DC Undervoltage

DC undervoltage trip limit is 0.65 · U_{1min}, where U_{1min} is the minimum value of the mains voltage range. For 400 V and 500 V units, U_{1min} is 380 V. For 690 V units, U_{1min} is 525 V. The actual voltage in the intermediate circuit corresponding to the mains voltage trip level is 334 V d.c. for 400 V and 500 V units, and 461 V d.c. for 690 V units.

ACS 600 Temperature

ACS 600 supervises the inverter module temperature. If inverter module temperature exceeds 115 °C, a warning is given. Temperature trip level is 125 °C.

Short Circuit

There are separate protection circuits for supervising the motor cable and the inverter short circuits. If a short circuit occurs, the drive will not start and a fault indication is given.

Input Phase Loss

Input Phase Loss protection circuits supervise the mains cable connection status by detecting intermediate circuit ripple. If a phase is lost, the ripple increases. The drive is stopped and a fault indication is given if ripple exceeds 13 %.

Note: The protection is designed by other means in the:

- 6- and 12-pulse versions of ACS 607-0400-3 to -0610-3, -0490-5 to -0760-5, and -0490-6 to -0760-6
- 12-pulse versions of ACS 607-0760-3, -0930-5, -0900-6 or above.

Ambient Temperature

The drive will not start if the ambient temperature is below -5 to 0 °C or above 73 to 82 °C (the exact limits vary within the given ranges depending on ACS 600 type).

Overfrequency

If the ACS 600 output frequency exceeds the preset level, the drive is stopped and a fault indication is given. The preset level is 50 Hz over the operating range absolute maximum speed limit (Direct Torque Control mode active) or frequency limit (Scalar Control active). The operating range limits are set by Parameters 20.1 and 20.2 (DTC mode active) or 20.7 and 20.8 (Scalar control active).

Internal Fault on the I/O Control Board

If the Application and Motor Control Board (NAMC) cannot communicate with the I/O Control Board (NIOC) or the I/O extension modules (Digital I/O Extension Modules or Analogue I/O Extension

Module) connected to the I/O Extension Link, the drive is stopped and a fault indication is given.

Internal Fault If the ACS 600 detects an internal fault the drive is stopped and a fault indication is given.

User Macro The customer can create two own user macros and save them into the permanent memory of the ACS 600. The macro can be loaded simply by parameter selection. The User Macro protection function gives a fault indication if an attempt is made to restore a nonexisting user macro.

Main Circuit

No Fixed Switching Frequency ACS 600 has no fixed switching frequency. As a consequence, there is no high-pitch audible whine that is found in motors driven by a PWM technology frequency converter.

The average switching frequency is 2 or 3 kHz. The low average switching frequency provides higher efficiency because of lower switching losses.

AC Choke The AC choke is employed for harmonic current reduction, i.e. line current waveform improvement purposes. This reduces filter capacitor ripple current and extends capacitor life. The choke is placed on the AC side of the rectifier bridge in order to protect the rectifier semiconductors against power line transients. The choke also attenuates frequency converter electromagnetic emissions.

In large units (ACS 607-0760-3, -0930-5, -0900-6 or above) there is a DC choke. The choke is placed on the DC side of the input bridge.

Wide Mains Voltage Range One of the unique features of the ACS 600 is that it is capable of utilizing a wide range of supply voltages.

The input voltage rating of the 500 V a.c. unit ranges from 380 V a.c to 500 V a.c. The 380 to 440 V a.c. mains voltage can be used with minor adjustments. (In ACS 604 and ACS 607 types the voltage ratio of the internal transformers should be adjusted.)

The reduced output capacity of the 500 V a.c unit with 380 to 460 V a.c. mains connection should be taken into account.

Other Features

Limits The ACS 600 offers adjustable limits for speed, current (max.), torque (max.) and DC voltage.

Power Limit The maximum allowed motor power is $1.5 \cdot P_{hd}$. If the limit is exceeded, the motor torque is automatically restricted. The function protects the input bridge of the ACS 600 against overload.

Automatic Resets The ACS 600 can automatically reset itself after Overcurrent, Overvoltage, Undervoltage and AI<Min faults. The Automatic Resets must be activated by the user.

Supervision Supervisions are a unique feature of the ACS 600 which allows the drive to monitor certain user selectable variables. Each limit can be defined as low or high.

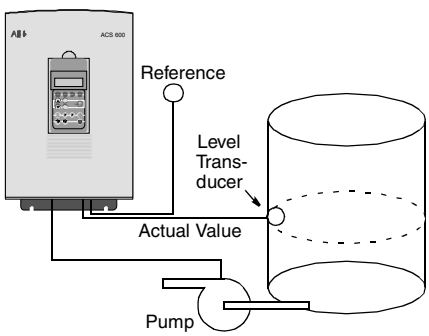
The user may set two speed limits, one current limit, two torque limits, two reference limits and two actual value limits. The indication of the active limit will appear on the control panel display, and can also be supervised through the relay outputs.

ACS 600 Information The ACS 600 software versions and test date can be displayed.

Parameter Lock The user can prevent unwanted parameter adjustment by activating the Parameter Lock.

Built-in PID Controller There is a built-in process PID Controller in the ACS 600. The controller can be used to control process variables such as pressure, flow or fluid level.

Instead of applying a speed reference to the ACS 600, a process reference (setpoint) is applied via an analogue input or the keypad. An actual value (process feedback) is brought back to the ACS 600 through one of the analogue inputs.



The internal PID controller of the ACS 600 eliminates the need to provide, mount, and wire a separate PID controller.

Chapter 7 – Optional Equipment

Overview

This chapter gives general information on optional equipment available for the ACS 600 SingleDrive.

The following are dealt with here:

- I/O Options (I/O Extensions, Pulse Encoder Interfaces, Fieldbus Adapter Modules, other related options)
- Specialised Application Programs
- Drive*Ware* PC Tools
- Braking Choppers and Braking Resistors
- EMC Filters, du/dt Filters, Sine Filters
- Standard Cabinet Options (e.g. cabling direction, line switching equipment, input bridge options, motor temperature supervision)
- Special Cabinet Options
- Control Panel and accessories, Fibre optic cables
- Coated circuit boards.

Applicability Labels

In this chapter, the following labels are used to indicate applicability:

ACS (ACS 600 with the Standard Application Program)
ACP (ACS 600 MotionControl)
ACC (ACS 600 CraneDrive)
ACx (any of the above).

The document *Ordering Information* (3AFY 58977985) specifies the availability of options for each frequency converter type and size.

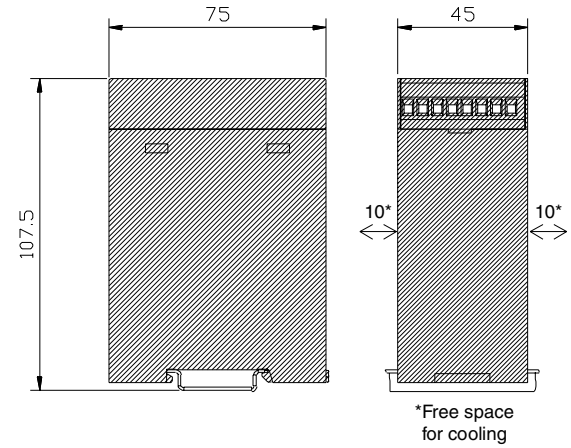
I/O Options

This section includes I/O extensions, pulse encoder interfaces, the Panel Bus interface, fieldbus adapters and related options. All of the I/O options can be ordered as separate add-on kits; most can also be ordered as factory-installed (see text at each option).

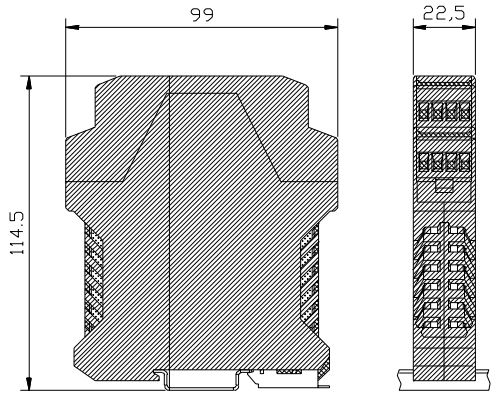
Housing

The I/O options listed in this section mainly use the IP20 plastic housings illustrated below. (The housing type of each option is indicated in the text at their individual descriptions.) The modules can be mounted onto a standard EN 50022/DIN rail without tools.

Housing Type 1

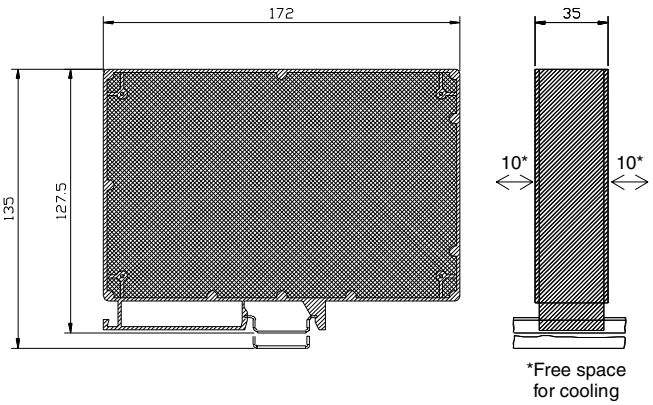


Housing Type 2

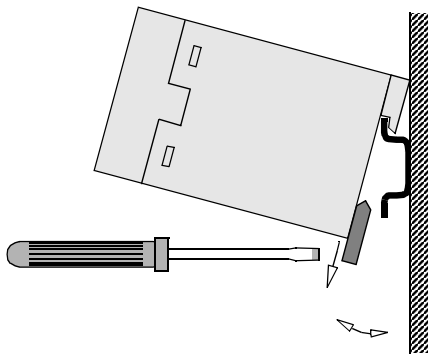


All dimensions in millimetres

Housing Type 3



Mounting/Removal of Module



Module Placement

ACx 601 frame R4 to R7 units can accommodate one module of housing type 1 or 2, while frame R2 and R3 units (ACx 601-0005-3 to -0016-3; ACx 601-0006-5 to -0020-5; ACx 601-0009-6 to -0020-6) require external mounting. ACx 607 cabinets can accommodate six modules as well as a power supply module.

Module Power Supply

The ACx 600 Standard I/O Board (NIOC) provides a 24 V d.c., 250 mA power supply. This is usually sufficient for at least one module. Additional modules require an external 24 V d.c. power supply. A suitable 3 A rail-mountable power supply (NPSM-02) is available.

Analogue I/O Extension Module NAIO-03 (ACS)

The Analogue I/O Extension Module offers two current ±0(4) to ±20 mA or voltage ±0(2) to ±10 V inputs and two current 0(4) to 20 mA outputs. The Module is connected to a high speed (4 Mbit/s) fibre optic I/O link on the ACS 600. The NAIO module provides:

- bipolar inputs, unipolar outputs
- better A/D and D/A decoding accuracy: 12-bit (unipolar) or 11-bit (+ sign bit) (bipolar) signal resolution
- distributed I/O connections through the module
- galvanic isolation thanks to the fibre optic connection.

The standard application program supports one NAIO module. The NAIO module inputs replace the standard analogue inputs AI2 and AI3; the NAIO module outputs add to the standard analogue outputs.

NAIO-03

Housing: Type 1
Weight: 0.2 kg

Front view

Screw terminal block for power supply connection

Fibre optic connectors for ACS 600 I/O link connection:
RXD = Receiver
TXD = Transmitter

Screw terminal block for analogue I/O connection

The module requires 24 V d.c. power (160 mA), which can be supplied by the ACS 600 Standard I/O Board.

Digital I/O Extension Module NDIO-02 (ACS)

The NDIO-02 Digital I/O Extension Module provides two digital inputs (24 to 250 V d.c. or 110 to 230 V a.c.) and two relay outputs (8 A/24 V d.c., 0.4 A/120 V d.c., 2000 VA/250 V a.c.). The inputs are galvanically isolated from each other and from the power supply.

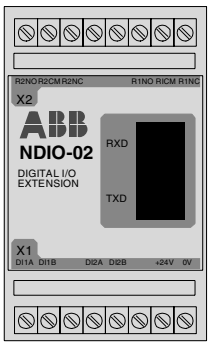
The NDIO module is connected to a high speed (4 Mbit/s) fibre optic I/O link on the ACS 600. The Standard Application Program supports maximum three NDIO modules. The inputs of the first NDIO module replace standard digital inputs DI1 and DI2; the inputs of the second NDIO replace DI3 and DI4; the inputs of the third NDIO replace DI5 and DI6.

The relay outputs of each NDIO module increase the total number of the relay outputs available. The information which the module outputs indicate is preprogrammed and not user-adjustable. The outputs of the first NDIO module indicate the drive states READY and RUNNING. The outputs of the second NDIO indicate the drive states FAULT and WARNING. The outputs of the third NDIO indicate the drive states REF 2 SEL (Reference 2 selected) and AT SPEED (Actual value has reached Reference value).

NDIO-02

Housing: Type 1
Weight: 0.2 kg

Front view



Screw terminal block
for the relay output connection

Fibre optic connectors
for the ACS 600 I/O link connection
RXD = Receiver
TXD = Transmitter

Screw terminal block
for digital input and power supply connection

The NDIO requires 24 V d.c. power (50 mA), which can be supplied by the ACS 600 Standard I/O (NIOC) Board.

Pulse Encoder Interface Module NTAC-01/02 (ACS/ACC)

The NTAC-01 and NTAC-02 Pulse Encoder Interface Modules offer an interface for an incremental pulse encoder connection. By measuring the motor actual speed with a pulse encoder, speed control accuracy can be improved. See the speed control performance figures in *Chapter 6 – Standard Features*.

The NTAC-01 is compatible with Standard Application Program versions 2.7 to 3.x, and the Crane Drive Application Program versions up to 3.x. The NTAC-02 is compatible with the Standard and Crane Application Programs, version 5.0 or later.

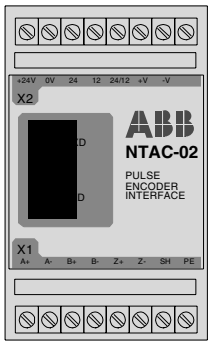
To achieve accurate speed control, special attention should be paid to the pulse encoder resolution/signal accuracy. These are the requirements for the encoder:

- Supply voltage 12 V d.c. (15 V d.c. for NTAC-02) or 24 V d.c. (supplied by the module)
- Available signal channels: 1/A, 2/B, 0/Z/N; for differential connection also $\overline{1}/\overline{A}$, $\overline{2}/\overline{B}$, $\overline{0}/\overline{Z}/\overline{N}$
- 90° (electrical) phase shift between channels 1 and 2
- Minimum recommended output rate: 1024 pulses per revolution
- Recommended output sinking/sourcing capability: 40 mA
- Maximum signal frequency $\leq$ 100 kHz.

NTAC-01/02

Housing: Type 1
Weight: 0.2 kg

Front view



Screw terminal block
for the power supply/source connections

Fibre optic connectors
for the ACx 600 I/O link connection
RXD = Receiver
TXD = Transmitter

Screw terminal block
for pulse encoder connection

The module requires 24 V d.c. power, which can usually be supplied by the ACx 600 Standard I/O Board (max. 250 mA). As the current consumption of the module is dependent on the configuration, it should be checked on each occasion if an additional power supply is needed. The current consumption can be read from the chart or calculated with the formula in Figure 7-1.

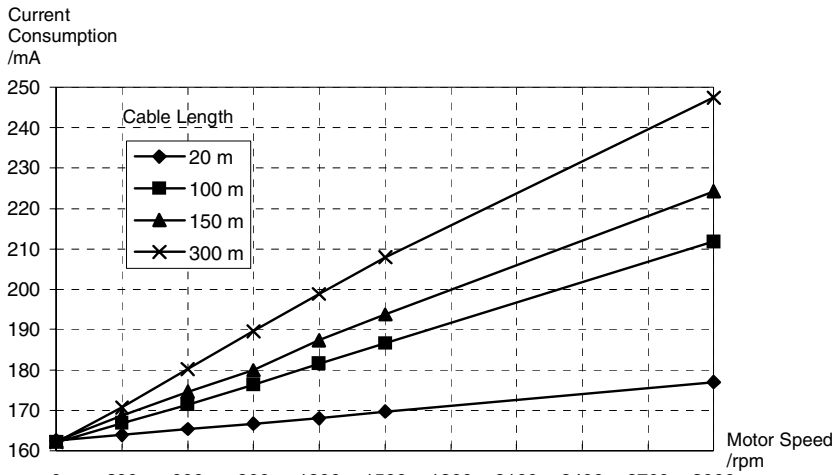
NTAC-xx Current Consumption (approx.):

$$162\ mA + k_c \cdot EPN \cdot \frac{n_{max}}{60 \cdot 10^3}$$

n_{max} = Motor Maximum Speed (rpm)
EPN = Encoder Pulse Number (ppr)
k_c = Coefficient (mA/kHz)
= 1.68 (300 m cable)
= 1.23 (150 m cable)
= 0.98 (100 m cable)
= 0.31 (20 m cable)

Note: The maximum allowed pulse frequency (f_{max}) is 100 kHz.

$f_{max} = EPN \cdot n_{max}/(60 \cdot 10^3)$ kHz



Encoder Pulse Number: 1024 ppr	0	300	600	900	1200	1500	1800	2100	2400	2700	3000
Encoder Pulse Number: 2048 ppr	0	150	300	450	600	750	900	1050	1200	1350	1500
Encoder Pulse Number: 512 ppr	0	600	1200	1800	2400	3000	3600	4200	4800	5400	6000

Figure 7-1 The current consumption for four different encoder cable lengths. The chart is based on a measurement with a 1024 ppr pulse encoder with differential outputs coupled to a 1500 rpm motor shaft.

Double Pulse Encoder Interface Module NTACP-01 (ACP)

The NTACP-01 Double Pulse Encoder Interface Module (for the ACP 600) offers two incremental encoder inputs, one encoder output, four digital inputs and two digital outputs.

Either encoder input can be relayed to the encoder output, which can then be used as a reference source for a follower drive, or as feedback for a higher-level control system.

Typically, the first encoder input is used with a motor encoder, the second with a master encoder for synchronisation.

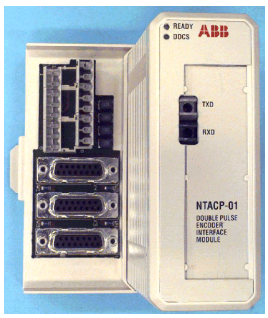
The general encoder requirements are as follows:

- Supply voltage 5 V d.c. (supply cable resistance compensation available)
- Available signal channels: 1/A, 2/B, 0/Z/N, $\overline{1}/\overline{A}$, $\overline{2}/\overline{B}$, $\overline{0}/\overline{Z}/\overline{N}$
- 90° (electrical) phase shift between channels 1 and 2
- Maximum signal frequency ≤ 200 kHz.

Front view

NTACP-01

Dimensions (H x W x D):
120 x 110 x 115 mm



Terminal block for the digital inputs/outputs and power supply connections

Fibre optic connectors
for the ACP 600 I/O link connection
RXD = Receiver
TXD = Transmitter

Three SUBD connectors:
two encoder inputs, one encoder output

The module requires 24 V d.c. power (max. 300 mA).

The NTACP-01 is available as an add-on kit for all ACP 600 types, and factory-installed for ACP 607.

Absolute Encoder Connection Board NSSIP-01 (ACP)

The NSSIP-01 Absolute Encoder Connection Board, available as an add-on kit for ACP 600 frequency converters, is mounted on the NIOCP-01 board (the default I/O interface with ACP 600 frequency converters). The NSSIP-01 offers an interface for an SSI absolute encoder.

The characteristics of the encoder connection are as follows:

- Supply voltage 24 V d.c. max. 250 mA
- Gray code
- Max. number of bits: 25
  e.g. 12 + 13 bits (4096 pulses/revolution × 8192 revolutions)
- Clock frequency 400 kHz
- Maximum cable length 50 m.

Bus Connection Interface Module NBCI-02

The NBCI-02 is used to connect a drive to a panel bus, which is controlled by a CDP 312 Control Panel or a Modbus controller (PLC or PC). PC connection usually requires an RS-232/485 converter, available as NPCU-01.

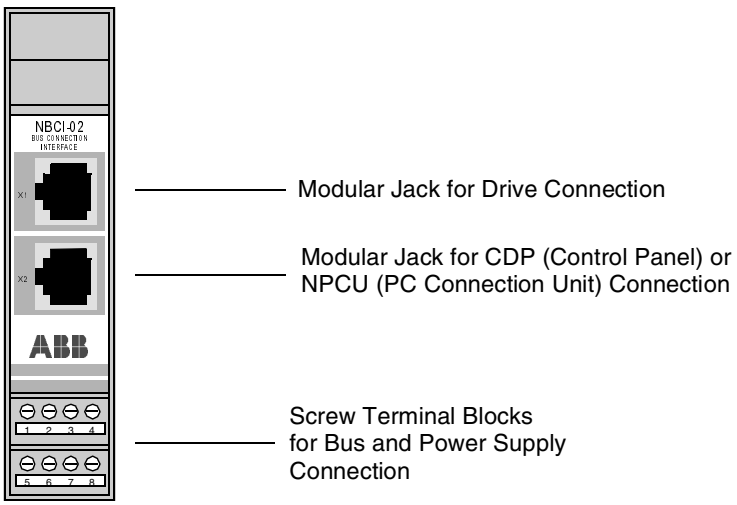
The panel bus is a serial communication bus that uses the RS-485 physical interface. The panel bus employs the Modbus protocol at a transfer rate of 9600 bit/s (max.). Through the use of the panel bus, it is possible to

- install the Control Panel (or a PC with an RS-232/485 converter) at a distance of up to 1200 metres from the drive(s)
- control, supervise and program any drive on the panel bus at a time
  Note: *This function is not supported by the ACC 600.*
- obtain a galvanically isolated connection between the drive and the panel bus.

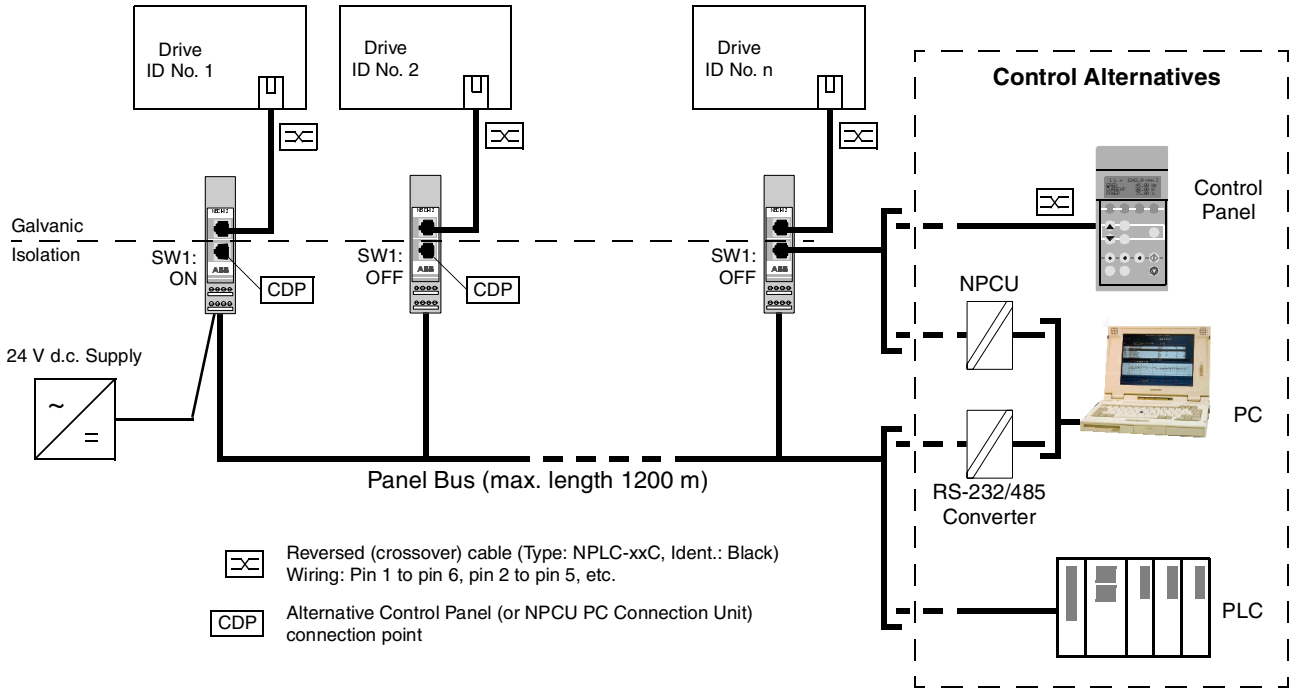
NBCI-02

Housing: Type 2
Weight: 0.2 kg

Front view



The figure below gives an example of a panel bus configuration.

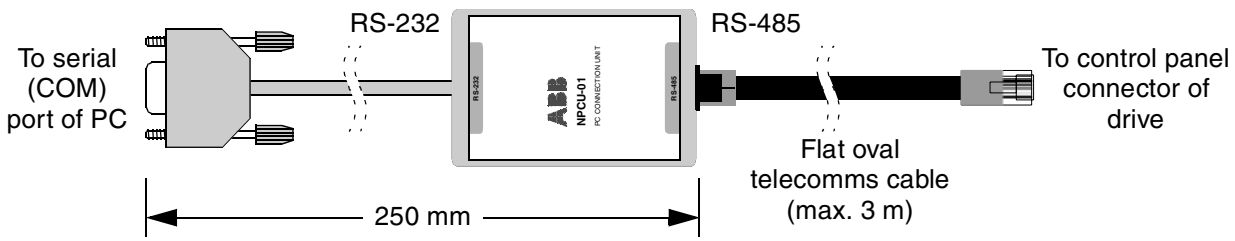


The NBCI-02 requires 24 V d.c. power (20 mA). All modules on the panel bus are powered by an external supply in order to retain galvanic isolation between the panel bus and the drives.

PC Connection Unit NPCU-01

The NPCU-01 PC Connection Unit is a galvanically-isolated RS-232/485 converter that enables the use of a PC – instead of the Control Panel – for controlling the drive.

The NPCU-01 is plugged into a serial port on the PC. The drive is connected to the NPCU-01 using the 3-metre (also the maximum length) flat oval telephone cable included. Locating the PC up to 1200 metres away from the drive is possible by constructing a panel bus using two NBCI Bus Interface Connection Modules.



Fieldbus Adapter Modules Nxxx-0x

There are several fieldbus adapter modules available for the ACx 600, including:

- NAFA-01 Advant Fieldbus AF100 Adapter kit
- NBAA-01 Building Automation Adapter Module
- NCAN-02 CANopen Adapter Module
- NCSA-01 CS 31 Adapter Module
- NDNA-02 DeviceNet Adapter Module
- NIBA-01 InterBus-S Adapter Module
- NLON-01 LONWORKS® Adapter Module
- NMBA-01 Modbus Adapter Module
- NMBP-01 Modbus Plus Adapter Module
- NPBA-02 PROFIBUS Adapter Module.

The fieldbus cable connects to the terminal block(s) on the adapter module. The adapter communicates with the ACx 600 via a fast (4 Mbit/s) half duplex fibre optic link. The fieldbus adapter modules require a 24 V d.c. power supply. See the entry for NPSM-02 below for options.

The table below shows the housing type, weight and current consumption of the fieldbus adapters.

Module Type	Housing	Weight [kg] (Gross)	Current Consumption [mA]
NIBA-01	Type 1	0.2 (0.4)	160
NPBA-02	Type 1	0.2 (0.4)	80
NMBA-01	Type 1	0.2 (0.4)	65
NMBP-01	Type 3	0.3 (0.6)	120
NCSA-01	Type 1	0.2 (0.4)	65
NDNA-02	Type 2	0.2 (0.4)	70
NCAN-02	Type 2	0.2 (0.4)	70
NAFA-01 (CI810)	170 × 84 × 122 mm	0.5 (0.7)	110
NLON-01	Type 2	0.2 (0.4)	30
NBAA-01	Type 1	0.2 (0.4)	65

Power Supply Module NPSM-02

If the total current consumption of optional modules exceeds 250 mA (the maximum output of the ACx 600 Standard I/O Board), an external 24 V d.c. power supply is required. For that purpose, a DIN/EN rail-mountable Power Supply Module (NPSM-02; 230 V a.c./+24 V d.c., 3 A; degree of protection IP 20) is available.

The power supply can be ordered as an add-on kit. For ACx 607, the power supply is automatically added if required by the total current consumption of 24 V d.c. optional equipment.

The dimensions of the NPSM-02 are (H x W x D): 132 x 75 x 71 mm, weight 0.6 kg.

DDCS Communication Options NDCO-01/02/03 (ACS)

The NDCO-xx DDCS Communication Options are add-on boards for the NAMC-11 Application and Motor Control Board. The NAMC-11 is used in ACS 600 frequency converters with the Standard Application Program, manufactured after 5 October 1998.

The NDCO boards include the fibre optic connectors for DDCS channels CH0, CH2 and CH3. (These channels are already present on the NAMC-03 board, used on all ACS 600 units manufactured before the above-mentioned date.)

The NAMC-11 requires the installation of the NDCO for use with devices that connect to DDCS channels CH0, CH2 and CH3, e.g. fieldbus adapters, NTAC-02 Pulse Encoder Interface Module and the Drive*Window* PC program.

The difference between NDCO-01, NDCO-02 and NDCO-03 is in the optical components of the DDCS channels as indicated below.

Board Type	Optical Component Type			
	CH0	CH1	CH2	CH3
NAMC-03 (ACS up to 4 Oct 1998/ACC/ACP)	5 MBd	5 MBd	5 MBd	5 MBd
NAMC-11 (ACS from 5 Oct 1998)	–	5 MBd	–	–
NDCO-01	10 MBd	–	10 MBd	10 MBd
NDCO-02	5 MBd	–	10 MBd	10 MBd
NDCO-03	5 MBd	–	5 MBd	5 MBd

The optical components at each end of a fibre optic link must be of the same type for the light intensity and receiver sensitivity levels to match. 10 MBd optical components enable the use of lower-attenuation cables, and thus longer distances.

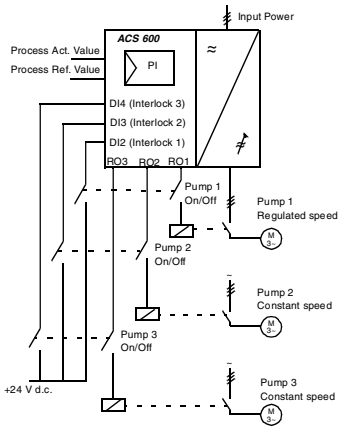
ACS 604 and ACS 607 frequency converters are always fitted with an NDCO-03 at the factory. ACS 601 units ordered with a fieldbus adapter, a pulse encoder interface module, or the Master/Follower Application Macro are automatically fitted with an NDCO-03 board.

The NDCO kits are also available separately, including coated versions designated NDCO-0x**C**.

Specialised Application Macros and Programs

In addition to the standard application program, there are specialised application macros and programs available.

Pump and Fan Control (ACS)



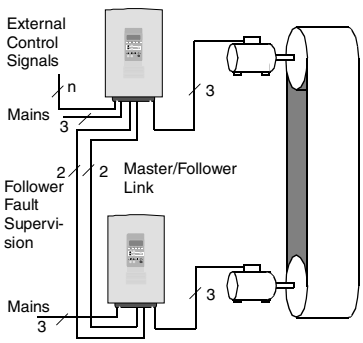
An ACS 600 equipped with the Pump and Fan Control (PFC) Application Macro can operate a pump/fan station with one to four parallel pumps/fans. The principle is as follows:

- The motor of pump no. 1 is connected to the ACS 600. The capacity of the pump is controlled by varying the motor speed.
- The motors of pumps nos. 2 and 3 are connected direct-on-line. These pumps can be switched on and off by the ACS 600 whenever necessary.
- The process reference and actual value are fed to the PI controller included in the PFC macro. The PI controller adjusts the speed of the first pump such that the process actual value follows the reference. When the speed exceeds the limit set by the user, the macro automatically starts the second pump. If even more capacity is required, the third pump is also started.

The PFC macro enables automatic pump alternation. It is also possible to implement an interlocking function where the macro detects the switch-off of a pump and starts another pump instead.

The PFC macro is available for ACS 600 frequency converters up to -0320-3, -0400-5 and -0400-6 inclusive.

Master/Follower (ACS/ACC)*



The Master/Follower Macro is designed for applications in which the equipment is run by several ACS 600 or ACC 600 drives and the motor shafts are coupled to each other via gearing, chain, belt etc. Thanks to the macro, the load can be evenly distributed between the drives.

External control signals are connected to the Master drive only. The Master controls the Follower(s) via a fibre optic serial link. The Master station is typically speed-controlled whereas the other drives follow the torque and/or speed reference of the Master.

*Optional for ACS, standard for ACC

Spinning Control (ACS)

The Spinning Control application program is designed for running spinning bobbins in ring frame textile machines. To achieve the best possible form for the doff, the drive follows a pre-set spinning sequence that can include 12 speed/time periods. These periods can also be offset, facilitating change of material. Yarn breakage is prevented by the wobbulation function, which adjusts the speed of the bobbin on the grounds of the ring rail position and the doff build-up stage.

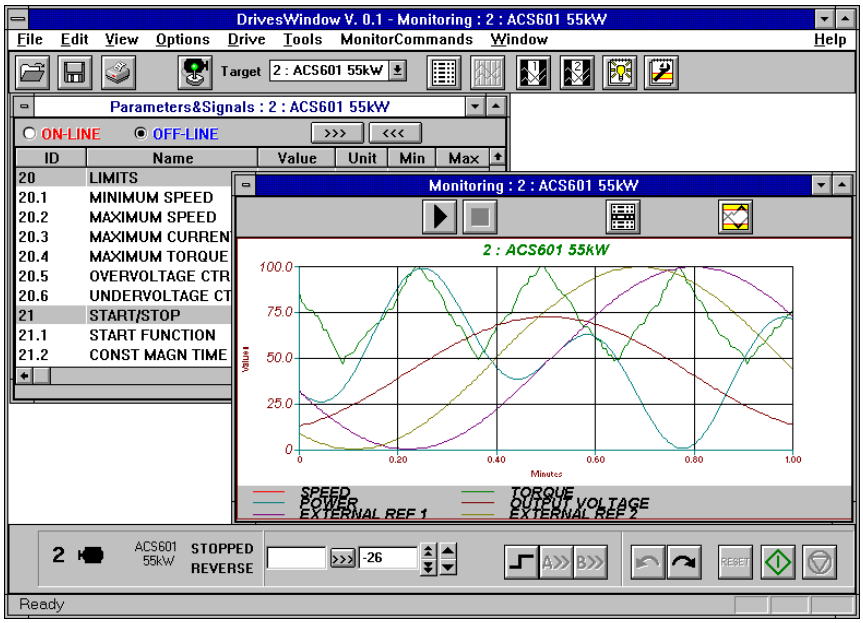
For further information, see the *Spinning Control Application Software* brochure, code: 3BFE 64018965.

Drive*Ware* PC Tools

The Drive*Ware* family of PC tools includes Windows-based applications for commissioning, control and maintenance of ACx 600 drives.

Drive*Window*

Drive*Window* is an application designed for online commissioning and maintenance purposes. It is possible to adjust the parameters, read the actual values and control the drive with Drive*Window* instead of the Control Panel. It is also possible to follow trends, draw graphs and load custom-made application software to the drive.



The Drive*Window* kit includes:

- either an ISA/DDCS or a PCMCIA/DDCS connection kit
- a pair of fibre optic cables
- installation CD-ROM.

Drive*Size*

Drive*Size* is an application designed for dimensioning of motors (ABB or customer-specified AC motors), drives and transformers in a drive system. Drive*Size* comes with Mot*Size,* a dimensioning tool for direct-on-line motors.

Drive*Builder*

Drive*Builder* is a tool for generating bills of material, actual cabinet dimensions and electrical single-line diagrams. In addition, Drive*Builder* produces system-specific customer documentation on the grounds of user input as well as information imported from Drive*Size.*

Drive*Support*

Drive*Support* is a multimedia-based service tool for ABB drives. It provides actual pictures and clear instructions for troubleshooting and servicing the drive. Drive*Support* also creates a maintenance record, including types of faults, operators' names, and service activities performed since start-up.

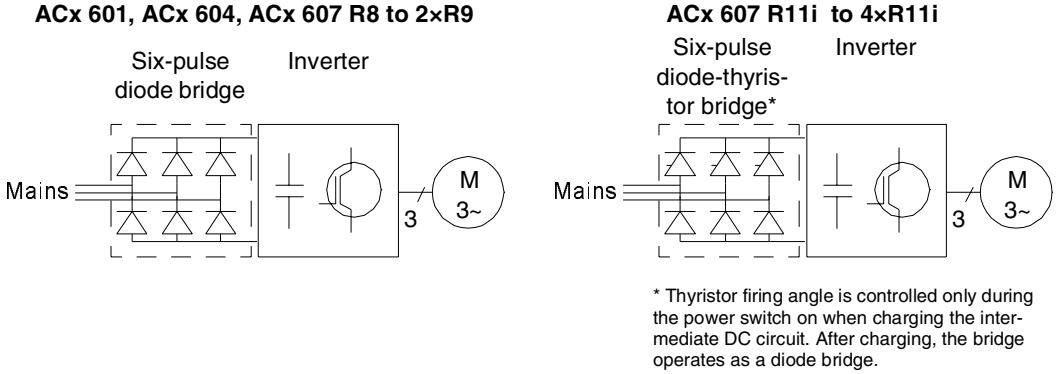
The customer can tailor Drive*Support* to meet the needs of his specific process by adding his own graphics, user language, more detailed instructions, spare part numbers and contact information.

Drive*Link* Drive*Link* is an application for connecting ABB drives with PC-based monitoring systems. Drive*Link* is compatible with all Windows applications that support DDE (Dynamic Data Exchange), such as WonderWare Intouch®, Genesis®, Excel®, Visual Basic®, Drive*Support* and Adva Command®.

Supply Bridge Versions

Six-pulse Diode Supply (ACx 6**0**_)

A six-pulse diode supply is standard in ACx 600. The diode bridge feeds power in one direction only. No regeneration is possible.



* Thyristor firing angle is controlled only during the power switch on when charging the intermediate DC circuit. After charging, the bridge operates as a diode bridge.

Twelve-pulse Diode Supply (ACx 6**2**7)

The twelve-pulse diode supply is available for the cabinet assemblys in range 400 to 3600 kVA (ACx 627 types). The option includes two six-pulse rectifier bridges connected in parallel.

Total harmonics distortion can be remarkably reduced by using a twelve-pulse rectifier, which eliminates the fifth and seventh harmonics. Since a line filter cannot be used with a twelve-pulse rectifier (the secondary side of the transformer is floating), it is recommended to equip the supply transformer with a static screen to reduce conducted emission. Other requirements for the transformer are:

- Connection: Dyn 11 d0
- Voltage difference between secondaries < 0.3%
- Short circuit impedance of secondaries ≥ 5%
- Short circuit impedance difference between secondaries < 3%

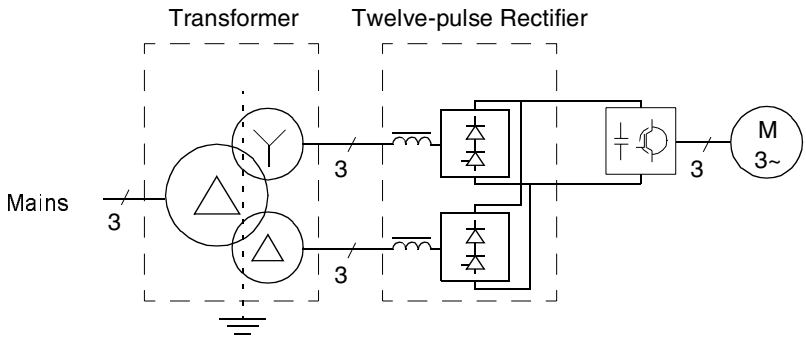


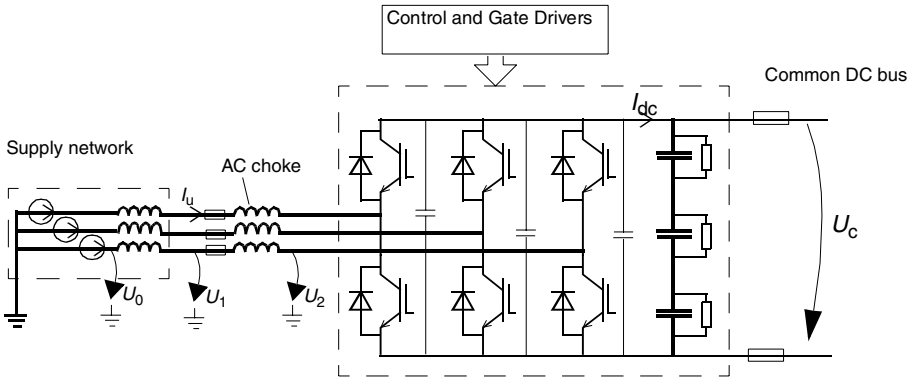
Figure 7-2 Circuit diagram of a Twelve-pulse Rectifier installation. The transformer has one primary and two secondary windings, and is equipped with a static screen. The secondary windings have a phase shift of 30°.

Regenerative IGBT Supply (ACx 6**1**__)

A regenerative IGBT input bridge is available for the wall mounted ACS 600 types in range 25 to 70 kVA (ACx 611 types), and for the cabinet assemblys in range 185 to 1380 kVA (ACx 617 types).

The IGBT bridge has the ability to regenerate back to the network, and it provides considerable energy savings with applications requiring excessive braking power.

IGBT bridge: ACx 611, ACx 617



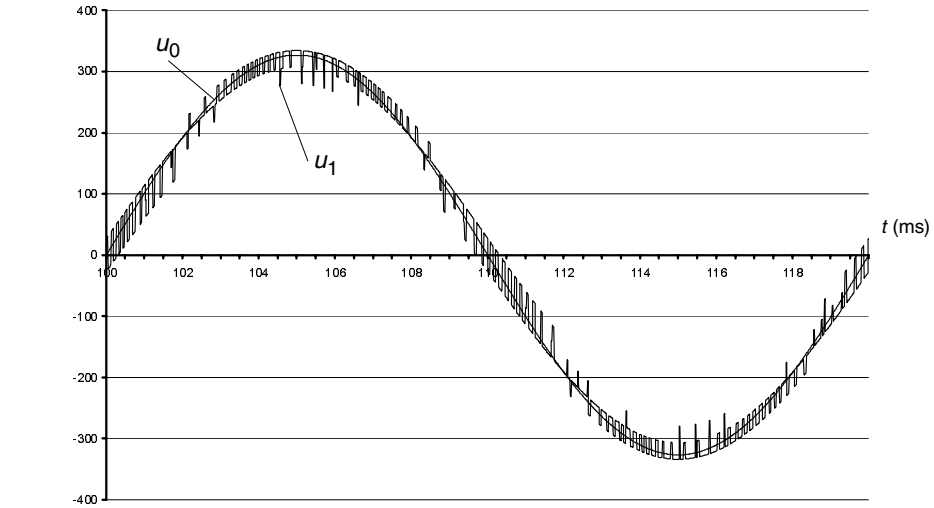
Operation

The ISU is a four-quadrant switching-mode converter. The a.c. current of the ISU is nearly sinusoidal at a unity power factor.

Voltage Waveforms

The high frequency switching and high du/dt slightly distorts the voltage waveform at the input of the converter. The depth of the voltage notches depends on the ratio of network inductance to total line inductance (network + AC choke inductance).

The waveforms of u_0 and u_1 shown below.



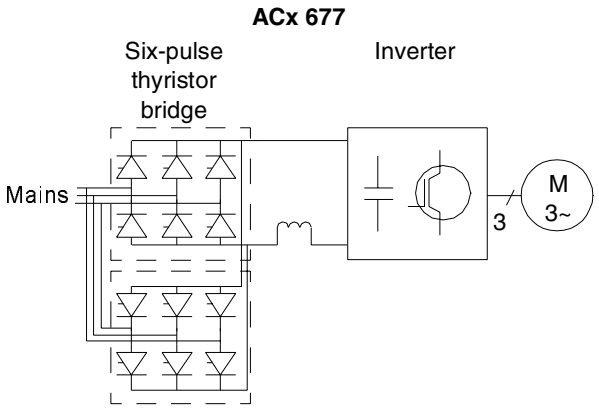
Harmonics

IGBT Supply Unit does not generate characteristic current/voltage overtones the way a traditional 6- or 12-pulse bridge does, because of

the sinusoidal waveform of the line current. The typical spectrum of the line current and line-to-line voltage harmonics is quite wide, but there are no high individual components. The Total Harmonic Distortion (THD) in voltage depends highly on the Short Circuit Ratio in the Point of Common Coupling (PCC).

Regenerative Thyristor Supply (ACx 67_)

A regenerative thyristor supply is available for the cabinet assemblys in range 185 to 3350 kVA (ACx 677 types). It consists of two six-pulse thyristor bridges in antiparallel connection. Thyristor supply has the ability to regenerate back to the network, and provides considerable energy savings with applications requiring excessive braking power.



Resistor Braking

Effective motor braking and short deceleration times can be achieved using resistor braking. In resistor braking, whenever the voltage in the intermediate circuit of a frequency converter exceeds a certain limit, a braking chopper connects the circuit to a braking resistor.

Braking Chopper NBRA-6xx

The NBRA-6xx series includes braking choppers for all ACx 600 types. Some of the choppers are to be mounted inside the converter unit; others are to be mounted outside the converter unit. (See the footnote at Table 7-1.)

The control board of the NBRA-6xx supervises the system status and detects failures such as braking resistor and resistor cable short circuits, chopper short circuit, chopper control card failure, and resistor overtemperature (optional).

There is one digital input, one relay output, and two fibre optic connectors on the chopper control board. The input can be connected to a resistor-mounted temperature sensitive switch to protect the resistor against overtemperature. The relay output indicates the faults listed above. The fibre optic connectors can be used for synchronising two or more choppers.

Braking Resistor SACE/SAFUR

The SACE/SAFUR braking resistors are separately available for all ACx 600 types. Resistors other than the standard resistors may be used providing the specified resistance value is not decreased, and the heat dissipation capacity of the resistor is sufficient for the drive application. For resistor specifications, see Table 7-1.

Cables and Fuses

Screened cable must be used. See the rating tables (Table 7-1 and Table 7-2) for specifications for standard cables. Two-conductor cable may also be used if available. The cable screen is essential for minimising electromagnetic interference. The length of the cable between the ACx 600 and the chopper must not exceed 5 metres; the length of the cable between the chopper and resistor must not exceed 20 metres.

For ACx 601 units, no separate fuses in the braking circuit are required if the following conditions are met:

- the ACx 600 mains cable is protected with fuses
- no mains cable/fuse overrating takes place
- in the braking circuit the specified cable is used (Table 7-3)

For ACx 607 R8 to 2×R9 and ACx 607 R11i to 4×R11i, the cables in the braking circuit must be protected with fuses. (Factory-installed choppers are automatically equipped with fuses when necessary.)

Applicability

The chopper(s) and resistor(s) suitable for each ACx 600 type, as well as technical data for each configuration (maximum braking power, fuses, cable cross-sections, etc.) are detailed in Tables 7-2 and 7-3. Table 7-4 gives the dimensions and weights for each chopper and resistor.

All choppers and resistors are available separately. Factory-installed choppers and resistors are available as follows:

ACx 601, Frames R2 and R3

Braking choppers and resistors are available as add-on kits only. The chopper and the resistor are to be installed outside the converter unit.

ACx 601, Frames R4 to R7

Braking choppers are available as factory-installed inside the converter unit. Braking resistors are available as add-on kits only, and are to be installed outside the converter unit.

ACx 604, Frame R7

Braking choppers and resistors are available as add-on kits only. The chopper is to be installed inside the converter unit; the resistor is to be installed outside the converter unit.

ACx 604, R8, R9, 2×R8, 2×R9

Braking choppers and resistors are available as add-on kits only. All components of the chopper circuit are to be installed outside the converter unit(s).

ACx 607, Frame R7

Braking choppers and resistors are available as factory-installed (line contactor compulsory). The chopper is installed inside the converter unit; the resistor (if ordered) is installed in a 400 mm wide cabinet extension on the right-hand side of the converter cabinet.

ACx 607, Frames R8 and R9

Braking choppers and resistors are available as factory-installed (line contactor compulsory). The chopper circuit is equipped with fuses.

The chopper without resistor option is installed in a 400 mm wide cabinet extension on the right-hand side of the converter cabinet. The chopper with resistor(s) option is installed in a 400 mm wide (one-resistor configurations) or 700 mm wide (two-resistor configurations) cabinet extension on the right-hand side of the converter cabinet.

ACx 607, Frames 2×R8 and 2×R9

Braking choppers and resistors are available as factory-installed (line contactors compulsory). Both chopper circuits are equipped with fuses.

The choppers without resistors option includes two choppers installed in two 400 mm wide cabinet extensions, one on either side of the converter cabinet. The choppers with resistors option includes two choppers with resistors, installed in two 700 mm wide cabinet extensions, one on either side of the converter cabinet.

ACx 607, Frames R11i, R12i, 2×R11i, 2×R12i, 4×R11i

Braking choppers and resistors are available as factory-installed (line contactor/air circuit breaker compulsory). Each chopper circuit is equipped with fuses and RC filtering.

The choppers without resistors option includes 3 to 6 (depending on converter type) choppers, each installed in a 400 mm wide cabinet extension on the right-hand side of the converter cabinet line-up. The choppers with resistors option includes 3 to 6 (depending on converter type) chopper/resistors combinations, each installed in a 400 + 800 mm cabinet extension on the right-hand side of the converter cabinet line-up.

Table 7-1 ACx 600 ratings for resistor braking.

ACx 600/Braking Chopper Combination			Braking Resistor(s)					Cable (Cu)
ACx 600 Type	**Braking Chopper Type**	**Braking Power P_{BRmax} [kW]**	**Type**	***R* [ohm]**	**E_R [kJ]**	**P_{Rcont} [kW]**	**No. of Elements***	***A* [mm^2]**
400 V a.c. Units								
-0005-3	NBRA-653	5.0	SACE08RE44	44.0	210.0	1	2	3x6+6
-0006-3	NBRA-653	6.2	SACE08RE44	44.0	210.0	1	2	3x6+6
-0009-3	NBRA-653	8.3	SACE08RE44	44.0	210.0	1	2	3x6+6
-0011-3	NBRA-653	11.0	SACE15RE22	22.0	420.0	2	4	3x6+6
-0016-3	NBRA-653	14.4	SACE15RE22	22.0	420.0	2	4	3x6+6
-0020-3	NBRA-654	19.7	SACE15RE13	13.0	435.0	2	4	3x6+6
-0025-3	NBRA-654	26.9	SACE15RE13	13.0	435.0	2	4	3x6+6
-0030-3	NBRA-655	33.2	SAFUR90F575	8.0	1800	4.5	9	3x25+16
-0040-3	NBRA-655	39.0	SAFUR90F575	8.0	1800	4.5	9	3x25+16
-0050-3	NBRA-655	52.8	SAFUR90F575	8.0	1800	4.5	9	3x25+16
-0060-3	NBRA-656	65.6	SAFUR80F500	6.0	2400	6	12	3x35+16
-0070-3	NBRA-656	79.5	SAFUR125F500	4.0	3600	9	18	3x35+16
-0100-3	NBRA-657	94.2	SAFUR125F500	4.0	3600	9	18	3x70+35
-0120-3	NBRA-657	128.3	SAFUR200F500	2.7	5400	13.5	27	3x70+35
-0140-3	NBRA-658	154.5	SAFUR200F500	2.7	5400	13.5	27	see Table 7-2
-0170-3	NBRA-658	190.7	2×SAFUR125F500	2.0	7200	18.0	2×18	
-0210-3	NBRA-658	229.5	2×SAFUR210F575	1.70	8400	21.0	2×21	
-0260-3	NBRA-659	282.3	2×SAFUR200F500	1.35	10800	27.0	2×27	
-0320-3	NBRA-659	352.8	2×SAFUR180F460	1.20	12000	30	2×30	
-0400-3	2×NBRA-658	436.1	2×(2×SAFUR210F575)	2×1.70	2×8400	2×21.0	2×(2×21)	
-0490-3	2×NBRA-659	536.3	2×(2×SAFUR200F500)	2×1.35	2×10800	2×27.0	2×(2×27)	
-0610-3	2×NBRA-659	670.3	2×(2×SAFUR180F460)	2×1.20	2×12000	2×30	2×(2×30)	
-0760-3	3xNBRA-659	1060	3x(2×SAFUR180F460)	3x1.20	3x12000	3x30	3x(2×30)	
-0930-3	3xNBRA-659	1060	3x(2×SAFUR180F460)	3x1.20	3x12000	3x30	3x(2×30)	
-1120-3	4×NBRA-659	1411	4×(2×SAFUR180F460)	4×1.20	4×12000	4×30	4×(2×30)	
-1440-3	5xNBRA-659	1764	5x(2×SAFUR180F460)	5x1.20	5x12000	5x30	5x(2×30)	
-1770-3	5xNBRA-659	1764	5x(2×SAFUR180F460)	5x1.20	5x12000	5x30	5x(2×30)	
-2140-3	6xNBRA-659	2117	6x(2×SAFUR180F460)	6x1.20	6x12000	6x30	6x(2×30)	
-2340-3	6xNBRA-659	2117	6x(2×SAFUR180F460)	6x1.20	6x12000	6x30	6x(2×30)	
-2820-3	6xNBRA-659	2117	6x(2×SAFUR180F460)	6x1.20	6x12000	6x30	6x(2×30)	
500 V a.c. Units								
-0006-5	NBRA-653	6.3	SACE08RE44	44.0	210.0	1	2	3x6+6
-0009-5	NBRA-653	7.8	SACE08RE44	44.0	210.0	1	2	3x6+6
-0011-5	NBRA-653	10.4	SACE08RE44	44.0	210.0	1	2	3x6+6
-0016-5	NBRA-653	14.0	SACE15RE22	22.0	420.0	2	4	3x6+6
-0020-5	NBRA-653	18.5	SACE15RE22	22.0	420.0	2	4	3x6+6
-0025-5	NBRA-654	25.2	SACE15RE13	13.0	435.0	2	4	3x6+6
-0030-5	NBRA-654	31.4	SACE15RE13	13.0	435.0	2	4	3x6+6
-0040-5	NBRA-655	42.6	SAFUR90F575	8.0	1800	4.5	9	3x25+16
-0050-5	NBRA-655	50.1	SAFUR90F575	8.0	1800	4.5	9	3x25+16
-0060-5	NBRA-655	62.6	SAFUR90F575	8.0	1800	4.5	9	3x25+16
-0070-5	NBRA-656	72.6	SAFUR80F500	6.0	2400	6	12	3x35+16
-0100-5	NBRA-656	88.4	SAFUR80F500	6.0	2400	6	12	3x35+16
-0120-5	NBRA-657	122.1	SAFUR125F500	4.0	3600	9	18	3x70+16
-0140-5	NBRA-657	147.3	SAFUR125F500	4.0	3600	9	18	3x70+16

ACx = ACS/ACC/ACP

ACx 600/Braking Chopper Combination			Braking Resistor(s)					Cable (Cu)
ACx 600 Type	**Braking Chopper Type**	**Braking Power P_{BRmax} [kW]**	**Type**	***R* [ohm]**	**E_R [kJ]**	**P_{Rcont} [kW]**	**No. of Elements***	***A* [mm^2]**
-0170-5	NBRA-658	181.1	SAFUR200F500	2.7	5400	13.5	27	see Table 7-2
-0210-5	NBRA-658	220.7	SAFUR200F500	2.7	5400	13.5	27	
-0260-5	NBRA-658	268.1	2×SAFUR125F500	2.0	7200	18.0	2×18	
-0320-5	NBRA-659	335.0	2×SAFUR210F575	1.7	8400	21.0	2×21	
-0400-5	NBRA-659	402.8	2×SAFUR200F500	1.35	10800	27.0	2×27	
-0490-5	2×NBRA-658	509.3	2×(2×SAFUR125F500)	2×2.0	2×7200	2×18.0	2×(2×18)	
-0610-5	2×NBRA-659	636.5	2×(2×SAFUR210F575)	2×1.7	2×8400	2×21.0	2×(2×21)	
-0760-5	2×NBRA-659	765.3	2×(2×SAFUR200F500)	2×1.35	2×10800	2×27.0	2×(2×27)	
-0930-5	3xNBRA-659	1208	3x(2×SAFUR200F500)	3x1.35	3x10800	3x27.0	3x(2×27)	
-1090-5	3xNBRA-659	1208	3x(2×SAFUR200F500)	3x1.35	3x10800	3x27.0	3x(2×27)	
-1380-5	3xNBRA-659	1208	3x(2×SAFUR200F500)	3x1.35	3x10800	3x27.0	3x(2×27)	
-1760-5	4×NBRA-659	1611	4×(2×SAFUR200F500)	4×1.35	4×10800	4×27.0	4×(2×27)	
-2160-5	5xNBRA-659	2014	5x(2×SAFUR200F500)	5x1.35	5x10800	5x27.0	5x(2×27)	
-2620-5	6xNBRA-659	2417	6x(2×SAFUR200F500)	6x1.35	6x10800	6x27.0	6x(2×27)	
-2850-5	6xNBRA-659	2417	6x(2×SAFUR200F500)	6x1.35	6x10800	6x27.0	6x(2×27)	
-3450-5	6xNBRA-659	2417	6x(2×SAFUR200F500)	6x1.35	6x10800	6x27.0	6x(2×27)	
(Continued)								

ACx 600/Braking Chopper Combination			Braking Resistor(s)					Cable (Cu)
ACx 600 Type	**Braking Chopper Type**	**Braking Power P_{BRmax} [kW]**	**Type**	***R* [ohm]**	**E_R [kJ]**	**P_{Rcont} [kW]**	**No. of Elements***	***A* [mm^2]**
(Continued) **690 V a.c. Units**								
-0009-6	NBRA-663	8.5	SACE08RE44	44.0	210	1	2	3x6+6
-0011-6	NBRA-663	12.9	SACE08RE44	44.0	210	1	2	3x6+6
-0016-6	NBRA-663	13.8	SACE08RE44	44.0	210	1	2	3x6+6
-0020-6	NBRA-663	19.8	SACE15RE22	22.0	420	2	4	3x6+6
-0025-6	NBRA-664	29.1	SACE15RE13	13.0	435	2	4	3x6+6
-0030-6	NBRA-664	35.0	SACE15RE13	13.0	435	2	4	3x6+6
-0040-6	NBRA-666	40.2	SACE15RE13	13.0	435	2	4	3x25+16
-0050-6	NBRA-666	53.0	SAFUR90F575	8.0	1800	4.5	9	3x25+16
-0060-6	NBRA-666	65.4	SAFUR90F575	8.0	1800	4.5	9	3x25+16
-0070-6	NBRA-666	80.1	SAFUR90F575	8.0	1800	4.5	9	3x35+16
-0100-6	NBRA-667	94.4	SAFUR80F500	6.0	2400	6	12	3x70+16
-0120-6	NBRA-667	132.5	SAFUR125F500	4.0	3600	9	18	3x70+35
-0140-6	NBRA-669	158.1	SAFUR210F575	3.4	4200	10.5	21	see Table 7-2
-0170-6	NBRA-669	193.4	SAFUR200F500	2.7	5400	13.5	27	
-0210-6	NBRA-669	228.5	SAFUR200F500	2.7	5400	13.5	27	
-0260-6	NBRA-669	275.9	2×SAFUR125F500	2.0	7200	18.0	2×18	
-0320-6	NBRA-669	346.7	2×SAFUR210F575	1.7	8400	21.0	2×21	
-0400-6	NBRA-669	403.7	2×SAFUR200F500	1.35	10800	27.0	2×27	
-0490-6	2×NBRA-669	524.2	2×(2×SAFUR125F500)	2×2.0	2×7200	2×18.0	2×(2×18)	
-0610-6	2×NBRA-669	658.7	2×(2×SAFUR210F575)	2×1.7	2×8400	2×21.0	2×(2×21)	
-0760-6	2×NBRA-669	767.0	2×(2×SAFUR200F500)	2×1.35	2×10800	2×27.0	2×(2×27)	
-0900-6	3xNBRA-669	1211	3x(2×SAFUR200F500)	3x1.35	3x10800	3x27.0	3x(2×27)	
-1040-6	3xNBRA-669	1211	3x(2×SAFUR200F500)	3x1.35	3x10800	3x27.0	3x(2×27)	
-1380-6	3xNBRA-669	1211	3x(2×SAFUR200F500)	3x1.35	3x10800	3x27.0	3x(2×27)	
-1710-6	4×NBRA-669	1615	4×(2×SAFUR200F500)	4×1.35	4×10800	4×27.0	4×(2×27)	
-2120-6	5xNBRA-669	2019	5x(2×SAFUR200F500)	5x1.35	5x10800	5x27.0	5x(2×27)	
-2540-6	6xNBRA-669	2422	6x(2×SAFUR200F500)	6x1.35	6x10800	6x27.0	6x(2×27)	
-2800-6	6xNBRA-669	2422	6x(2×SAFUR200F500)	6x1.35	6x10800	6x27.0	6x(2×27)	
-3350-6	6xNBRA-669	2422	6x(2×SAFUR200F500)	6x1.35	6x10800	6x27.0	6x(2×27)	

P_{BRmax} Maximum braking power of the ACx 600 equipped with the standard chopper and the standard resistor. The drive and the chopper will withstand this braking power for one minute every ten minutes. ***Note:*** The braking energy transmitted to the resistor during any period shorter than 400 seconds may not exceed E_R.

R Resistance value for the listed resistor type. ***Note:*** This is also the minimum allowable resistance value for the braking resistor.

E_R Energy pulse that the resistor assembly will withstand (400 s duty cycle). This energy will heat the resistor element from 40 °C to the maximum allowable temperature.

P_{Rcont} Continuous power (heat) dissipation of the resistor when placed correctly. Energy E_R dissipates in 400 seconds.

A Conductor cross-sectional areas for the copper cable to be used for connecting the braking resistor and the chopper (or the chopper and the ACx 600). The cable should have a concentric conductor (screen). The standard cables with three-phase conductors and a concentric conductor are given. A two-conductor screened cable may also be used if available.

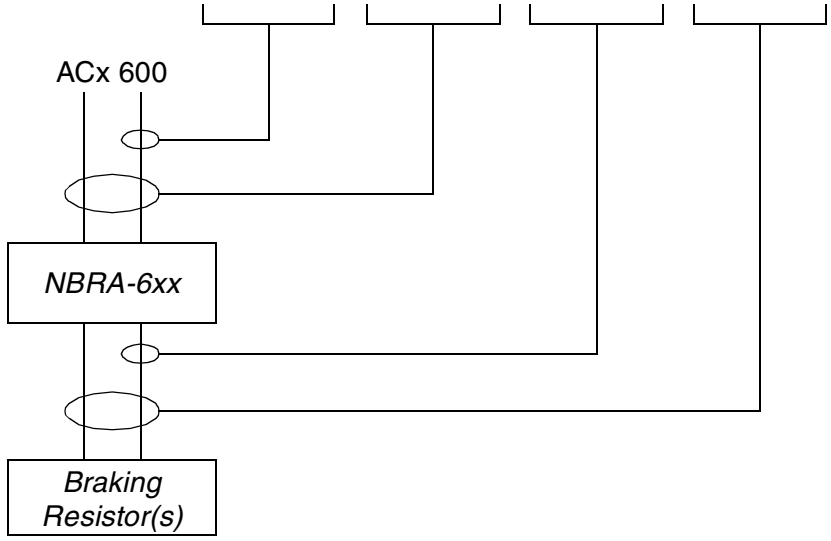
* The SACE04RE44 resistor consists of two resistor elements connected in parallel. The resistance of one element is 88 ohm.
The SACE15RE13 resistor consists of four resistor elements connected in parallel. The resistance of one element is 52 ohm.
The SACE15RE22 resistor consists of four resistor elements connected in parallel. The resistance of one element is 88 ohm.
The SAFUR resistors consist of several resistor elements. The resistance of one element is 8 ohm.

The NBRA-653 and -663 are to be installed outside the converter module. Their degree of protection is IP54.
The NBRA-654, -655, -656, -657, -664, -666 and -667 are to be installed inside the converter module.
The NBRA-658, -659 and -669 are to be installed outside the converter module. Their degree of protection is IP00.

All braking resistors are to be installed outside the converter module.
The SACE braking resistors are built in an IP21 metal housing.
The SAFUR braking resistors are built in an IP00 metal frame.

*Table 7-2 Braking circuit cable and fuse ratings for NBRA-658, NBRA-659 and NBRA-669. (**Note:** All ratings are per one braking chopper.)*

ACx 600 Type	Braking Chopper Type	Fuse (Ultrarapid)		Chopper Cable (Cu)		Resistor Cable (Cu)	
		I_{nom} [A]	[1] DIN 43653 Type	[2] Single-core [mm²]	Multicore [mm²]	[2] Single- core [mm²]	Multicore [mm²]
400 V a.c. Units							
-0140-3	NBRA-658	315	170M5140	50	3x70+35	50	3x70+35
-0170-3	NBRA-658	400	170M5142	70	3x95+50	50	3x50+25
-0210-3	NBRA-658	400	170M5142	70	3x95+50	50	3x50+25
-0260-3	NBRA-659	500	170M5144	95	3x120+70	50	3x70+35
-0320-3	NBRA-659	630	170M5146	120	3x185+95	70	3x95+50
-0400-3	2×NBRA-658	400	170M5142	70	3x95+50	50	3x50+25
-0490-3	2×NBRA-659	500	170M5144	95	3x120+70	50	3x70+35
-0610-3	2×NBRA-659	630	170M5146	120	3x185+95	70	3x95+50
-0760-3 to -2820-3	(3 to 6)x NBRA-659	630	170M5146	120	3x185+95	70	3x95+50
500 V a.c. Units							
-0170-5	NBRA-658	315	170M5140	50	3x70+35	50	3x70+35
-0210-5	NBRA-658	400	170M5142	70	3x95+50	70	3x95+50
-0260-5	NBRA-658	400	170M5142	70	3x95+50	50	3x50+25
-0320-5	NBRA-659	500	170M5144	95	3x120+70	50	3x70+35
-0400-5	NBRA-659	630	170M5146	120	3x185+95	70	3x95+50
-0490-5	2×NBRA-658	400	170M5142	70	3x95+50	50	3x50+25
-0610-5	2×NBRA-659	500	170M5144	95	3x120+70	50	3x70+35
-0760-5	2×NBRA-659	630	170M5146	120	3x185+95	70	3x95+50
-0930-5 to -3450-5	(3 to 6)x NBRA-659	630	170M5146	120	3x185+95	70	3x95+50
690 V a.c. Units							
-0140-6	NBRA-669	250	170M5138	35	3x50+25	35	3x50+25
-0170-6	NBRA-669	315	170M5140	50	3x70+35	50	3x70+35
-0210-6	NBRA-669	400	170M5142	70	3x95+50	70	3x95+50
-0260-6	NBRA-669	400	170M5142	70	3x95+50	50	3x50+25
-0320-6	NBRA-669	500	170M5144	95	3x150+70	50	3x95+50
-0400-6	NBRA-669	630	170M5146	120	3x185+95	70	3x95+50
-0490-6	2×NBRA-669	400	170M5142	70	3x95+50	50	3x50+25
-0610-6	2×NBRA-669	500	170M5144	95	3x150+70	50	3x95+50
-0760-6	2×NBRA-669	630	170M5146	120	3x185+95	70	3x95+50
-0900-6 to -3350-6	(3 to 6)x NBRA-669	630	170M5146	120	3x185+95	70	3x95+50



1) Ultrarapid Bussmann fuses (U_N = 1250 V). Fuses with the same ratings from other manufacturers can also be used. The type of the base for these fuses is 170H3005 (1400 V, 630 A, 110 mm).

2) In order for the installation to comply with the EMC Directive, unscreened single-core cable can only be used if routed inside a cabinet that efficiently suppresses the radiated RFI emissions.

Table 7-3 Braking Chopper and Resistor Dimensions and Weights.

Braking Chopper / Braking Resistor	Height mm	Width mm	Depth mm	Weight kg (Gross)
NBRA-653/663	198.5	157	149	2.9 (3.5)
NBRA-654/664	135	121	150	1.5 (3.1)
NBRA-655/656/665/666	176	140	156	2.3 (2.9)
NBRA-657/667	212	165	203	2.7 (3.3)
NBRA-658	584	334	240	24 (34)
NBRA-659/669	584	334	240	24 (34)
SACE08RE44	365	290	131	6.1 (6.5)
SACE15RE22	365	290	131	6.1 (6.5)
SACE15RE13	365	290	131	6.8 (7.2)
SAFUR80F500	600	300	345	14 (34)
SAFUR90F575	600	300	345	12 (32)
SAFUR180F460	1320	300	345	32 (52)
SAFUR125F500	1320	300	345	25 (45)
SAFUR200F500	1320	300	345	30 (50)
SAFUR210F575	1320	300	345	27 (47)

EMC Filters

The EMC Filters option minimises the RFI emission of the ACx 600. The option is available factory-installed as follows:

- Internal RFI filter boards for ACx 601 R2 to R7
- Line filter for ACx 607 R8 to 2×R9, and ACx 607 frame R11i.

The option is not available for 690 V units or 12-pulse supplied units.

Also note that it is not allowed to use the EMC Filters option on an unearthed (floating) mains supply network.

du/dt Filters

As with all frequency converters employing the most modern IGBT inverter technology, the ACx 600 output comprises – regardless of output frequency – pulses of approximately 1.35 times the mains network voltage with a very short rise time. The voltage can be almost double at the motor terminals, depending on motor cable properties.

du/dt filtering suppresses inverter output voltage spikes and rapid voltage changes that stress motor insulation. Additionally, du/dt filtering reduces capacitive leakage currents and high frequency emission of the motor cable as well as high frequency losses and bearing currents in the motor.

When to Use?

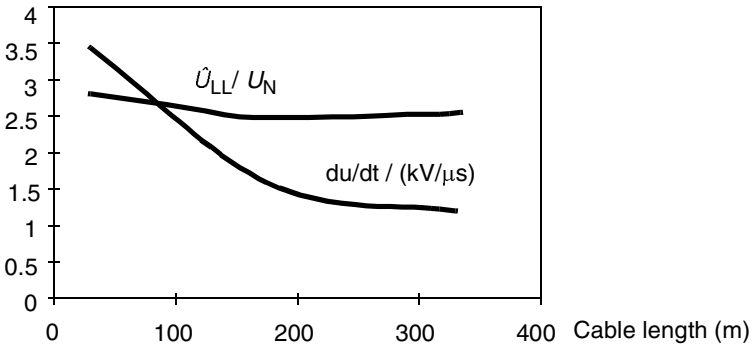
The need of du/dt filtering depends on the motor insulation. (For information on the construction of the motor insulation, consult its manufacturer.) Failure of the motor to fulfil the following requirements may shorten its life.

Motor Type	Nominal Mains Voltage (U_N)	Motor Insulation Requirement
ABB M2_ with IEC Frame	$U_N \leq 500$ V	Standard insulation system.
	500 V < $U_N \leq 600$ V	Standard insulation system in conjunction with du/dt filtering or reinforced insulation system.
	600 V < $U_N \leq 690$ V	Reinforced insulation system in conjunction with du/dt filtering.
ABB M2_ with NEMA Frame	460 V $\leq U_N \leq$ 600 V	Reinforced insulation system.
Random-wound	$U_N \leq 420$ V	Insulation system must withstand $\hat{U}_{LL}$ = 1300 V.
	420 V < $U_N \leq 500$ V	If the insulation system withstands $\hat{U}_{LL}$ = 1600 V and $\triangle t$ = 0.2 μs, du/dt filtering is not required. With du/dt filtering, the insulation system must withstand $\hat{U}_{LL}$ = 1300 V.
	500 V < $U_N \leq 600$ V	Insulation system must withstand $\hat{U}_{LL}$ = 1600 V. du/dt filtering is required.
	600 V < $U_N \leq 690$ V	Insulation system must withstand $\hat{U}_{LL}$ = 1800 V. du/dt filtering is required.
Form-wound	$U_N \leq 690$ V	If the insulation system withstands $\hat{U}_{LL}$ = 2000 V and $\triangle t$ = 0.3 μs, du/dt filtering is not required.

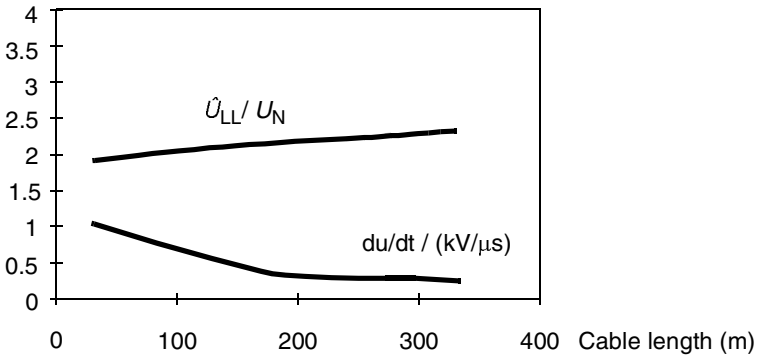
Symbol	Explanation
U_N	Nominal supply voltage.
$\hat{U}_{LL}$	Peak line-to-line voltage at motor terminals.
$\triangle t$	Rise time, i.e. interval during which line-to-line voltage at motor terminals changes from 10% to 90% of full voltage range. **Equals 0.8 · $\hat{U}_{LL}$/(du/dt).** The values of $\hat{U}_{LL}$ and du/dt can be read from the diagrams below.

The following diagrams present $\hat{U}_{LL}$ and *du/dt* as a function of cable length without and with du/dt filtering.

Without du/dt filtering



With du/dt filtering



Applicability Factory-installed du/dt Filters are available for ACx 607, ACx 617 and ACx 677. They are installed inside the converter cubicle (no additional cabinet is required).

The filters are separately available for all ACx 600 types. They need to be mounted externally. Unprotected (IP00) filters must be encased.

*Table 7-4 Applicability of du/dt Filters. The number indicates the quantity of Filters required for the ACx 600 type. (Note that the kits marked * include 3 filters.)*

ACx 601, ACx 604 and ACx 607 Types			ACx 617/677 Types			**du/dt Filter Type** (3 filters included in kits marked *)											
						Unprotected (IP00)							Protected to IP22			Protected to IP54		
						NOCH0016-60	NOCH0030-60	NOCH0070-60	*NOCH0120-60	*NOCH0260-60	*NOCH0400-60	NOCH0760-60	NOCH0016-62	NOCH0030-62	NOCH0070-62	NOCH0016-65	NOCH0030-65	NOCH0070-65
0005-3 0006-3 0009-3 0011-3	0006-5 0009-5 0011-5 0016-5	0009-6 0011-6 0016-6				1							1			1		
0016-3 0020-3	0020-5 0025-5	0020-6 0025-6 0030-6					1							1			1	
0025-3 0030-3 0040-3 0050-3 0060-3	0030-5 0040-5 0050-5 0060-5 0070-5	0040-6 0050-6 0060-6 0070-6						1							1			1
0070-3 0100-3 0120-3	0100-5 0120-5 0140-5	0100-6 0120-6							3									
0140-3 0170-3 0210-3	0170-5 0210-5 0260-5	0140-6 0170-6 0210-6 0260-6	0185-3 0225-3	0215-5 0255-5	0185-6 0205-6 0255-6 0315-6					3								
0260-3 0320-3	0320-5 0400-5	0320-6 0400-6	0265-3 0335-3	0325-5 0395-5	0375-6 0485-6						3							
0400-3	0490-5	0490-6								6								
0490-3 0610-3	0610-5 0760-5	0610-6 0760-6									6							
		0900-6	0405-3 0500-3 0630-3	0495-5 0610-5 0770-5	0600-6 0750-6 0900-6							3						
0760-3 0930-3	0930-5 1090-5	1040-6 1380-6	0765-3 0935-3	0935-5 1095-5	1045-6 1385-6						9							
1120-3	1380-5	1710-6	1125-3	1385-5								6						
1440-3 1770-3	1760-5 2160-5	2120-6 2540-6									18							
2140-3 2340-3	2620-5 2850-5	2800-6 3350-6										12						
2820-3	3450-5										36							

What to Consider

The main items to consider when opting to use du/dt filtering are:

- A slight decrease in motor pull-out torque caused by the voltage drop over the du/dt filter(s)
- Motor cable length restrictions
- The length of the cable between ACx 600 and the filter(s) must not exceed 3 metres
- Cooling requirements when encasing filters.

More information is obtainable from separate publication *du/dt Filters Installation Guide* (3AFY 58933368).

Dimensions and Weights

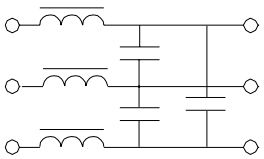
Table 7-5 Dimensions and weights of the du/dt Filters.

du/dt Filter	Height mm	Width mm	Depth mm	Weight kg
NOCH0016-60	195	140	115	2.4
NOCH0016-62/65	323	199	154	6
NOCH0030-60	215	165	130	4.7
NOCH0030-62/65	348	249	172	9
NOCH0070-60	261	180	150	9.5
NOCH0070-62/65	433	279	202	15.5
NOCH0120-60	200	154	106	7
NOCH0260-60	383	185	111	12
NOCH0400-60	383	185	126	17
NOCH0760-60	500	250	176	43

Sine Filter / Step-up Drive

A sine filter is available as standard cabinet option for ACx 607-0210-6 to 0760-6 and -0210-5 to -0760-5. For the other ACx 607 units, ACx 617 and ACx 677, see section *Special Cabinet Options*. For the ACx 601 units, commercial filters have been tested and approved by ABB. For more information please consult your local ABB representative.

Sine Filter



The sine filter option includes:

- a filter connected at the ACx 607 output and installed inside an additional cubicle
- a modified drive software which is loaded at the factory to every ACx 607 with a sine filter

The sine filter efficiently suppresses the high-frequency components of the ACx 607 output; The voltage and current waveforms are sinusoidal. The filter consists of single phase reactors and AC capacitors.

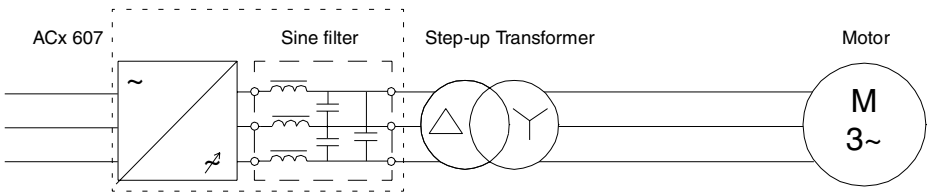
When to Use?

The sine filter makes it possible:

- to control a medium voltage motor using ACx 607 (through an additional step-up transformer)
- to use ACx 607 with a motor which does not have an adequate insulation level required with a frequency converter (i.e. a retrofit of an old direct-on-line motor)
- to use long motor cables (no voltage reflections)

Step-up Drive

The Step-up drive consists of the components shown in the figure below.



The step-up transformer is selected by the user.

Additional Information

See *User's Guide Step-up Sine Filter* (EN code: 64162519) for more information on:

- filter data (ratings, dimensions, losses etc.)
- the sine filter dedicated software features
- allowed motor cable length
- transformer selection instructions
- restrictions to be noted (ACx 607 output frequency range, voltage drop over sine filter)

Factory-installed Standard Cabinet Options

The standard cabinet options form pre-designed packages that are easy to implement to the basic product. Only a little engineering work at the factory is required: the part lists and the delivery drawings are ready-made and easy to tailor for each delivery.

Cabling Direction Options

As standard, all cables enter the cabinet from below. However, the cabling direction options make it possible e.g. to lead the supply cables into the cabinet from above.

Variant 1 For ACx 607 R7, R8 & R9, it is also possible to lead the supply cables through the roof, or lead both the supply and motor cables through the roof. The cabinet has two signal cable lead-throughs, one at the top, one at the bottom.

Variant 2 For ACx 607 2×R8, 2×R9, the mains supply cables can alternatively be led into the cabinet through the roof. The motor and signal cables are led through the bottom.

Variant 3 For ACx 607 R11i to 4×R11i, bottom or top entry can be selected for the mains supply cables (or busbars). ACS 627 R11i and R12i (when equipped with two B3 size rectifier modules) has two 600 mm additional cubicles for the mains cable entries.

The following motor cabling options are available:

- Motor cables exit the cabinet through the bottom of the inverter cubicle(s). In case of multiple inverter units in parallel, motor cables are run separately from each inverter unit to the motor.
- The outputs of all inverter units are led to an additional common motor terminal cubicle. Bottom or top motor cable exit can be selected. (Note that the common motor terminal cubicle is always required for top motor cable exit.) The widths of the additional cubicles are:
  For R11i: 400 mm
  For R12i: 600 mm
  For 2×R11i: 600 mm
  For 2×R12i: 800 mm
  For 4×R11i: 800 mm

These converters are equipped with signal cable lead-throughs both at the top and at the bottom.

Mains Supply Conductor Types

ACx 607 converters are, as standard, equipped with power cable lead-throughs. A busbar (bus duct) mains supply connection is available for ACx 607 R11i to 4×R11i, ACx 617 and ACx 677.

Earthing Switch

The supply section of ACx 607 R11i to ACx 617 and ACx 677 (apart from 12-pulse types ACx 627-0760-3, -0930-5, -1090-5, -0900-6 and -1040-6) can be optionally equipped with an earthing switch. It is used to earth the AC busbars for maintenance work on the system. The earthing switch is mechanically or electrically interlocked with the main switch.

Line Switching Equipment, Emergency Stop Functions

Variant 1

ACx 607 R7 to 2×R9 are automatically equipped with a switch fuse. A line contactor (two for 2×R8 and 2×R9) is optional. The line contactor(s) option includes an emergency stop push-button and a start/stop switch installed on the cabinet door. (External emergency stop push-buttons can be wired to a terminal block inside the converter cabinet.) Pressing the emergency stop push-button immediately opens the line contactors and the motor coasts to stop. See Immediate Removal of Power (IEC/EN60204-1 / Category 0) in subsection *Variant 2* below.

The Controlled Emergency Stop (IEC/EN60204-1 / Category 1) is a special cabinet option for ACx 607 R7 to 2×R9. See section *Special Cabinet Options*.

Variant 2

ACx 607 R11i to 4×R11i with supply unit type B3 (and type -0900-6) are available equipped either with a manually-operated switch fuse or with a switch fuse/contactor combination. Converters with supply unit type B4 or B5 (excluding -0900-6) are available equipped either with a manually-operated load switch/ disconnector or with an air circuit breaker.

If a contactor or an air circuit breaker is ordered, an emergency stop push-button and a start/stop switch are automatically included. One of the following emergency stop modes can be selected:

- Immediate Removal of Power (IEC/EN60204-1 / Category 0): the Emergency Stop command blocks the inverter semiconductors and opens the main contactor or air circuit breaker. The motor coasts to stop.
- Controlled Emergency Stop (IEC/EN60204-1 / Category 1): the Emergency Stop command stops the drive according to a drive parameter. After the drive is stopped, the main contactor or air circuit breaker is opened. The effective use of the Controlled Emergency Stop function requires a braking device (a chopper with resistors or a regenerative input bridge).

Standards for the Emergency Stop Option

The Emergency Stop option is designed in accordance with the standards:

- IEC/EN60204-1 :1997 “Safety of machinery – Electrical equipment of machines – Part 1: General requirements”
- EN418 :1992 “Safety of machinery – Emergency stop equipment, functional aspects – Principles for design”
- EN292 :1991 “Safety of machinery. Basic concepts, general principles for design. Part 2: Technical principles and specifications”
- EN954-1 :1996 “Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design”
- prEN954-2 :1998

Prevention of Unexpected Start-up

A Prevention of Unexpected Start-up circuitry is available as an option for ACx 607 R11i to 4×R11i, ACx 617 and ACx 677. For the other units see section *Special Cabinet Options*.

Operation

The Prevention of Unexpected Start-up function disables the control voltage of the power semiconductors, thus preventing the inverter from generating the AC voltage required to rotate the motor. The function makes the safe commissioning of the machinery possible without the need to switch off the AC drive power supply. Note that the function does not switch off the main or auxiliary voltages. Thus it does not fulfil the requirements stated for a safety switch: **no maintenance work of the electric parts is allowed**.

IGBT Protection

A control voltage cut off of the loaded power semiconductors might cause damage. To avoid this, an IGBT protection is implemented by:

- connecting an auxiliary contact of the A400 relay unit to the NDIO module digital input DI1, and
- setting the module DI1 as the source for the “emergency stop by coast” command in the drive application program (parameter setting).

If the Prevention of Unexpected Start-up circuit is opened while the drive is running, the drive is first given the “emergency stop by coast” command, only after which the IGBT control voltage is cut off. The emergency stop causes a drive fault trip. Resetting is needed before the restart is possible.

Equipment

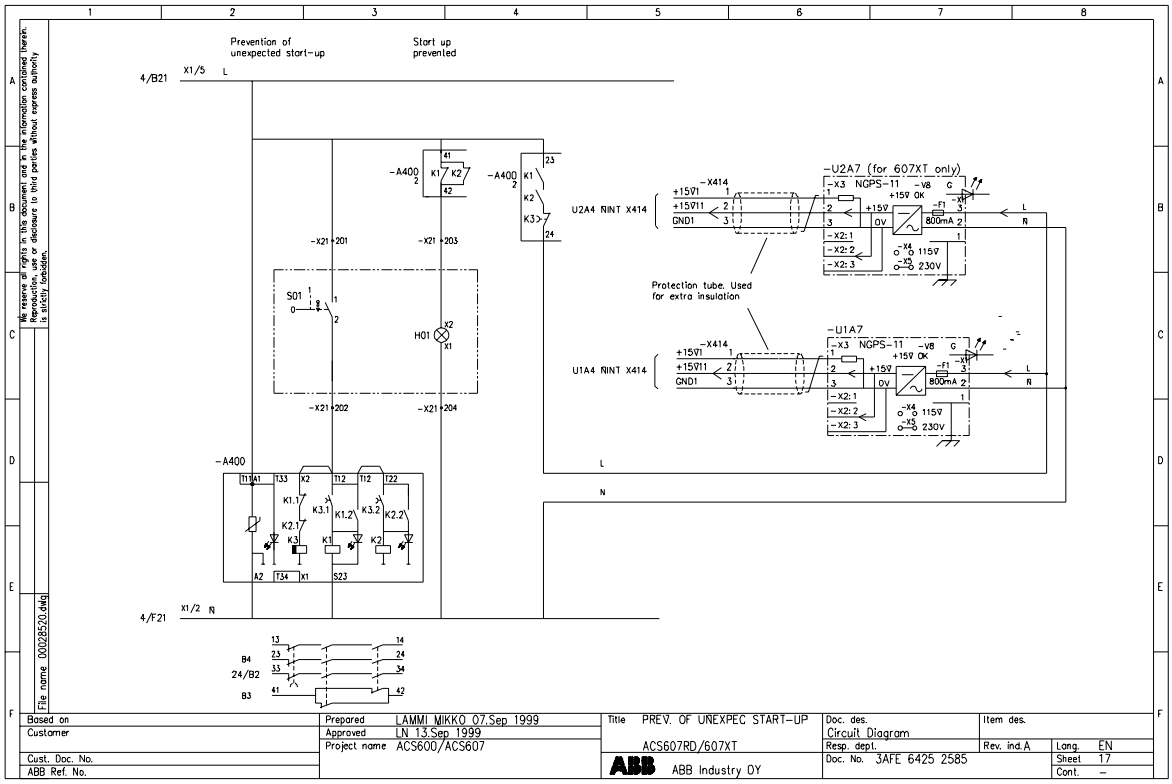
The table below lists the equipment of the Prevention of Unexpected Start-up circuit.

Symbol	**Description** (See the circuit diagrams below.)
A400	Relay unit
NGPS	Gate Driver Power Supply Board supplying inverter IGBT gate drivers
S01	Switching/disconnecting device for the circuitry (to be installed by the user). According to the standard: “Means shall be provided to prevent inadvertent, and/or mistaken closure of the disconnecting device.” For more information on the requirements, see the European standard EN 60204-1.
H01	Pilot light (to be installed by the user). On= Drive is in operation Off= Drive start is prevented
NDIO	Digital I/O Extension Module

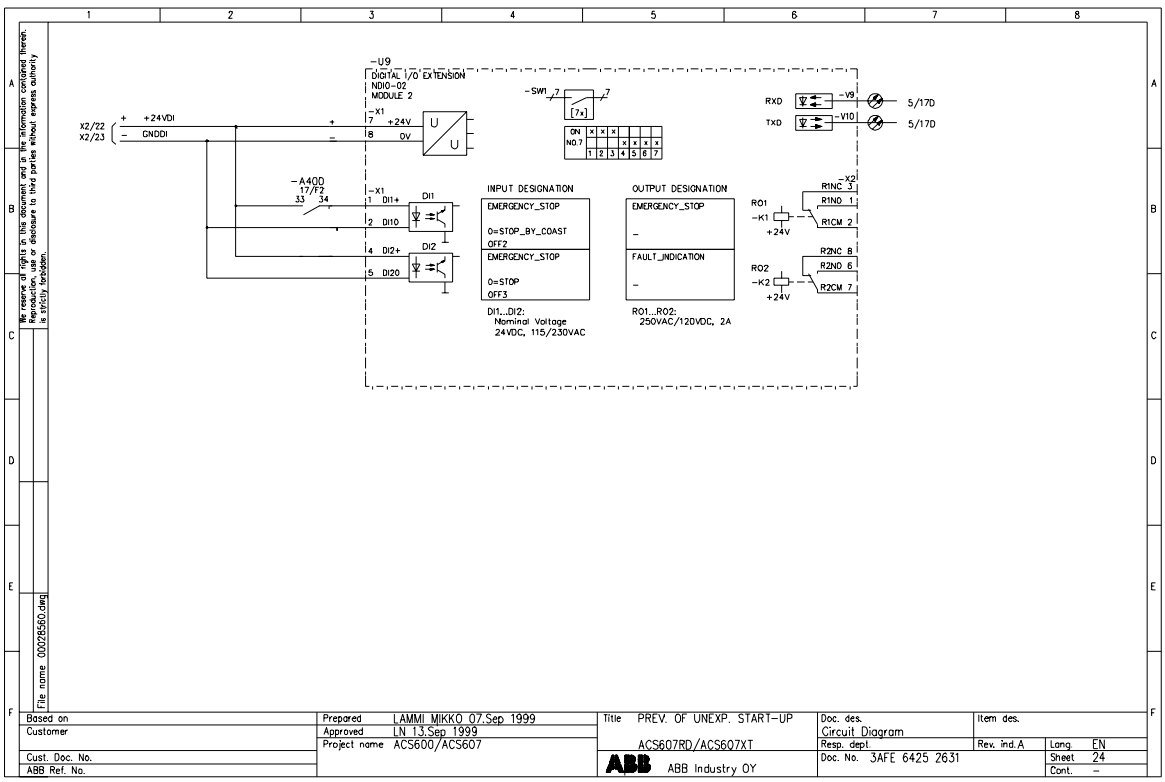
Notes

Note 1: The Prevention of Unexpected Start-up is not intended for stopping the drive.
Note 2: An attempt to start the drive while the Prevention of Unexpected Start-up is active will cause a drive fault trip. Resetting is needed before the restart is possible

Circuit Diagram 1 The figure below shows the Prevention of Unexpected Start-up circuit.



Circuit Diagram 2 The figure below shows the IGBT protection circuit.



DC Busbar Material

Aluminium DC busbars are standard for ACx 607 R11i to 4×R11i, ACx 617 and ACx 677. These converters are optionally available with tin-plated copper DC busbars.

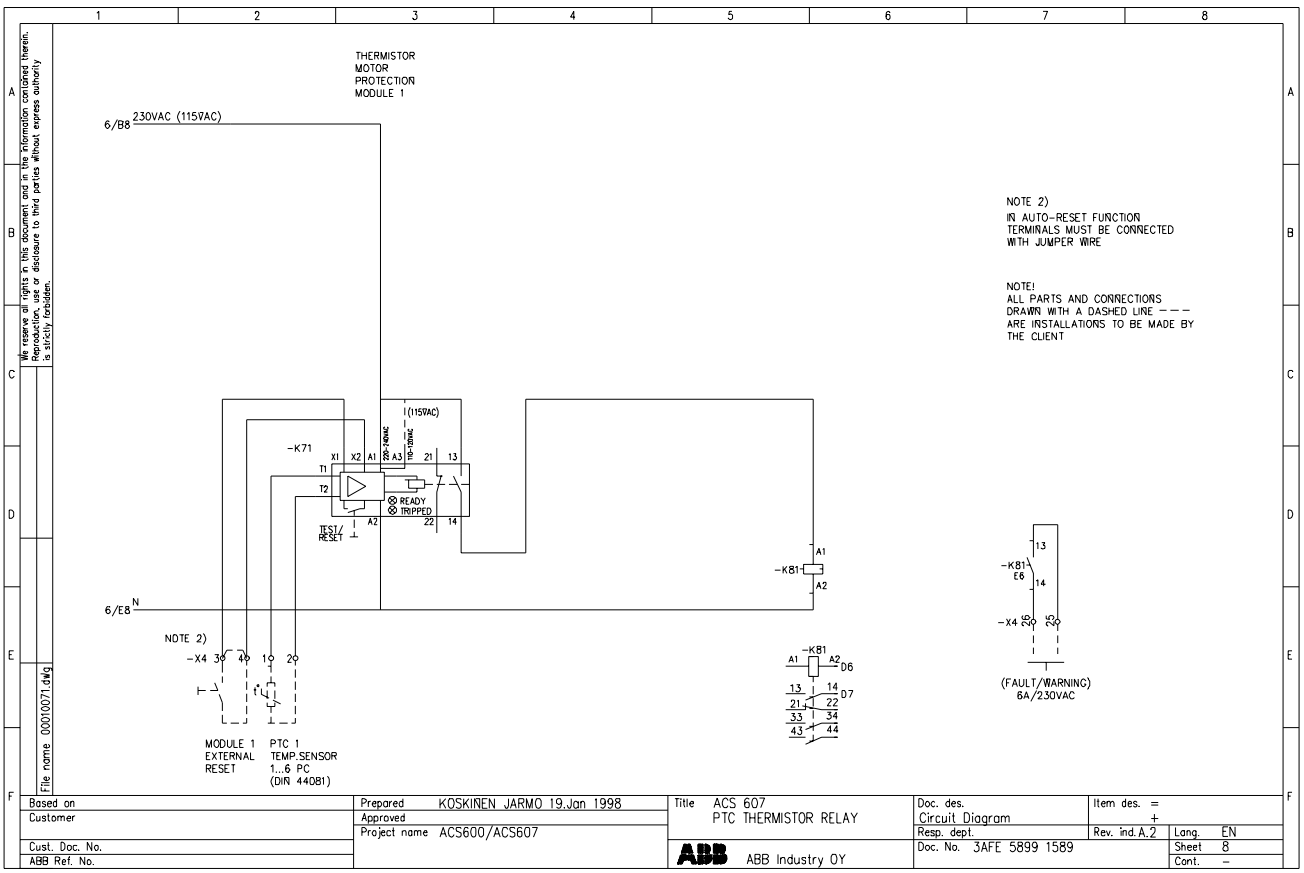
Thermistor (PTC) Relay

The Thermistor Relay is available as an option for all ACx 607, ACx 617 and ACx 677 units.

The option includes a PTC relay and an auxiliary relay wired to a terminal block.

A thermistor relay is used for the overtemperature supervision of motors equipped with the PTC thermistors. When the motor temperature rises to the thermistor wake-up level, the thermistor resistance increases sharply. The relay detects the change and indicates motor overtemperature through its auxiliary contacts.

The figure below shows the factory wirings. The connections to be done by the customer are drawn in dashed lines.



User Wirings, Examples

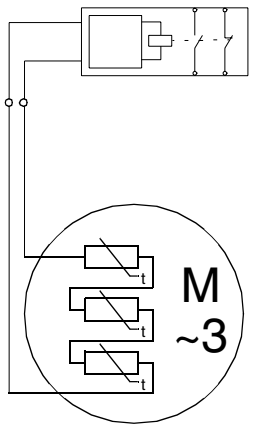
Example 1: Motor overtemperature causes main breaker trip. (See the figures above/below.)

- Connect motor PTC sensor(s) to the relay.
- Connect the normally open contact 13-14 of relay K81 to the main breaker control circuit.
- Connect a reset switch to the relay, or short circuit the reset switch terminals (= autoreset). ***Note:*** Autoreset is not allowed with the type “EEx e” motor used in explosive gas atmosphere.

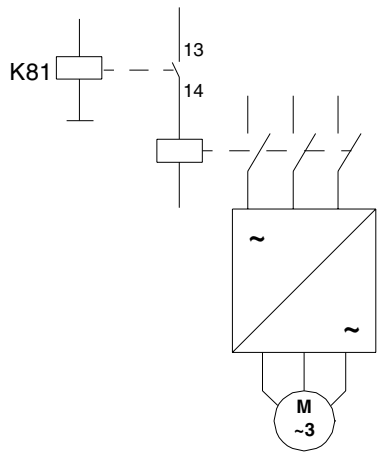
Example 2: Motor overtemperature causes ACS 600 fault trip. Panel display shows a fault message. (See the figures above/below.)

- Connect the motor PTC sensor(s) to the relay.
- Connect the normally open contact 13-14 of relay K81 to a digital input DI6.
- Activate the ACS 600 external fault supervision, and set the digital input DI6 to the fault signal interface.
- Connect a reset switch to the relay, or short circuit the reset switch terminals (= autoreset). ***Note:*** Autoreset is not allowed with the type “EEx e” motor used in explosive gas atmosphere.

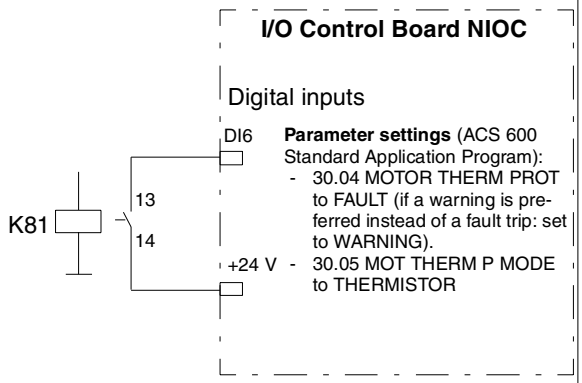
Motor Thermistor Connection



Example 1: Motor overtemperature trips the main breaker



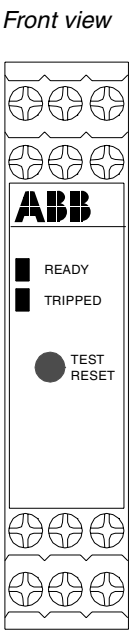
Example 2: Motor overtemperature trips the drive and generates a fault message on the panel display



Technical Data, Thermistor Relay

The table below shows the technical data of the thermistor relay.

Front view

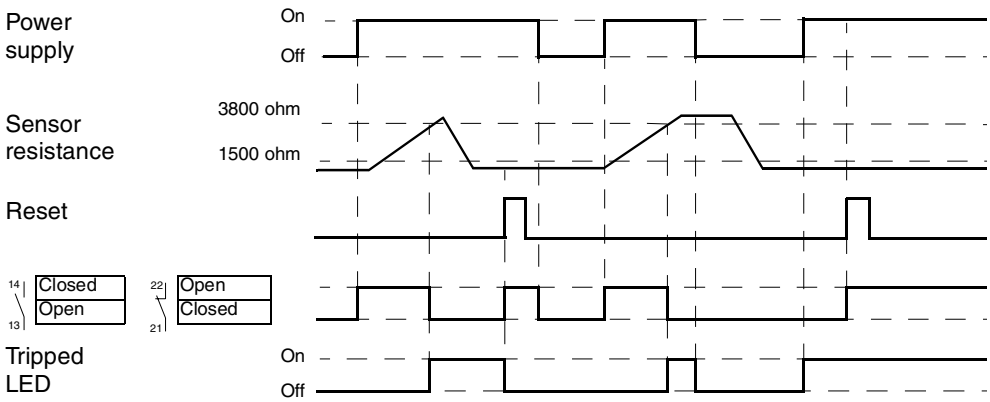


Type	ABB C506.02	
Rated control voltage (U_i)	115 or 230 V a.c.	
Rated frequency	50 Hz / 60 Hz	
Dielectric test voltage	2.5 kV	
Power consumption	< 2 W	
Conductor connection	2 • (0.5 mm^2 to 2.5 mm^2)	
PTC thermistor circuit		
Total cold state resistance per sensor loop	≤ 1.5 kΩ	
Triggering threshold	3.4 kΩ to 3.8 kΩ	
Recovery threshold	1.5 kΩ to 1.65 kΩ	
Measuring circuit load	≤ 5 mW (at cold resistance ≤1.5 kΩ)	
Thermistor circuit voltage	≤ 2 V (at cold resistance ≤ 1.5 kΩ)	
Max conductor length between sensor and relay	2.5 mm^2 1.5 mm^2 0.5 mm^2	2 • 2800 m 2 • 1500 m 2 • 500 m
Auxiliary contacts		
Auxiliary contacts	1 normally open + 1 normally closed	
Rated thermal current	5 A	
Rated operational current (AC-15)	3 A / 240 V	
Mechanical endurance	20 million ops.	

PDM-code: 00032021 - 24 Feb 2000

PTC Relay Operation Diagram

The figure below shows the state of the PTC relay contacts and the “Tripped” LED as a function of the temperature sensor resistance and power supply status.



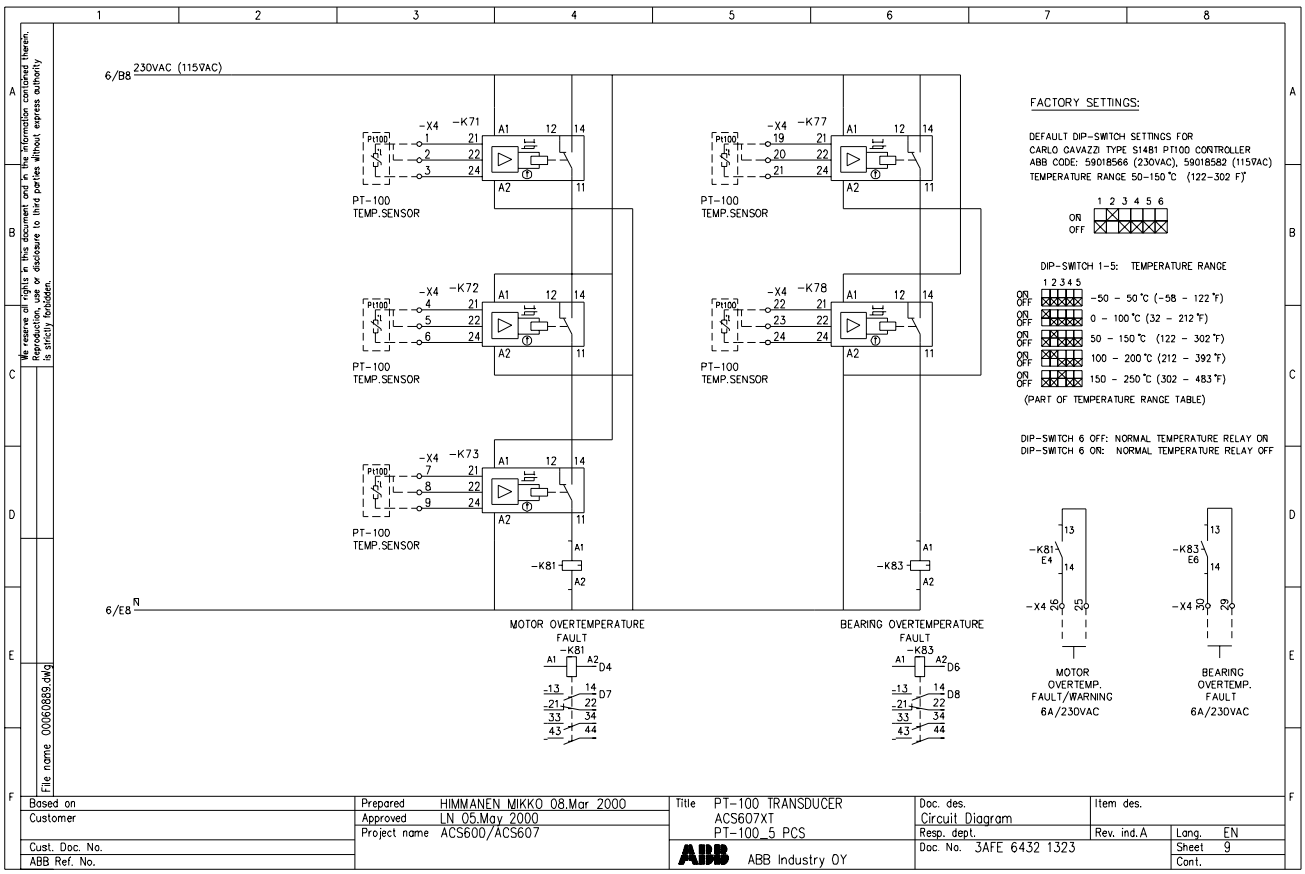
Pt100 Motor Protection

The Pt100 relay is available as an option for all ACx 607, ACx 617 and ACx 677 units. The number of relays is selectable.

The option includes a Pt100 relays and an auxiliary relays wired to a terminal block.

The Pt100 relay is used for the overtemperature supervision of motors equipped with the Pt100 sensors. As the motor temperature rises the sensor resistance increases linearly. At the adjustable wake-up level the relay releases and indicates motor overtemperature through a change-over contact.

The figure below shows the factory wirings of an assembly consisting of five Pt100 and Pt100 relays: Three Pt100s measure the temperature of motor windings, two Pt100s measure the temperature of the bearings. The connections to be done by the customer are drawn using dashed lines.



User Wirings, Examples

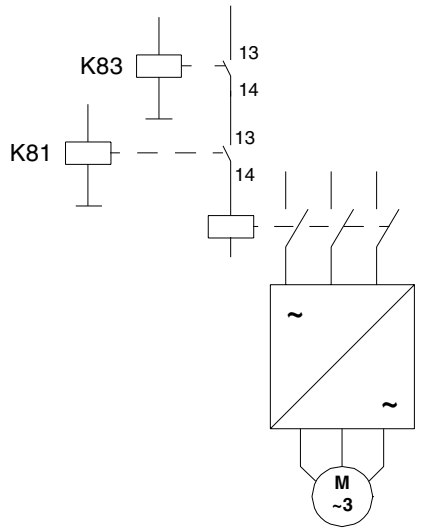
Example 1: Motor overtemperature causes main breaker trip

- Connect the motor Pt100 sensors as shown in the figure above.
- Connect the contact 13-14 of relay K81, and contact 13-14 of relay K83 to the main breaker control circuit as shown in the figure below.

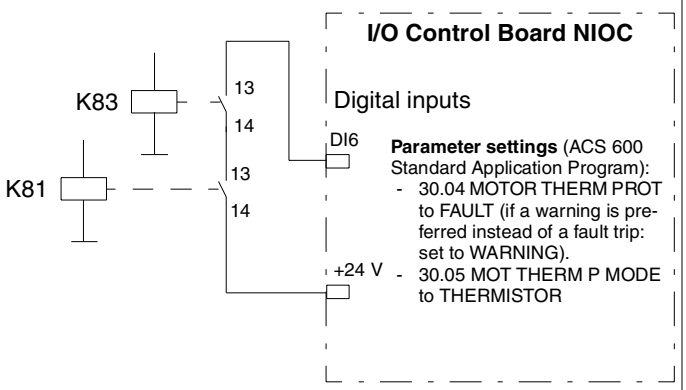
Example 2: Motor overtemperature causes ACS 600 fault trip. Panel display shows a fault message.

- Connect the motor Pt100 sensors as shown in the figure above.
- Connect the contact 13-14 of relay K81, and contact 13-14 of relay K83 to a digital input DI6 as shown in the figure below.
- Activate the ACS 600 external fault supervision, and set the digital input DI6 to the fault signal interface.

Example 1: Motor overtemperature trips the main breaker



Example 2: Motor overtemperature trips the drive and generates a fault message on the panel display



User Settings, Pt100 Relay

Temperature range setting (Five DIP switches)**:** The factory setting is 50 to 150 °C. However, it is a good practise to check the setting on field. For the alternative settings, see the circuit diagram above.

Overtemperature wake-up level (adjusting knob): To be set on field**.**

$$\frac{x}{100} \cdot \text{temperature range maximum °C}$$

x = percent value set with the knob

Hysteresis for the temperature supervision (adjusting knob): To be set on field

$$\frac{x}{100} \cdot 20\ °C$$

x = percent value set with the knob

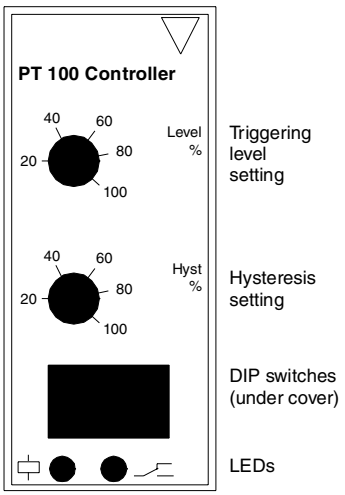
Pt 100 Relay Technical Data

Manufacturer: Carlo Gavazzi

Relay types: S1481 156 230 (for 230 V a.c. aux. voltage), or S1481 156 115 by Carlo Gavazzi (for 115 V a.c. aux. voltage)

LEDs for ”READY” and ”TRIPPED” indications

Front view

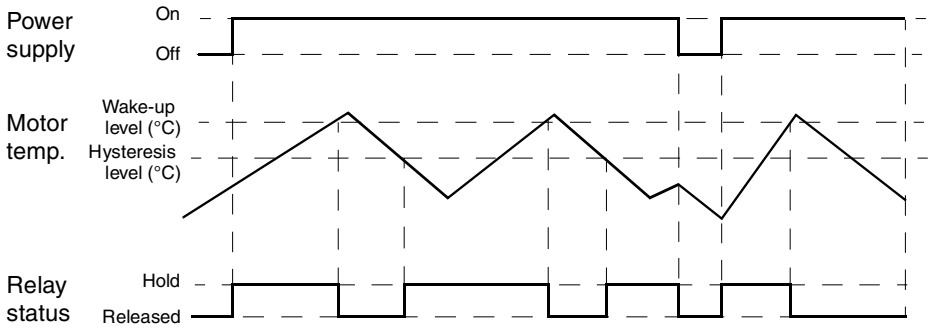


Temperature Settings	
Temperature Range	-50 … +850°C
Range selection	17 ranges, selected by DIP switches
Triggering level	Adjustable relative scale (0 to 100%)
Hysteresis	Adjustable on relative scale (1 to 20°C)
Dimensions and Weight	
WxHxD	35 x 80 x 80 (+ 30 mm mounting socket)
Weight	200 g
Sensor Circuit	
Input	Pt-100 temperature input (EN 60751)
Number of Pt100 channels	1 pc
Measurement range	- 50 to + 850 °C
Sensor connection	3-wire connection (2-wire possibility)
Sensor cable compensation	Up to 10Ω/wire in 3-wire system
Sensor current	< 1 mA
Scale inaccuracy	± 2 °C
Relay Output	
Auxiliary contacts	1 pcs SPDT
Rated insulation voltage	250VAC
Rated thermal current (AC1)	10 A / 250 VAC (2500VA)
Rated operational current (AC15):	2,5 A / 230 VAC
Dielectric voltage	2.0 kVAC
Rated impulse withstand voltage (IEC60664)	4 kV (1.2/50us)
Mechanical life	> 30 million operations
Electrical life (AC1)	> 100 000 operations (at max. load)

Carlo Gavazzi S1481 data sheet 08.03.2000 (PDM code: 00062630.pdf - 27.03.2000)
Specification PDM code: 00054664.doc - 27.01.2000

Pt100 Relay Operation Diagram

The figure below shows the state of the Pt100 relay as a function of the supervised temperature and power supply status. The relay is set to supervise overtemperature limit (DIP switch DI6 is off).



Cubicle Heater

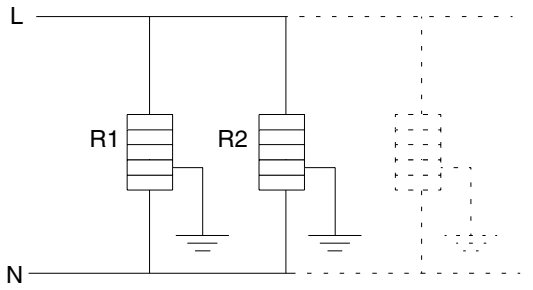
The Cubicle Heater is available as an option for all ACx 607, ACx 617 and ACx 677 units. The heater prevents humidity condensation inside the ACx 607 cabinet in a power-off state.

The Cubicle Heater option includes a heating element in each converter cubicle (in 1000 and 1500 mm wide cubicle there are two). The heater elements are to be supplied from an external 230 V a.c. power supply by the user (50 W per element).

Variant 1

In units up to ACx 607 R7 to 2×R9, the heating circuit must be equipped with external disconnector and protection device(s) by the user. Also the heater on/off control, if needed, should be arranged by the user.

The figure below shows the equipment and wirings.

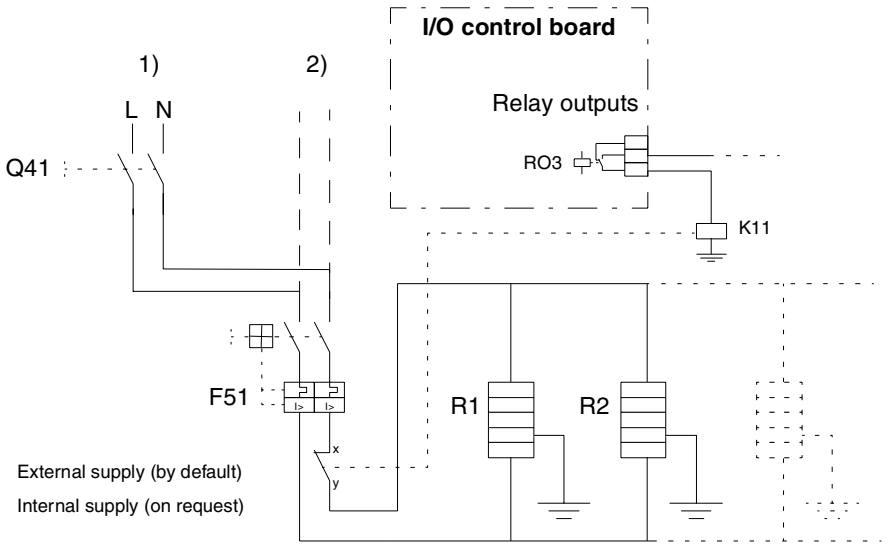


PDM-code: 00011581-C

Variant 2

In ACx 607 R11i to 4×R11i, ACx 617 and ACx 677, the heating circuit is equipped with a load switch and a protective circuit breaker. Heating is switched off when the drive supply bridge is operating i.e. a relay output on the I/O control board has energised relay K11.

The figure below shows the equipment and wirings.



PDM-code: 00011580-C

Starter for Auxiliary Motor Fan

The Starter for Auxiliary Motor Fan option is available as an option for all ACx 607, ACx 617 and ACx 677 units.

The option includes a motor protection switch and a contactor wired to a terminal block. The starter supplies a fan of a separately ventilated motor with a 3-phase supply voltage equal to the ACx 600 input voltage. (1, 2 or 4 auxiliary motor fan starters can be selected for ACx 607 R11i to 4×R11i, ACx 617 and ACx 677)

Table 7-6 Available current ratings for the auxiliary motor fan starters.

ACx 607 frames R7 to R9	ACx 607 frames 2×R8 to 2×R9	ACx 607 R11i to 4×R11i, ACx 617, ACx 677
1 to 1.6 A		1 to 1.6 A
1.6 to 2.5 A	1.6 to 2.5 A	1.6 to 2.5 A
2.5 to 4 A	2.5 to 4 A	2.5 to 4 A
4 to 6 A	4 to 6.3 A	4 to 6.3 A
	6 to 10 A	6 to 10 A
	9 to 14 A	9 to 14 A
	13 to 18 A	13 to 18 A
		18 to 25 A
		25 to 40 A (not for 690 V units)
		40 to 50 A (not for 500 V and 690 V units)

Motor Heater Outputs

The Motor Heater Outputs are available as a standard cabinet option for ACx 607 R11i to 4×R11i, ACx 617 and ACx 677. For the other units see section *Special Cabinet Options*.

The heater prevents humidity condensation inside the motor enclosure in the drive power-off state. When the main breaker of the drive is closed, the heater is off.

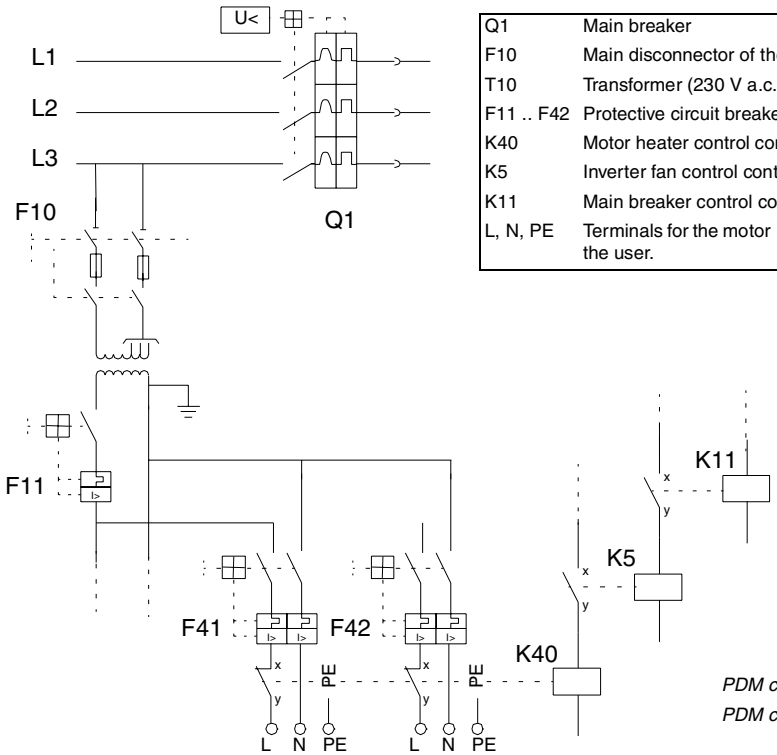
The option includes:

- Heater output terminals
- Terminals for the external power supply (**only** if external power supply is used)
- A protective circuit breaker and an on/off contact wired between the heater power supply and output terminals

Each heater output is rated to max. 230 V a.c., 4 A. The customer specifies:

- the number of heater outputs (two or four)
- the heater power source: internal (from the ACx 607 auxiliary voltage transformer), or external (a user-defined power supply)

The figure below shows the internal wiring of a configuration with two heater outputs. The heater terminals are supplied internally from the ACx 607 auxiliary transformer.



Q1	Main breaker
F10	Main disconnector of the auxiliary circuits
T10	Transformer (230 V a.c. or 115 V a.c. secondary)
F11 .. F42	Protective circuit breakers
K40	Motor heater control contactor
K5	Inverter fan control contactor
K11	Main breaker control contactor
L, N, PE	Terminals for the motor heater: To be connected by the user.

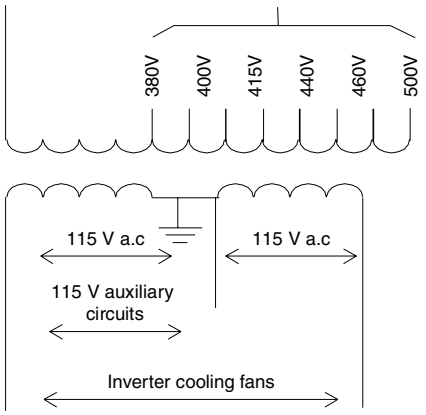
PDM code: 00011574.dwg - C
PDM code: 00011575.dwg - D

Auxiliary Control Voltage

As standard, all ACx 600 units are equipped with 230 V a.c. auxiliary voltage components.

115 V a.c. auxiliary voltage circuitry and components are available as a standard cabinet option for ACx 607 R11i to 4×R11i, ACx 617 and ACx 677. For the other units see section *Special Cabinet Options*.

Note: With combination 115 V a.c. / **50 Hz** control voltage, the inverter cooling fans need 230 V a.c. supply to meet the cooling requirements. The extra arrangement is shown in the figure below.



Auxiliary voltage transformer
- 380 to 500 V / **50 Hz** primary
- 115 V / **50 Hz** secondary (auxiliary circuits)
- 230 V / **50 Hz** secondary (inverter fans)

NAMC/NIOC Power Supply

The NAMC and NIOC boards of the ACx 600 are, as standard, powered from the frequency converter intermediate DC link through a Power Supply Board (NPOW). The NAMC and NIOC boards are live when the DC link is live i.e. the main breaker is closed.

To keep the NAMC and NIOC live also when the main contactor/breaker is open, the drive can be equipped with 230 V a.c. / 24 V d.c. power supply. See section *Power Supply Module NPSM-02*.

The NAMC/NIOC power supply is available as a standard cabinet option for ACx 607 R11i to 4×R11i, ACx 617 and ACx 677. For the other units see section *Special Cabinet Options*.

Terminals for External Control Voltage Supply (e.g. UPS)

The Terminals for External Control Voltage Supply (e.g. UPS) is available as an option for ACx 607 R11i to 4×R11i, ACx 617 and ACx 677. For the other units see section *Special Cabinet Options*.

The external supply backs up the internal control voltage supply i.e. it keeps the auxiliairy circuits live during a ACx 607 mains supply interruption. The supply is to be selected and connected by the user. Ratings:

- 230 or 115 V a.c. (according to the ACx 607 control voltage)
- 1000 VA

Option includes a disconnecting switch, connection terminals, protective circuit breakers and ACx 607 internal wirings.

Note: No Uninterrupted Power Supply (UPS) is included: The user selects (and instals) the UPS if a battery charged back up is needed. The UPS is also to be fed by a user-defined power source.

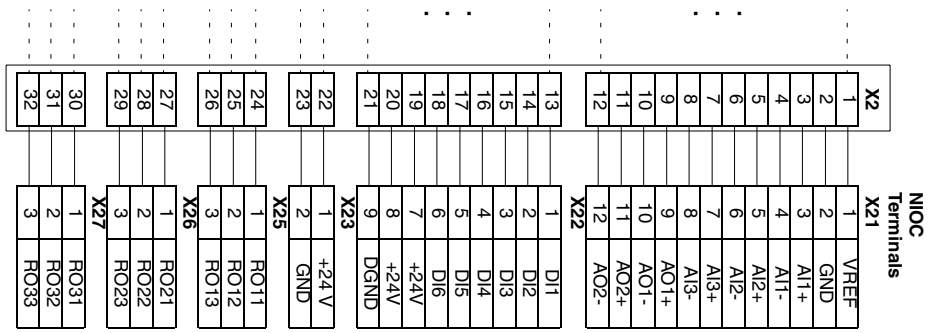
Note: To keep the ACx 607 control live during a mains supply interruption:

- The control voltage supply is to be backed up.
- The Application and Motor Control Board, NAMC, and Standard I/O Control Board, NIOC, are to be fed through an optional 230 V a.c / 24 V d.c. power supply module. See subsection *NAMC/NIOC Power Supply*.

Additional I/O Terminal Block X2

An additional terminal block X2 for the user digital and analogue I/O signal connections is included as default for ACx 607 R11i to 4×R11i, ACx 617 and ACx 677. X2 is available as an option for ACx 607 R7 to 2×R9.

The terminal block X2 is installed beside the NIOC board on a easy-to-access assembly plate. The X2 terminals are wired to the NIOC board I/O terminals at the factory. See the figure below.



X2:

- terminals for the user I/O signal connections
- conductors 0.5 to 2.5 mm^2 (# 20 to # 14 AWG)

X21, X22, X23, X25, X26, X27:

- I/O terminals on the NIOC Board
- conductors 0.5 to 1.5 mm^2 (# 20 to # 16 AWG)

Earth Fault Protection in IT Network (floating mains supply)

The earth fault protection is a standard feature for ACx 607 R7 to 2×R9. See *Chapter 6 – Standard Features*.

The earth fault protection in IT network is available as an option for ACx 607 R11i to 4×R14i, ACx 617 and ACx 677. This section describes the protection for these units.

The option includes an assembly of four resistors (SCAU-Z), a rectifier, an overvoltage relay and an fault indication circuitry wired as shown below.

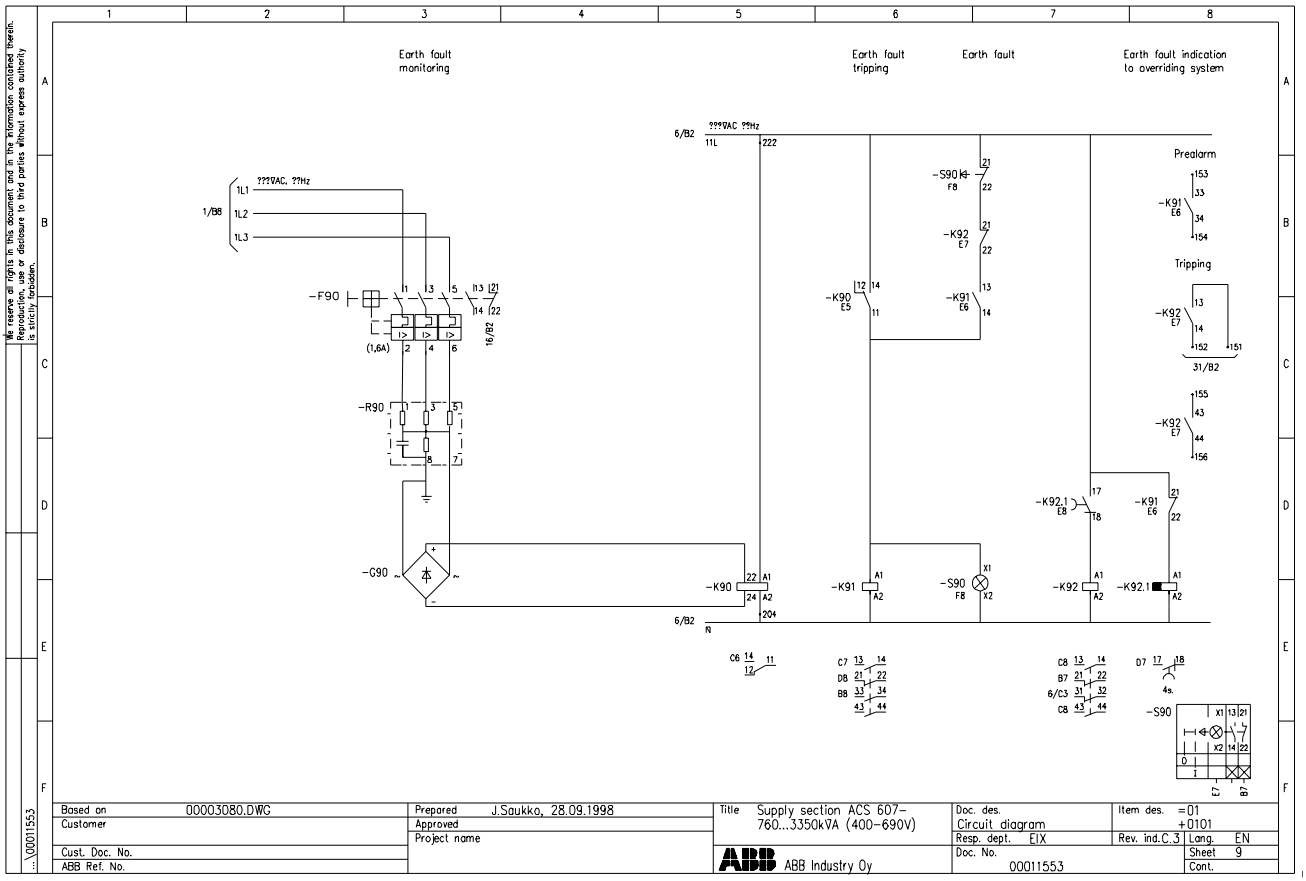
Operation

Three symmetrically connected resistors form an artificial neutral point to the 3-phase system. A high resistance resistor is connected between the artificial neutral point and the earth. The overvoltage relay supervises the rectified voltage over the high resistance resistor. An earth fault at the inverter output causes an asymmetry to the 3-phase system and a voltage difference between the neutral point and the earth. The overvoltage relay detects the voltage difference and wakes up.

Stage	Description
1. Earth fault occurs	Overvoltage relay K90 operates. Relay K91 operates. K91/21-22 de-energises time relay K92.1. K91/33-34 gives a prealarm to an external system (if wired by the user).
2. a) Earth fault condition ceases in less than 4 s.	K90 releases. K91 releases. K92.1 operates. Prealarm contact reset (K91/33-34).
2. b) Earth fault lasts longer than 4 seconds.	K92.1 releases. K92 releases. K92/13-14 opens the main contactor/breaker control circuit. Main contactor/breaker trips. (Factory-wired, not shown below). K92/31-32 connects earth fault indication to a converter module digital input causing a module fault trip. (Factory-wired, not shown below). K92 contact 21-22 closes the K91 holding circuit. The earth fault indications remain until K90 releases (=no earth fault) and the reset switch S90 is pushed.

The overvoltage relay is pre-tuned at the factory. When necessary, the relay can be retuned on field. For information on the tuning procedure contact your local ABB representative.

Circuit Diagram 1 The figure below shows the Earth Fault Protection circuit.



Earth Fault Protection in an TN Network (earthed mains supply)

The earth fault protection is a standard feature for ACx 607 R7 to 2×R9. See *Chapter 6 – Standard Features*.

The earth fault protection in TN network is available as an option for ACx 607 R11i to 4×R14i, ACx 617 and ACx 677. This section describes the protection for these units.

The option includes a current transformer which is wired to an analogue input which is either on a supply control board (diode supply bridge) or an additional board (thyristor supply bridge). In addition the earth fault supervision function in the rectifier control program is activated.

Operation

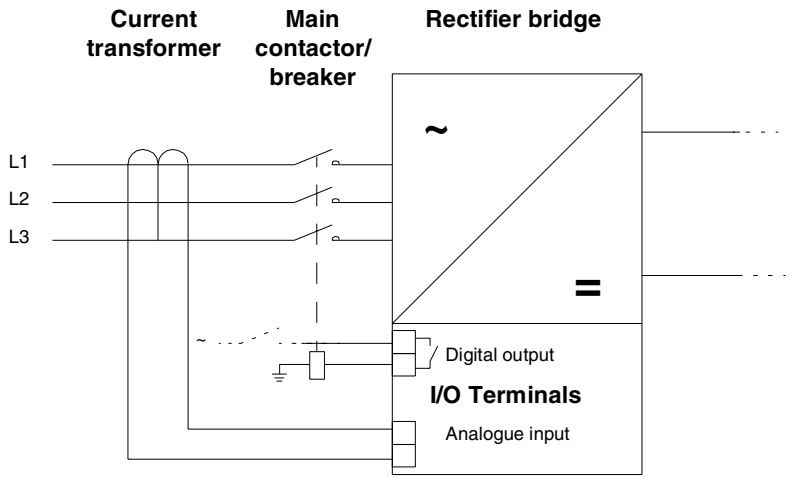
The earth fault protection in a TN network is based on a summation current transformer, monitoring the sum of the three-phase supply currents. Transformer output is monitored through an analogue input of the rectifying bridge.

In normal operation conditions the current sum is approximately zero. An earth fault leads to an imbalance in the 3-phase system and to a current sum which is greater than zero. If the current induced to the transformer secondary winding exceeds the limit set in the software, the main contactor/breaker is tripped and a fault message is generated.

The transformer transformation ratio is fixed. The protection is tuned by a rectifier control program parameter. The factory presetting (4 A) can be retuned on field.

Circuit Diagram

The figure below shows the wiring principle of the “Earth Fault Protection in an TN Network” option based on the summation current transformer.



Cable Markings

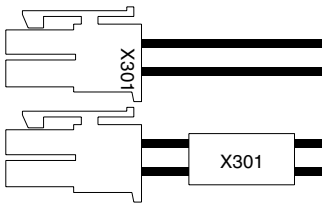
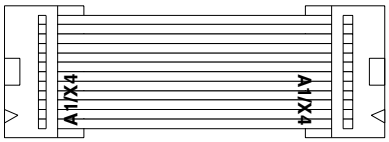
As standard the conductors and terminals in ACS 600 frequency converters are marked in accordance with the Standard Class as described below.

In the cabinet assemblys, the conductors outside the converter module can also be equipped with additional markings. For information on the optional marking types, contact a factory representative.

Standard Class

PDM-code: 00012745.doc

In Standard Class, only input and output terminals, plug-in connectors, fibre optic connectors and ribbon cables are marked. Conductor bundles may have markings printed on the insulation. The table below shows the marking principle.

Item	Description	Figure
Plug-In Connectors	Terminal identifier is marked either on the side of the plug-in connector or on a sleeve slid over the conductors or on adhesive tape. Marking rings are not used on conductors that cannot be detached from the connector otherwise than by a special tool.	
Ribbon Cables	On ribbon cables, apparatus and terminal identifiers are marked direct on the cable or on adhesive tape by means of waterproof ink.	
Fibreoptics	On fibreoptics, apparatus and terminal identifiers are marked using marking rings or adhesive tape.	
Busbars and Cables	Main circuit terminals are marked either directly on the busbar or beside the connector, with the terminal or busbar identifier printed on the insulating material. Earthing cables are marked with yellow-and-green tape.	

Cabinet Option Weights

Additional weight caused by some factory-installed cabinet options are given in the tables below.

Option	Weight kg	Transformer Add kg [1]	Power Supply Add kg [2]	X1 Term.Block Add kg
Thermistor Relay	0.5	7	-	0.5
Cubicle Heater	0.5	-	-	0.5
Auxiliary Motor Fan Starter	0.5	-	-	0.5
I/O; Fieldbus Adapter Module	0.2	7	1.9	0.5
Cabinet Extension	Weight/Width 190 kg/m	-	-	-

[1] ACx 607 units up to -0320-3, -0400-5, -0400-6 only.
[2] One power supply supplies one to six modules.

ACx 607			EMC Line Filter kg	IP54[1] kg	Line Cont. & Emer. Stop Devices [2] kg
0100-3	0120-5	0100-6	-	30	10
0120-3	0140-5	0120-6	-	30	10
0140-3	0170-5	0140-6/0170-6	18	50	13
0170-3	0210-5	0210-6	18	50	13
0210-3	0260-5	0260-6	18	50	14
0260-3			49	50	21
0320-3			49	50	21
	0320-5	0320-6	49	50	21
	0400-5	0400-6	49	50	21
0400-3	0490-5	0490-6	49	70	24
0490-3	0610-5	0610-6	90	70	35
0610-3	0760-5	0760-6	90	70	35

[1] Special roof construction, extra fan(s).
[2] Contactor(s), control switch, emergency stop switch, terminal block, transformers, protection switch.

Special Cabinet Options

The special cabinet options form no pre-designed packages as the standard cabinet options i.e. they cannot be specified using the type code key. Instead they require additional engineering work at the factory: the part lists and the delivery drawings are done case by case for each delivery. The actual connections and used components may vary.

The special cabinet options are available only on request.

Note: It is also possible to have other special options than the ones described in this document. Please consult a factory representative.

Controlled Emergency Stop

The Controlled Emergency Stop is available as a special cabinet option for ACx 607 R7 to 2×R9.

The design is the same as for the ACx 617 and ACx 677. See section *Factory-installed Standard Cabinet Options*.

Prevention of Unexpected Start-up

The Prevention of Unexpected Start-up is available as a special cabinet option for ACx 607 R7 to 2×R9.

The design is the same as for the larger units. See section *Factory-installed Standard Cabinet Options*.

Auxiliary Control Voltage

115 V a.c. auxiliary voltage circuitry and components are available as a special cabinet option for ACx 607 R7 to 2×R9.

Note: The converter module fans are always supplied from the intermediate circuit DC link.

NAMC/NIOC Power Supply

The internal power supply is available as a special cabinet option for ACx 607 R7 to 2×R9.

The design is the same as for the ACx 617 and ACx 677. See section *Factory-installed Standard Cabinet Options*.

Sine Filter / Step-up Drive

The sine filter is available as a special cabinet option for ACx 607 R11i to 4×R11i, ACx 617 and ACx 677.

The design is the same as described in section *Sine Filter / Step-up Drive*.

Empty Cabinet

Empty cabinet is available as special cabinet option for all ACx 607, ACx 617 and ACx 677 units.

The cabinet is identical into which the ACx 607, ACx 617 and ACx 677 are assembled:

- The same materials
- The joints between the cover plates and the frame are sealed to fulfil the Electromagnetic Compatibility requirements (European EMC Directive).
- The roof construction is the same including the air outlet (openings, fabric filter, brass grid, and louvre).

The following needs to be specified using the document “Empty Cabinet Specification” (EN code: 61411542) when ordering:

- Loose cabinet or an additional empty cubicle attached to the drive (left or right side).
- Degree of protection: IP 21, IP 22, IP 42, IP 54 or IP54R
- Door: With or without air inlet openings, with or without the panel mounting platform
- Blank (no holes) assembly plates inside the cabinet: None, one on the back or one on the back and one on a side
- Cable lead-through:

  1. No cable lead-through needed.

  2. Standard lead-through from above. See section *Customer-defined Cable Lead-through Plate*.

  3. Standard lead-through from below. See section *Customer-defined Cable Lead-through Plate*.

  4. Customer-defined lead-through (holes or without holes). See section *Customer-defined Cable Lead-through Plate*.

- Cabinet width: 400, 600, 700 or 800 mm

Terminals for External Control Voltage Supply (e.g. UPS)

The terminals for external control voltage supply (e.g. UPS) are available as a special cabinet option for ACx 607 R7 to 2×R9.

The option includes connection terminals, protective circuit breakers and ACx 607 internal wirings.

The external supply backs up the internal control voltage supply i.e. it keeps the customer-selected auxiliary circuit live during an ACx 607 mains supply interruption. In the basic design the external supply backs up the power supply of the optional modules: Digital I/O extensions, analogue I/O extension, and/or fieldbus adapter. On request other circuits can also be backed up.

The external power supply is to be selected and connected by the user. Ratings:

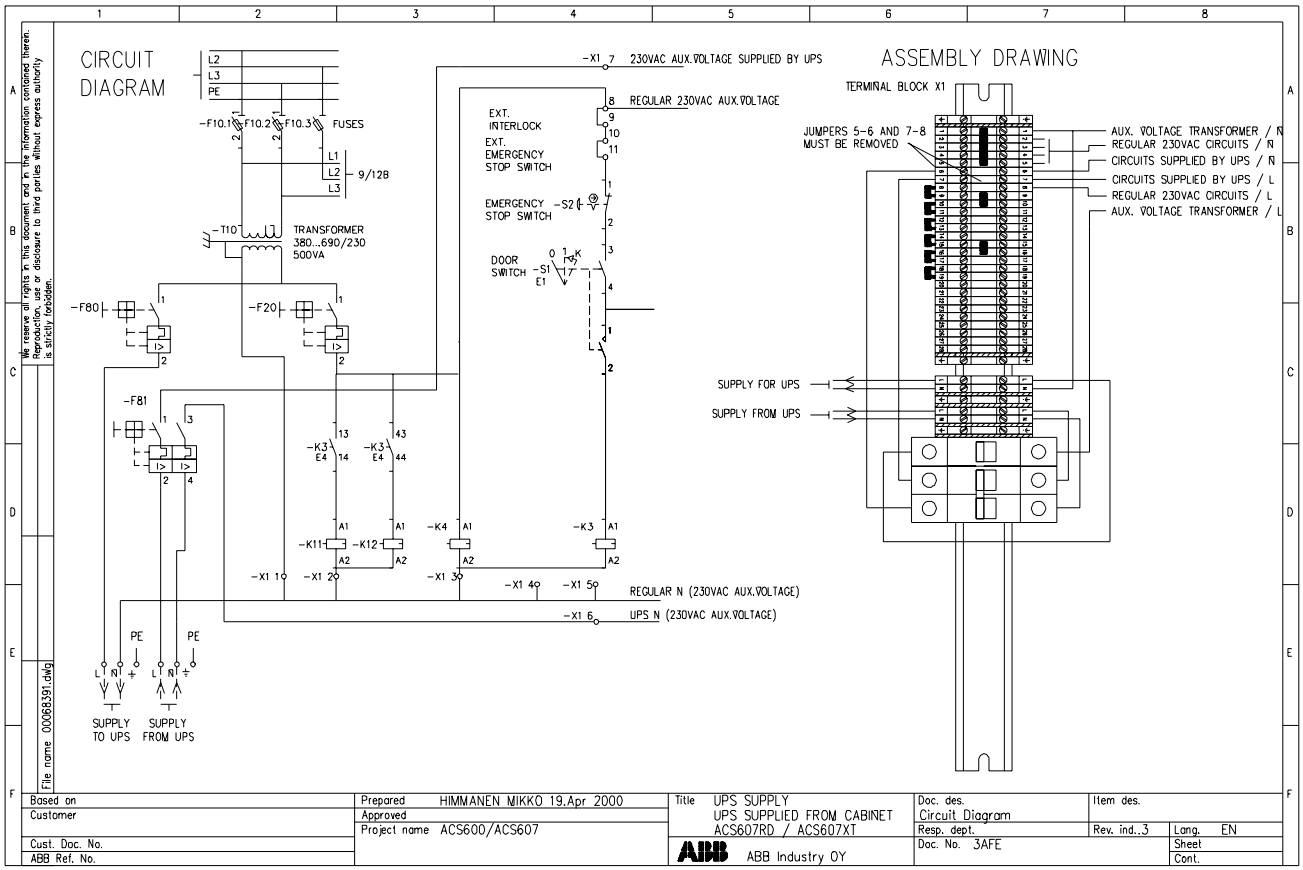
- 230 or 115 V a.c. (according to the ACx 607 control voltage)
- power depends on the power consumption of the circuits backed up

Note: No Uninterrupted Power Supply (UPS) is included: The user selects and instals the UPS if a battery charged back up is needed. However, it is possible to feed the user-defined UPS from the ACx 607 auxiliary voltage transformer.

Note: To keep the ACx 607 control live during a mains supply interruption:

- The control voltage supply is to be backed up.
- The Application and Motor Control Board, NAMC, and Standard I/O Control Board, NIOC, are to be fed through an optional 230 V a.c / 24 V d.c. power supply module. See subsection *NAMC/NIOC Power Supply*.

Basic Wiring Diagram The figure below shows the internal wirings of the UPS connection.



Motor Heater Output

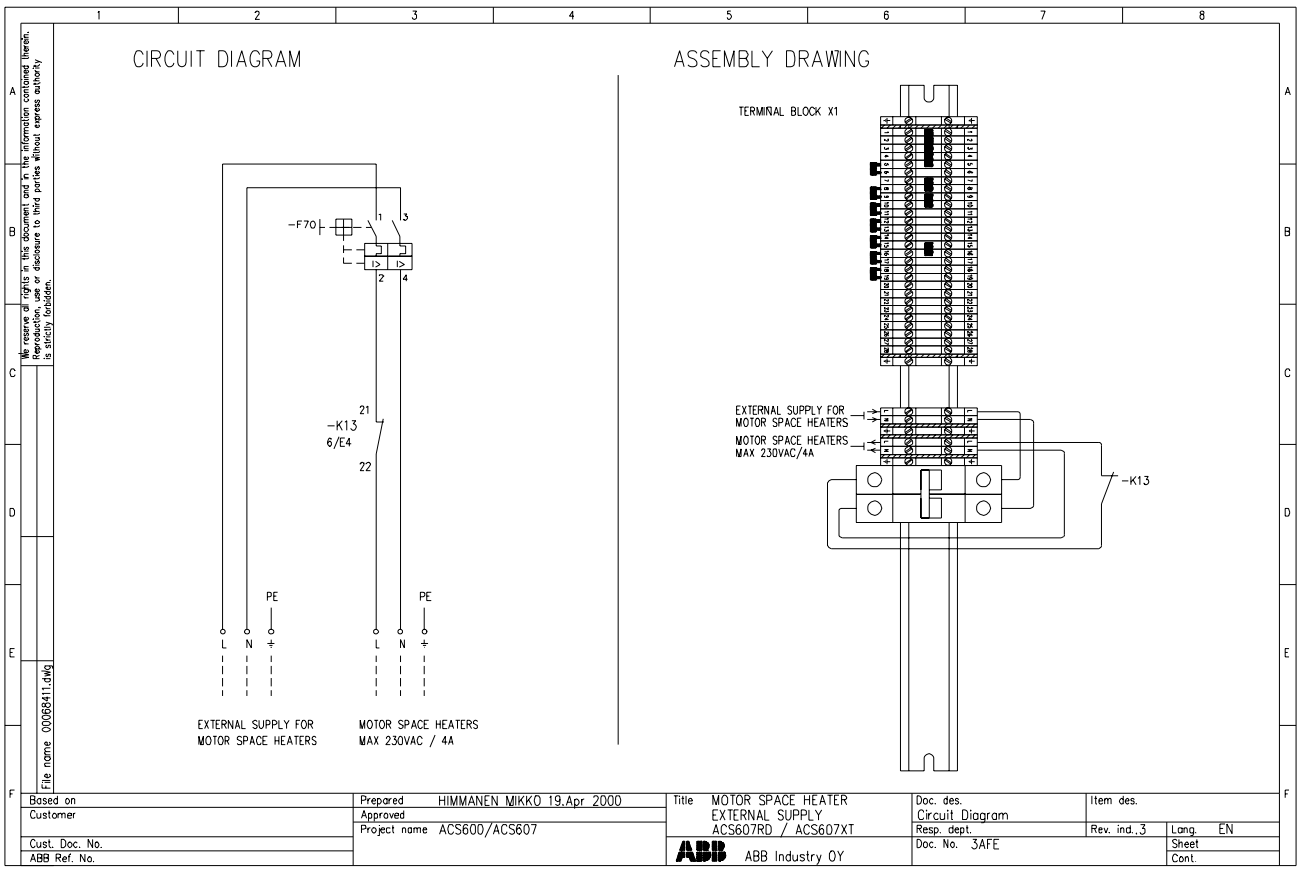
The motor heater output is available as a special cabinet option for ACx 607 R7 to 2×R9.

The heater prevents humidity condensation inside the motor enclosure in the drive power-off state. When the ACx 607 main breaker is closed, the heater is off.

The option includes:

- terminals for the motor heater (max. 230 V a.c., max. 4 A)
- terminals for an external heater supply that needs to be connected by the user: max. 230 V a.c., max. 4 A
- a protective circuit breaker and an on/off contact wired between the power supply and heater terminals

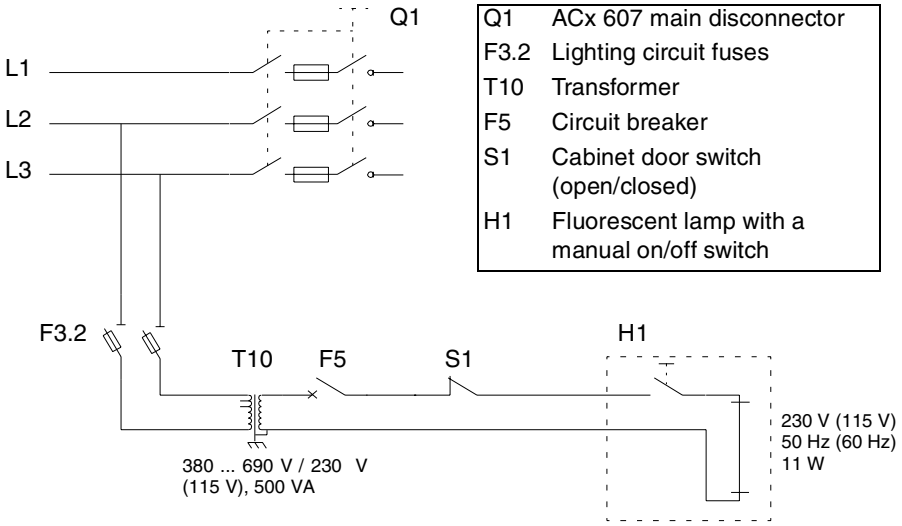
The figure below shows the ACx 607 internal wirings.



Cabinet Lighting

The cabinet lighting is available as a special cabinet option for all ACx 607, ACx 617 and ACx 677 units.

An example of the cabinet lighting is shown in the figure below.



Q1	ACx 607 main disconnector
F3.2	Lighting circuit fuses
T10	Transformer
F5	Circuit breaker
S1	Cabinet door switch (open/closed)
H1	Fluorescent lamp with a manual on/off switch

Customer-defined Cable Lead-through Plate

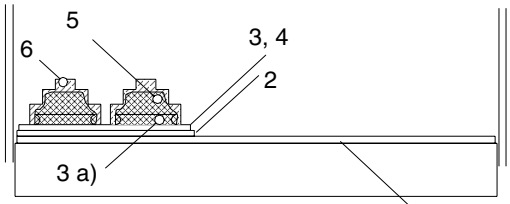
The customer-defined cable lead-through plate is available as a special cabinet option for all ACx 607, ACx 617 and ACx 677 units

If the standard lead through does not meet the specific local requirements, it is also possible to equip the cabinet with a brass or steel cable lead-through plate with no holes, with holes or with holes and threads. For more information, please contact a factory representative.

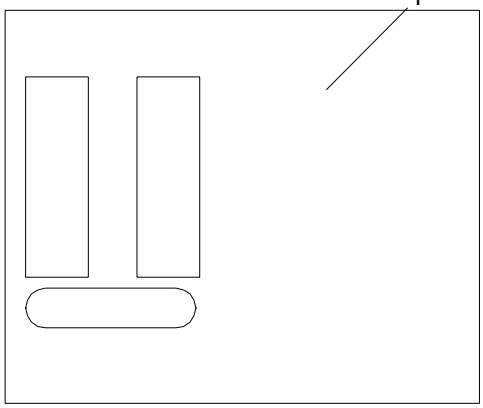
Standard Cabinet Lead-Through

The principle of the standard cable lead-through is shown in the figure below. The amount and size of the holes vary depending on the unit.

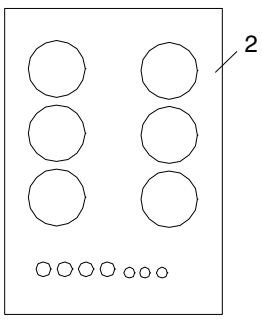
Front view



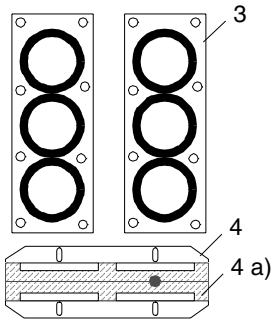
Top view



Top view



Top view

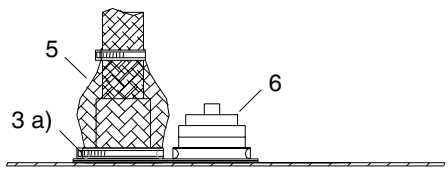


1	Base plate	1.5 - 2 mm steel
2	Lead-through plate[1)]	1.5 - 2 mm steel
3	EMC lead-through plate(s) for power cables	1.5 - 2 mm steel
3 a)	EMC sleeve fixing collar	1.5 - 2 mm steel
4	EMC lead-through plate for control cables	1.5 - 2 mm steel
4 a)	Conductive cushions	
4 b)	Grommet[2)]	Rubber
5	EMC-sleeve	Metal-wire mesh
6	Grommet	Rubber

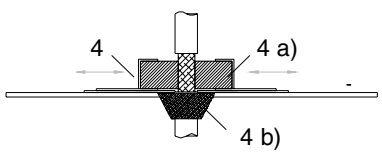
[1)] Not in all units.
[2)] Only with degree of protection IP 54.
The steel plates have a zinc surface treatment FE/Zn 8 c 2.

Cable Shield Grounding at Lead-through

Front view Power Cable

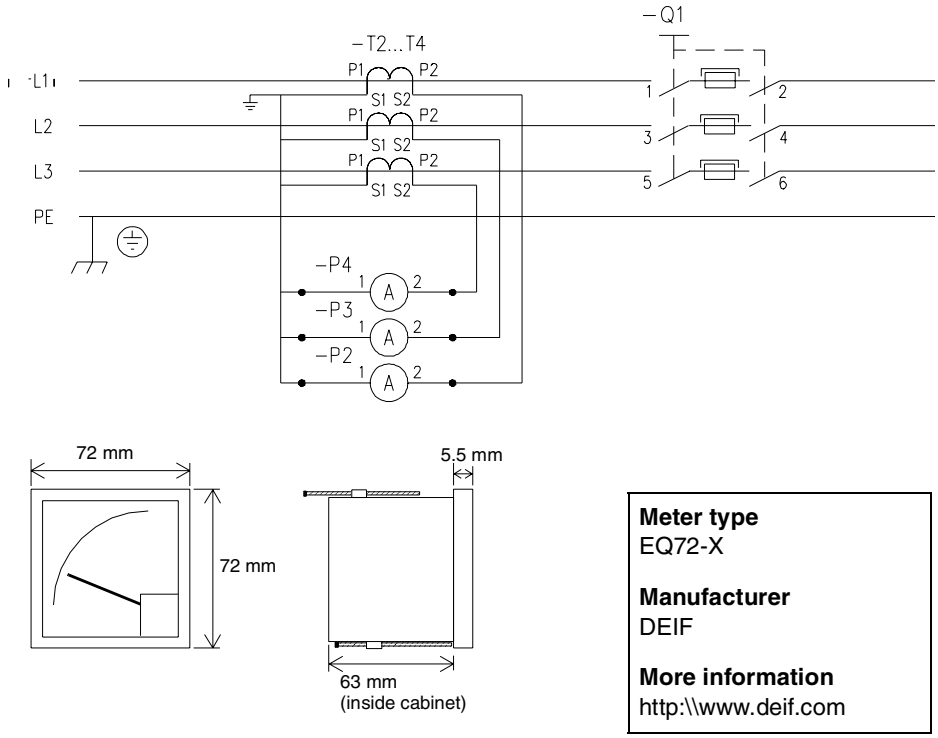


Side view Control Cable



Ammeters One to three ammeters are available as a special cabinet option for all ACx 607, ACx 617 and ACx 677 units.

The ammeters are installed on the front door. The equipment and wiring of the current meters are shown in the figure below.



Meter type
EQ72-X

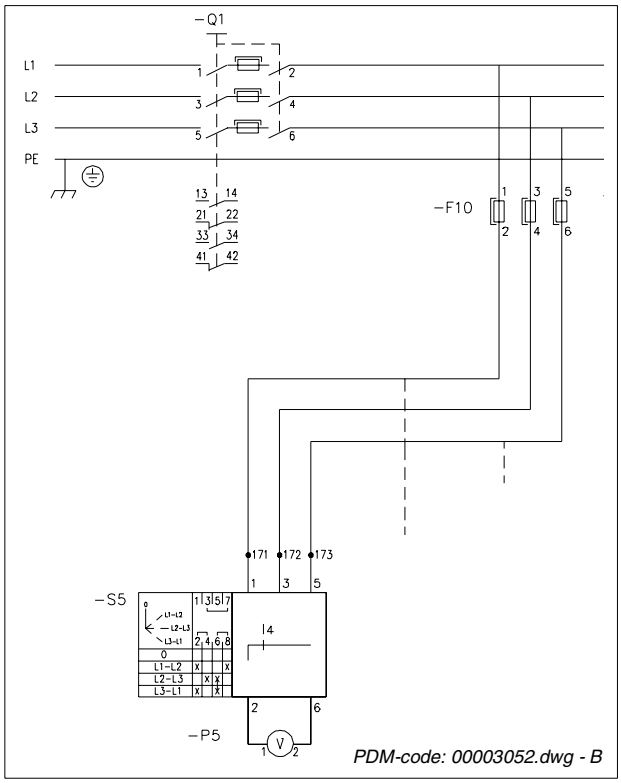
Manufacturer
DEIF

More information
http:\\www.deif.com

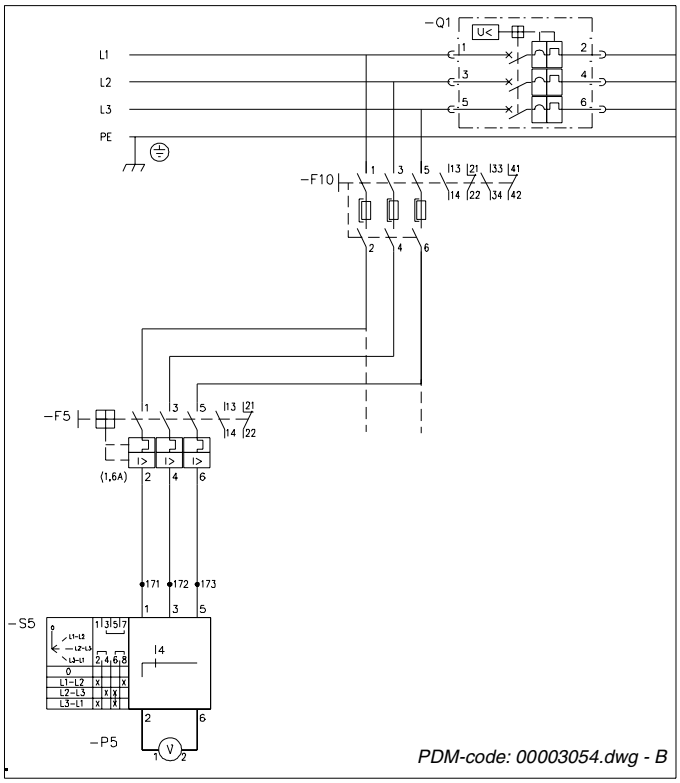
Voltmeter A voltmeter is available as a special cabinet option for all ACx 607, ACx 617 and ACx 677 units.

The voltmeter and the phase selection switch are installed on the front door. The equipment and wiring of the voltmeter option are shown in the figure below.

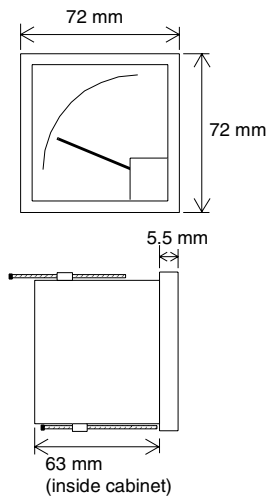
Drive equipped with a fuse switch



Drive equipped with an air circuit breaker



F10	Fuses
S5	Phase selection switch
P5	Voltage meter
Q1	Main supply disconnector / air circuit breaker
F5	Protection switch (needed only if the rating of F10 exceeds 16 A)



Meter type
EQ72-X

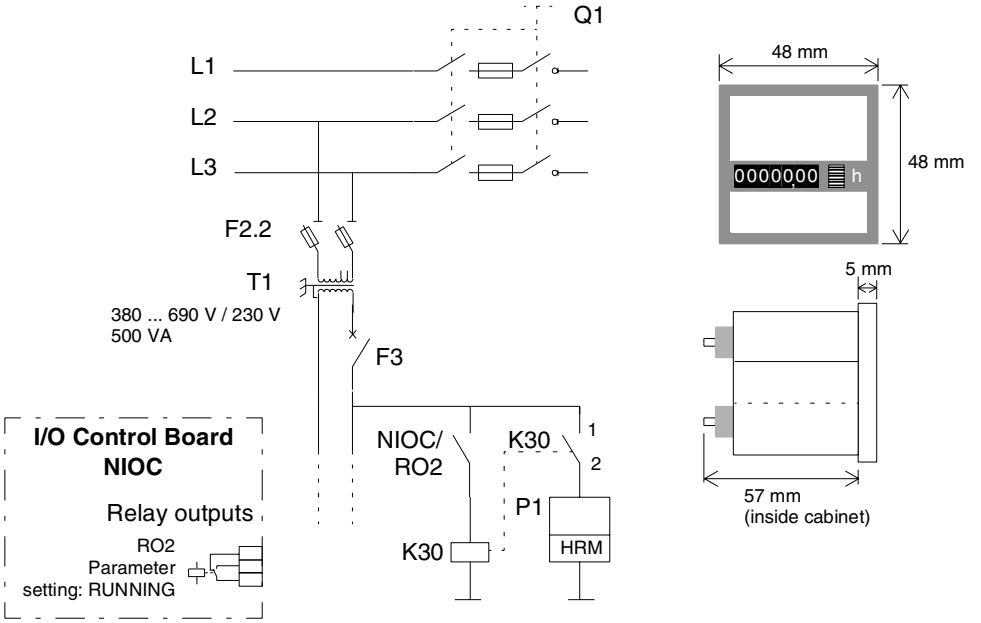
Manufacturer
DEIF

More information
http:\\www.deif.com

Running Hour Counter

A running hour counter is available as a special cabinet option for all ACx 607, ACx 617 and ACx 677 units.

The counter is installed on the front door above the main disconnecting switch. The counter runs when the drive is running (start signal and run enable signals are on, no fault). The figure below shows the equipment and the wiring.



Meter type
HCQ48

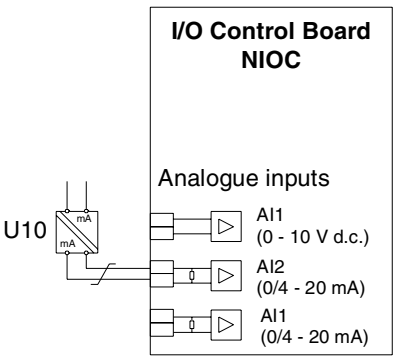
Manufacturer
DEIF

More information
http:\\www.deif.com

AI/O Galvanic Isolation

The current analogue inputs and or outputs can be equipped with galvanic isolators. The isolators are available as a special cabinet option for all ACx 607, ACx 617 and ACx 677 units.

In the figure below a 0 to 20 mA reference signal is connected to analogue input 2 via a galvanic isolator.



Type	SXRH GE20
Manufacturer	Scanfil
U_{inmax}	16 V
I_{in}	0 -20 mA
	4 - 20 mA
	0 - 5 mA
Tr. ratio	1:1

Analogue Output Signal Meters

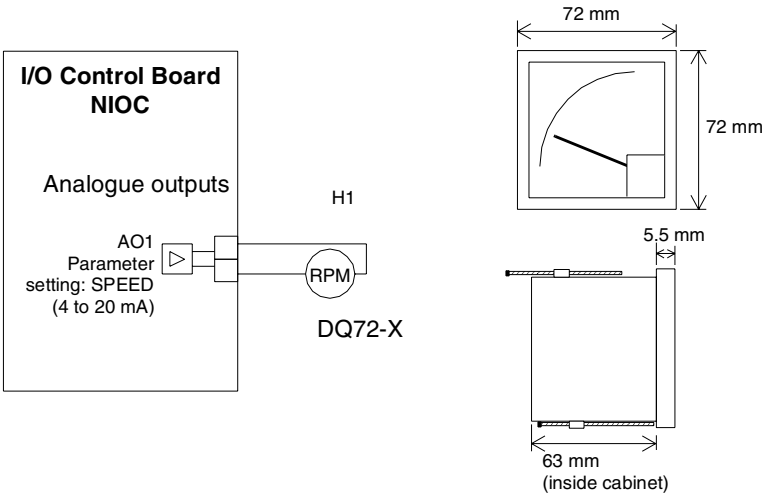
Analogue output signal meters are available as special cabinet options for all ACx 607, ACx 617 and ACx 677 units.

The meter type is selected according to the value to be monitored. Various scales/units are available. For example the following units can be selected:

- current
- direct voltage
- rotating speed
- percentage
- power

The meter is installed on the front door above the main disconnecting switch. The drive actual value to be indicated through an analogue output is selected with an application program parameter.

The figure below shows the wiring and the drive application program parameter setting for an RPM-meter. Also the meter dimensions and the very basic data is given below.



Meter type
DQ72-X

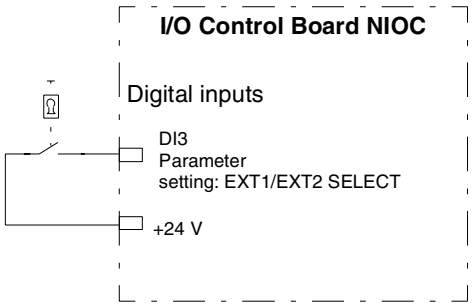
Manufacturer
DEIF

More information
http:\\www.deif.com

Key-operated Switch

A key-operated switch is available as a special cabinet option for all ACx 607, ACx 617 and ACx 677 units.

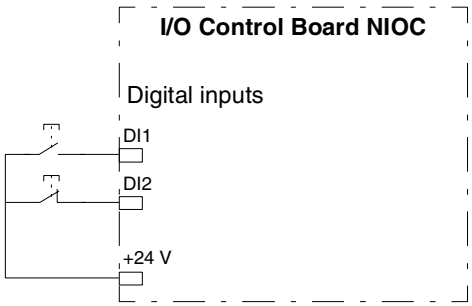
The switch is installed on the front door. The figure below shows an example of the usage of the switch. The switch selects between two control signal interfaces, i.e. the I/O signal terminals and the serial communication link (fieldbus control). Accidental control interface change is prevented by locking the switch.



Push Buttons

Push buttons are available as a special cabinet option for all ACx 607, ACx 617 and ACx 677 units.

The push buttons are installed on the front door. The figure below shows an example of the usage of the buttons.

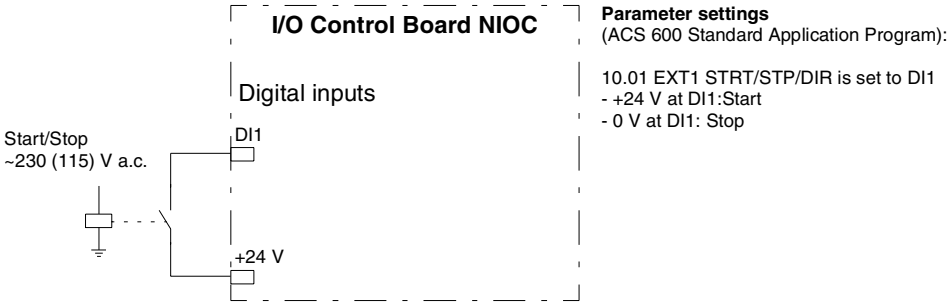


Parameter settings
(ACS 600 Standard Application Program):

10.01 EXT1 STRT/STP/DIR is set to DI1P,2P
- pulse start through digital input DI1
- pulse stop through digital input DI2

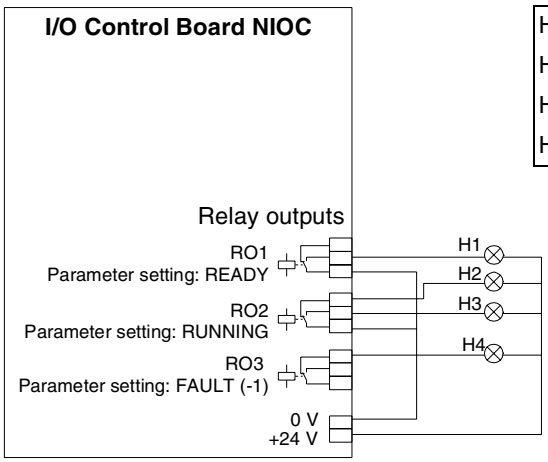
Additional Relay(s) Additional relay(s) is available as a special cabinet option for all ACx 607, ACx 617 and ACx 677 units.

The figure below shows an example of the usage of the additional relay: A 230 V a.c. circuit is used as the source for the start and stop commands. An additional relay is needed between the external 230 V circuit and the ACx 607 digital input DI1 terminal (24 V d.c).



Signal Lamp(s) Signal lamps are available as special cabinet options for all ACx 607, ACx 617 and ACx 677 units.

The signal lamps are installed on the front door above the main disconnecting switch. The figure below shows an example of the use of signal lamps.



H1	ready	green
H2	stopped	white
H3	running	blue
H4	fault	red

Other Options

Control Panel CDP 312

The detachable Control Panel is available as factory-installed and as an add-on kit for ACx 601 and ACx 607. For ACx 604, the panel is available as an add-on kit only. The dimensions of the CDP 312 are (H x W x D): 170 x 80 x 21 mm, weight 0.2 kg.

Panel Link Cables NPLC-0xy

The NPLC series consists of screened telecommunications cables with crossover wiring (suffix **C**) or straight-through wiring (suffix **S**).

The following types are available:

Type	Length [m]	Wiring	Example Application
NPLC-00C	0.5	Crossover (1 to 6, 2 to 5, etc.)	Control Panel connection
NPLC-02C	2		
NPLC-03C	3		
NPLC-00S	0.5	Straight-through (1 to 1, 2 to 2, etc.)	Linking of NIOC boards for common control
NPLC-01S	1		
NPLC-02S	2		

Control Panel Mounting Platform Kit NPMP-01/02/03

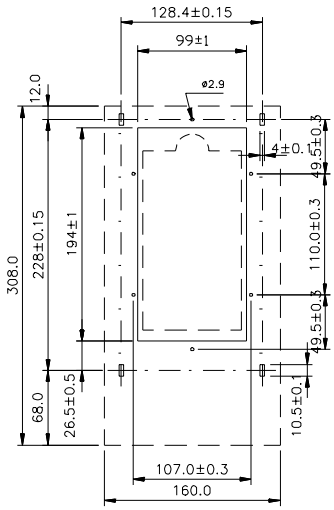
The Panel Mounting Platform add-on kit NPMP-01 includes the Control Panel Mounting Platform, a telephone connector, NDPI-02 Connection Board, and a 3-metre telephone cable. Gaskets are also included for IP54 protection.

NPMP-02 contains the above parts and a CDP 311 Control Panel.

NPMP-03 contains the above parts and a CDP 312 Control Panel.

Mounting Platform

Dimensions (H x W x D):
320 x 193 x 47.5 mm
Protrusion: 22 mm



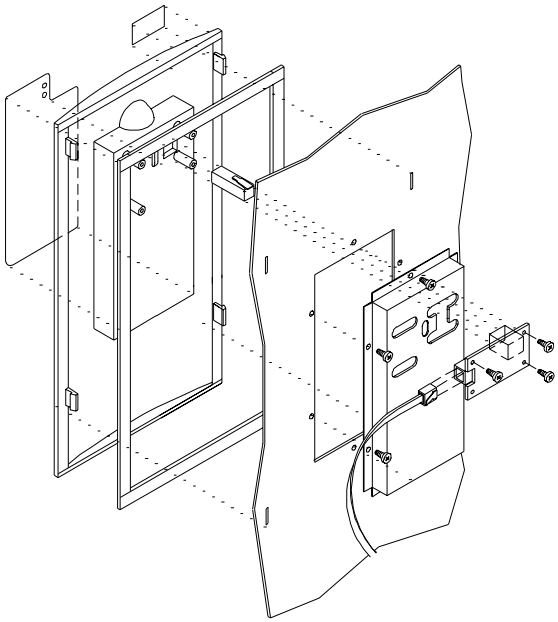


Figure 7-3 Installation of the Control Panel Mounting Platform kit.

The NPMP-xx kits can be used with all ACx 600 types for installing the Control Panel on a cabinet door or a remote control desk. The NDPI-02 Connection Board (supplied with the kit) is wired to the Standard I/O Board (NIOC) of the ACx 600. (See also section *Bus Connection Interface Module NBCI-02* above.) The NDPI-02 has two LEDs which indicate the status of the drive while the control panel is detached. The green LED indicates that the ACx 600 is powered, the red LED indicates that a fault is detected. The Control Panel is attached to the Control Panel Mounting Platform on the cabinet door by pushing it into the recess.

Fibre Optic Cables NLWC-xx

The Fibre Optic Cables option includes two single-core plastic fibre optic cables with connectors at the ends. The option is available as an add-on kit in five lengths:

- 2 metres (NLWC-02)
- 3 metres (NLWC-03)
- 5 metres (NLWC-05)
- 7 metres (NLWC-07)
- 10 metres (NLWC-10)

Fibre optic cables are needed e.g. when connecting an I/O Extension or a fieldbus adapter module to the ACx 600. As standard, the module package contains cable pairs of which the longest one is two metres. If longer cables are required, a suitable type from the available NLWC-xx Fibre Optic Cables options can be chosen.

Coated Circuit Boards

The Coated Circuit Boards option can be ordered as factory-installed for all ACx 600 types. (Coated boards are also available separately as spare parts.) The following boards are coated when this option is selected:

- NAMC (Application and Motor Control Board)
- NIOC (Standard I/O Control Board)
- NINT (Main Circuit Interface Board)
- NGDR (Gate Driver Board)
- NDCO (DDCS Communication Option), if present
- NBRC (Braking Chopper Control Board), if present.

The boards are varnished with a UL-approved acrylic coating for protection against hazards like humidity, dust and dirt, and airborne contaminants. Conformal coating remarkably increases the corrosion resistance of the ACx 600.

To further improve the protection, it is recommended to combine the Coated Circuit Boards option with IP54 protection of the ACx 600.

The allowable contamination levels for the boards are given in the *Technical Data* appendix.

Chapter 8 – Selecting the Motor and the ACS 600

Overview

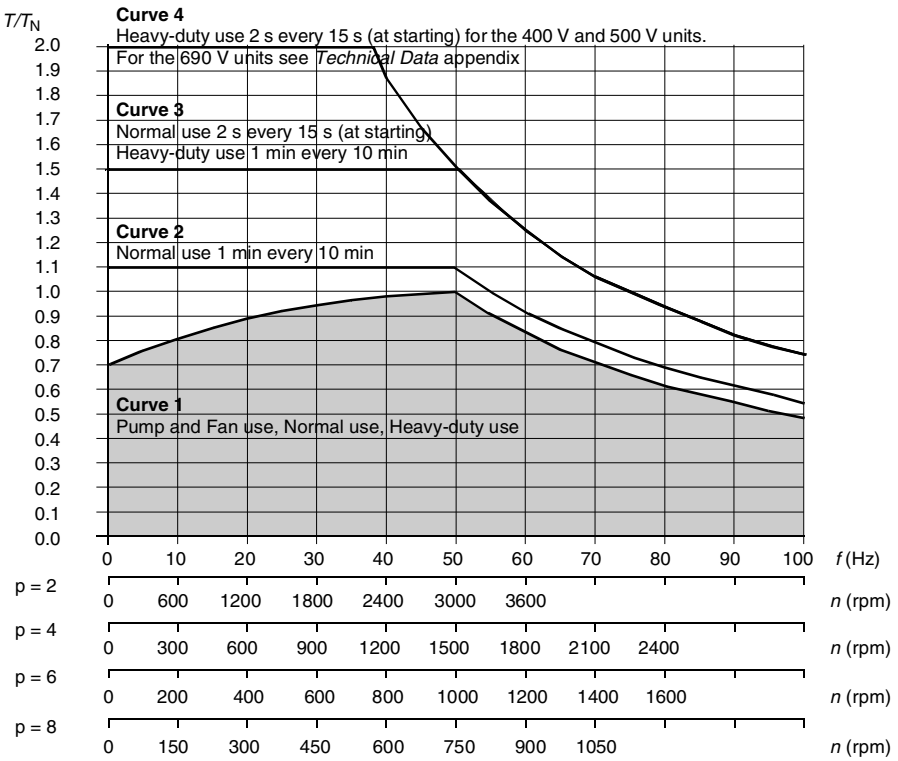
The excellent performance of the ACS 600 makes it suitable for most applications.

To specify your ACS 600 drive, select the ACS 600 rating according to the overload capacity required. Then choose a motor and a suitable ACS 600 for your motor.

There is a Drive*Size* PC tool available for optimal motor and ACS 600 selection. See *Chapter 7 – Optional Equipment* for more information.

Load Capacity Curves

The motor rated frequency and the field weakening point are at 50 Hz.



p = number of poles
T = load torque
T_N = rated motor torque
n = speed
f = output frequency of ACS 600

Figure 8-1 ***Curve 1****: Typical continuous load capacity curve of an IEC 34 self-ventilated motor controlled by the ACS 600.*
Curves 2 and 3*: Short term overload capacity and peak overload (starting torque boost) capacity of a typical IEC 34 motor and ACS 600 combination. The ACS 600 is rated for normal use.*
Curves 3 and 4: *Short term overload capacity and peak overload capacity of a typical IEC 34 motor and ACS 600 combination. The ACS 600 is rated for heavy-duty use.*

Note: If the ACS 600 is operated at high speeds (output frequency over 90 Hz), it should be observed that the motor maximum torque is not exceeded.

At low frequencies, the reduction in the continuous load capacity is due to the fact that the cooling capacity of a self-ventilated motor is reduced. In the field weakening range (f > 50 Hz), the load capacity is reduced because the output voltage of the ACS 600 cannot be increased.

At frequencies above 37.5 Hz, the reduction in the 200 % peak overload capacity (Figure 8-1, Curve 4) is due to the fact that the internal power limit ($1.5 \cdot P_{hd}$) restricts the allowed motor torque.

Selecting the ACS 600 Rating

There are three ratings for the ACS 600, the pump and fan use rating, the normal use rating and the heavy-duty use rating. Typically, the ACS 600 rated for pump and fan use or for normal use is selected. The pump and fan rating provides no overload capacity but the highest possible continuous load capacity. It is suitable for the squared torque applications (pump and fan drives). With the normal use rating ACS 600 provides 110 % short term overload capacity and 150 % peak overload capacity, which fulfils most requirements. If even higher overload capacity is needed the ACS 600 rated for heavy-duty use is selected.

Exception: If Scalar Control is used, the heavy-duty use rated ACS 600 must be selected for constant torque applications, even if no high overload capacity is required. Scalar Control must be used instead of Direct Torque Control in special applications, such as variable configuration multimotor drives. For more information on Scalar Control, see *Chapter 2 – Motor Control Methods* and *Chapter 6 – Standard Features*.

Motor Selection

As a general rule, the motor rated speed should be selected so that the motor continuous load capacity throughout the required speed range is as high as possible.

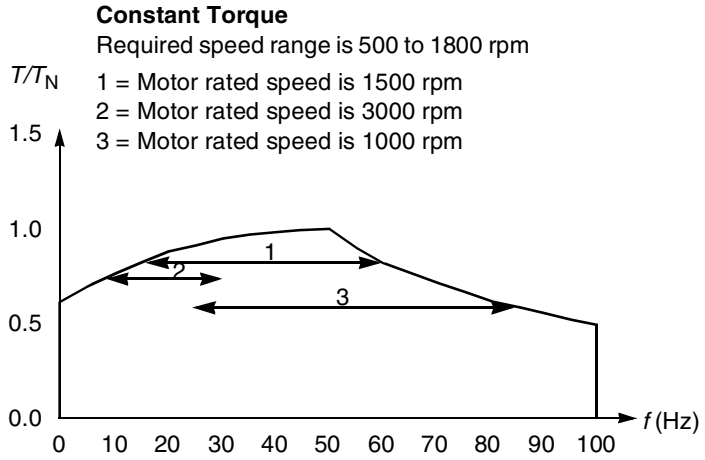


Figure 8-2 Continuous load capacities for three motors controlled by the ACS 600; required speed range is 500 to 1800 rpm. A four-pole motor, synchronous speed 1500 rpm, is selected.

The rated motor power must be higher than the continuous power required by the driven machine. In addition, the following factors must be considered:

- the continuous load capacity of the motor controlled by the ACS 600,
- the short-term overload capacity of the motor controlled by the ACS 600,
- the peak overload capacity of the motor controlled by the ACS 600.

The relation between the motor power and the torque is given by:

$$P = n \cdot T / 9550 \text{ kW}$$

P = power (kW)
n = speed (rpm)
T = torque (Nm)
$9550 = 1000 \cdot 60/(2 \cdot \pi)$

ACS 600 Selection

The ACS 600 is selected according to the rated motor power. It must be then checked that the rated output current of the ACS 600 is higher than, or equal to, the rated motor current.

In certain situations, it is possible to use an oversize motor. Please consult an ABB representative for more information.

To Be Noted

This chapter contains the general rating instructions for the motor and the ACS 600. It is assumed that the motor overload capacities correspond to the figures given for the ACS 600.

In applications requiring an exceptionally high short term overload capacity, the simplification above may lead to selection of a motor with higher rating to what is actually required. However, the ACS 600 is correctly selected also in these cases. If in any doubt about the preliminary motor selection, please refer to the actual overload capacity figures given by the motor manufacturer.

In applications requiring high peak overload capacities (up to 200 %), it should always be observed that the motor maximum torque is not exceeded.

Example 1.a
Constant Torque Drive

The minimum and maximum speeds are 600 rpm and 1900 rpm. The continuous torque required on the motor shaft is constant at 20 Nm, and the breakaway torque (during start for about one second) is 30 Nm. The supply voltage is 400 V.

Selecting the ACS 600 Rating

The ACS 600 is selected according to the normal use rating since the breakaway torque is not exceptionally high and no short term overload capacity is required.

Motor Selection

A four-pole motor is chosen. Its synchronous speed is 1500 rpm at 50 Hz.

The motor power rating is calculated:

- The power corresponding to the continuous load torque (20 Nm) is $P = 1900 \cdot 20/9550 = 4.0$ kW.
- The continuous load capacity of the motor controlled by ACS 600 is 89 % at 600 rpm and 80 % at 1900 rpm. See Figure 8-1, Curve 1.
- The peak overload capacity of the motor controlled by ACS 600 is 150 %. See Figure 8-1, Curve 3.
- No short term overload capacity is required.

Table 8-1 The required motor torque rating at critical points.

Critical Point	Load Capacity Restriction	Required Motor Rated Torque
Start	150 % (Curve 3)	30/1.5 = 20 Nm
600 rpm (20 Hz)	89 % (Curve 1)	20/0.89 = 22.5 Nm
1900 rpm (63.3 Hz)	80 % (Curve 1)	20/0.80 = 25 Nm

The motor is rated according to the most critical point. The required motor power is $P = 1500 \cdot 25/9550 = 3.9$ kW. The next larger standard motor from a motor catalogue is chosen. The rated power is 4 kW and the rated current is 9 A.

ACS 600 Selection

For the 4.0 kW motor, the ACS 601-0006-3 is selected. The rated currents are checked. Since the rated motor current is lower than the rated output current of the ACS 600, the selection is accepted.

Example 1.b *Constant Torque Drive High Breakaway Torque*

The requirements are the same as in *Example 1.a*, except that a 70 Nm breakaway torque is required.

Selecting the ACS 600 Rating

The ACS 600 is chosen according to the heavy-duty use rating since a breakaway torque higher than 150 % of continuous load torque is required.

Motor Selection

A four-pole motor is selected. Its synchronous speed is 1500 rpm at 50 Hz.

The motor power rating is calculated:

- The power corresponding to the continuous load torque of 20 Nm is $P = 1900 \cdot 20/9550 = 4.0$ kW.
- The continuous load capacity of the motor controlled by ACS 600 is 89 % at 600 rpm and 80 % at 1900 rpm. See Figure 8-1, Curve 1.
- The peak overload capacity of the motor controlled by ACS 600 is 200 %. See Figure 8-1, Curve 4.
- No short term overload capacity is required.

Table 8-2 The required motor torque rating at critical points.

Critical Point	Load Capacity Restriction	Required Motor Rated Torque
Start	200 % (Curve 4)	70/2.00 = 35 Nm
600 rpm (20 Hz)	89 % (Curve 1)	20/0.89 = 22.5 Nm
1900 rpm (63.3 Hz)	80 (Curve 1)	20/0.80 = 25 Nm

The motor power is rated according to the most critical point. The required motor power is $P = 1500 \cdot 35/9550 = 5.5$ kW. A standard motor is chosen from a motor catalogue. The rated power is 5.5 kW and the rated current is 12 A.

ACS 600 Selection

For the 5.5 kW motor, the ACS 601-0011-3 is selected. The rated currents are checked. Since the rated motor current is lower than the rated output current of the ACS 600, the selection is accepted.

Example 2 *Squared Torque Drive*

The power requirement of a centrifugal fan is 40 kW at 3000 rpm. The maximum fan speed is 3600 rpm and the minimum speed is 1200 rpm. The supply voltage is 400 V.

Selecting the ACS 600 Rating

The ACS 600 is selected according to the pump and fan use rating since no overload capacity is required.

Motor Selection

A two-pole motor is chosen. Its synchronous speed is 3000 rpm at 50 Hz.

Since the torque of a centrifugal fan increases according to the square of the speed and the power according to the cube of the speed, the required motor power is calculated only on the basis of the required power at maximum speed.

$P = (3600/3000)^3 \cdot 40$ kW = 69.1 kW.

The continuous load capacity of the motor controlled by the ACS 600 is 83 % (Figure 8-1, Curve 1) at 3600 rpm. The required motor torque is $T = 9550 \cdot 69.1/(3600 \cdot 0.83) = 220.9$ Nm and the required motor power is $P = 3000 \cdot 220.9/9550 = 69.4$ kW.

The next larger standard motor from a motor catalogue is selected. The rated power is 75 kW and the rated current is 135 A.

ACS 600 Selection

For the 75 kW motor, the ACS 601-0100-3 is selected. The rated currents are checked. Since the rated motor current is lower than the rated output current of the ACS 600, the selection is accepted.

***Example 3** Constant Torque Drive High Short Term Overload Required*

The drive is run at a constant 800 rpm speed. The load torque on the motor shaft varies in 10 minute cycles: the torque is 800 Nm for nine minutes and 1500 Nm for one minute. The starting torque is 1800 Nm (needed for about one second). The supply voltage is 400 V.

Selecting the ACS 600 Rating

The ACS 600 is selected according to the heavy-duty use rating since short term overload capacity more than 110% of continuous load torque is required.

Motor Selection

An eight-pole motor is chosen. Its synchronous speed is 750 rpm at 50 Hz.

The continuous power required by the driven machine is $P = 800 \cdot 800/9550 = 67$ kW.

- The continuous load capacity of the motor controlled by the ACS 600 is 94 % at 800 rpm. See Figure 8-1, Curve 1.
- The peak overload capacity of the motor controlled by the ACS 600 is 200 % (during the start). See Figure 8-1, Curve 3.
- The short term overload capacity of the ACS 600 is 140 % at 800 rpm during a one minute step. See Figure 8-1, Curve 3.

Table 8-3 The required motor torque rating at critical points:

Critical Point	Load Capacity Restrictions	Required Motor Rated Torque
Start	200 % (Curve 4)	1800/2.00 = 900 Nm
800 rpm (continuous)	94 % (Curve 1)	800/0.94 = 851 Nm
800 rpm (1 min step)	140 % (Curve 3)	1500/1.4 = 1071 Nm

The motor is rated according to the most critical point. The required motor power is $P = 750 \cdot 1071/9550 = 84.1$ kW. The next larger standard motor from a motor catalogue is chosen. The rated power is 90 kW and the rated current is 178 A.

ACS 600 Selection

For the 90 kW motor, the ACS 607-0140-3 is selected. The rated currents are checked. Since the rated motor current is lower than the rated output current of the ACS 600, the selection is accepted.

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Chapter 9 – Installation Guidelines

Input Fuses

The fuses are needed for input bridge and mains cable short circuit protection. The ACx 600 protects the installation against overload.

ACx 601

For frame sizes R5, R6 and R7, ultrarapid fuses must be used. Ultrarapid fuses are recommended also for frame sizes R2, R3 and R4. Fuses are to be installed outside the unit, one for each phase conductor. The ultrarapid fuses protect the ACx 600 input bridge in internal short circuits. When installed at the distribution board, they also protect the mains cable against short-circuits.

ACx 604 / ACx 607 / ACx 617 / ACx 677

The ACx 607, ACx 617 and ACx 677 are equipped with internal ultrarapid fuses that protect the input bridge against short-circuits. The ACx 604 is not equipped with input fuses. When installing the ACx 604, the supply must always be connected via ultrarapid fuses. When the ultrarapid fuses are installed at the distribution board, they also protect the mains cable against short-circuits.

Supply Disconnecting Device

The ACx 601 and ACx 604 are not equipped with a disconnector or main switch. According to European Standard EN 60204-1, *Safety of Machinery*, a hand-operated supply disconnecting device shall be installed in each power supply. The disconnecting device must be one of the following types:

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

The ACx 607, ACx 617 and ACx 677 can be equipped with a hand operated main switch, which fulfils the above requirements for the supply disconnecting device. The ACx 607 can also be equipped with line contactor, start-stop switch and emergency stop switch.

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