Hardware manual
ACS880-37 drives (160 to 3200 kW)
List of related manuals

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### Manuals and quick guides for I/O extension modules, fieldbus adapters, etc.

You can find manuals and other product documents in PDF format on the Internet. See section Document library on the Internet on the inside of the back cover. For manuals not available in the Document library, contact your local ABB representative.

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**ACS880-37 (160 to 3200 kW) manuals**
Hardware manual

ACS880-37 drives (160 to 3200 kW)

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3AXD50000020437 Rev B
EN
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Safety instructions

Contents of this chapter
This chapter contains the safety instructions which you must obey when you install and operate the drive and do maintenance on the drive. If you ignore the safety instructions, injury, death or damage can occur.

Use of warnings and notes
Warnings tell you about conditions which can cause injury or death, or damage to the equipment. They also tell you how to prevent the danger. Notes draw attention to a particular condition or fact, or give information on a subject.

The manual uses these warning symbols:

- **Electricity warning** tells about hazards from electricity which can cause injury or death, or damage to the equipment.
- **General warning** tells about conditions, other than those caused by electricity, which can cause injury or death, or damage to the equipment.
- **Electrostatic sensitive devices warning** tells you about the risk of electrostatic discharge which can cause damage to the equipment.
General safety in installation, start-up and maintenance

These instructions are for all personnel that install the drive and do maintenance work on it.

**WARNING!** Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur.

- Secure the cabinet to the floor to prevent it from toppling over when you pull out power (inverter/supply/filter) modules. The power modules are heavy and have a high center of gravity.

- Wear protective gloves and long sleeves. Some parts have sharp edges.

- Handle the inverter, supply and filter modules carefully:
  - Use safety shoes with a metal toe cap to avoid foot injury.
  - Lift the module with a lifting device only. Use the designated lifting points shown in the drawing below.
  - Do not tilt the module. It will overturn very easily because it is heavy and its center of gravity is high.
  - Make sure that the module does not topple over when you move it on the floor. Whenever possible secure the module with chains. Do not leave the module unattended on a sloping floor.
  - Do not use the module extraction/installation ramp with plinth heights over 50 mm (2”). The ramp supplied with the drive system is designed for a plinth height of 50 mm (2”) (the standard plinth height of ABB cabinets).
  - Secure the module extraction/installation ramp carefully.
  - Push the module into the cabinet and pull it from the cabinet carefully preferably with help from another person. Keep a constant pressure with one foot on the base of the module to prevent the module from falling on its back.
• Beware of hot surfaces. Some parts, such as heatsinks of power semiconductors, remain hot for a while after disconnection of the electrical supply.
• Beware of hot air exiting from the air outlets.
• Keep the drive in its package or protect it otherwise from dust and burr from drilling and grinding until you install it. Protect also the installed drive against dust and burr. Electrically conductive debris inside the drive can cause damage or malfunction.
• Vacuum clean the area around the drive before the start-up to prevent the drive cooling fan from drawing the dust inside the drive.
• Do not cover the air inlet or outlet when the drive is running.
• Make sure that there is sufficient cooling. See section Examining the installation site (page 59).
• Keep the cabinet doors closed when the drive is powered. With the doors open, a risk of a potentially fatal electric shock, arc flash or high-energy arc blast exists. If you cannot avoid working on a powered drive, obey the local laws and regulations on live working (including – but not limited to – electric shock and arc protection).

• Before you adjust the drive operation limits, make sure that the motor and all driven equipment can operate throughout the set operation limits.

• Before you activate the automatic fault reset or automatic restart functions of the drive control program, make sure that no dangerous situations can occur. These functions reset the drive automatically and continue operation after a fault or supply break. If these functions are activated, the installation must be clearly marked as defined in IEC/EN 61800-5-1, subclause 6.5.3, for example, “THIS MACHINE STARTS AUTOMATICALLY”.

• The maximum number of drive power-ups is five in ten minutes. Too frequent power-ups can damage the charging circuit of the DC capacitors.

• Make sure that any safety circuits (for example, emergency stop and Safe torque off) are validated at start-up. See chapter The Safe torque off function (page 237). For other safety functions, see their separate instructions.

Note:

• If you select an external source for the start command and it is on, the drive will start immediately after fault reset unless you configure the drive for pulse start. See the firmware manual.

• When the control location is not set to Local, the stop key on the control panel will not stop the drive.

• Only authorized persons are allowed to repair a malfunctioning drive.
Electrical safety in installation, start-up and maintenance

Electrical safety precautions

These warnings are for all personnel who do work on the drive, motor cable or motor.

**WARNING!** Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur. If you are not a qualified electrician, do not do installation or maintenance work. Go through these steps before you begin any installation or maintenance work.

1. Keep the cabinet doors closed when the drive is powered. With the doors open, a risk of a potentially fatal electric shock, arc flash or high-energy arc blast exists.

2. Clearly identify the work location.

3. Disconnect all possible voltage sources.
   - Open the main switch-disconnector [Q1.1] or breaker [Q1] of the drive.
   - Open the disconnector of the supply transformer as the main switch-disconnector or breaker of the drive does not remove the voltage from the input busbars of the drive or from the voltmeter (option +G334).
   - Make sure that reconnection is not possible. Lock the disconnectors to open position and attach a warning notice to them.
   - Disconnect any external power sources (eg. UPS, motor fan supply, or cubicle heater supply) from the control circuits before you do work on the control cables.
   - After you disconnect the drive, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you continue.

4. Protect any other energized parts in the work location against contact.

5. Take special precautions when close to bare conductors.

6. Measure that the installation is de-energized.
   - Use a multimeter with an impedance of at least 1 Mohm.
   - Make sure that the voltage between the drive input power terminals and the grounding (PE) busbar is close to 0 V.
   - Make sure that the voltage between the drive DC busbars (+ and -) and the grounding (PE) busbar is close to 0 V.

**WARNING!** If the measurement requires removal or disassembly of shrouding or other cabinet structures, obey the local laws and regulations applicable to live working (including – but not limited to – electric shock and arc protection).

7. Install temporary grounding as required by the local regulations. Close the grounding switch (option +F259, Q9) if present.

8. Ask the person in control of the electrical installation work for a permit to work.
Additional instructions and notes

**WARNING!** Obey these instructions. If you ignore them, injury or death, or damage to the equipment can occur.

- If you are not a qualified electrician, do not do electrical installation or maintenance work.
- Do not install a drive with EMC filter option +E202 on an ungrounded power system or a high resistance-grounded (over 30 ohms) power system.
- Do not connect the drive to a voltage higher than what is specified on the type designation label. If you do, the brake chopper (if present) starts to operate which causes the overheating of the brake resistor. Overvoltage can also cause the motor to rush to its maximum speed.
- We do not recommend that you secure the cabinet by arc welding. If you have to, obey the instructions on page 74.
- Do not do insulation or voltage withstand tests on the drive or its modules.

**Note:**
- The motor cable terminals of the drive are at a dangerous voltage when the input power is on, regardless of whether the motor is running or not.
- The DC bus, brake chopper and brake resistors (if any) are at a dangerous voltage.
- External wiring can supply dangerous voltages to the relay outputs of the control units of the drive.
- The Safe torque off function does not remove the voltage from the main and auxiliary circuits. The function is not effective against deliberate sabotage or misuse.

**WARNING!** Use a grounding wrist band when you handle the printed circuit boards. Do not touch the boards unnecessarily. The boards contain components sensitive to electrostatic discharge.

**WARNING!** Obey these instructions. If you ignore them, equipment malfunction and damage to the fiber optic cables can occur.

- Handle fiber optic cables with care.
- When you unplug the cables, always hold the connector, not the cable itself.
- Do not touch the ends of the fibers with bare hands as the ends are extremely sensitive to dirt.
- Do not bend the fiber optic cables too tightly. The minimum allowed bend radius is 35 mm (1.4").
Grounding

These instructions are for all personnel who are responsible for the grounding of the drive.

**WARNING!** Obey these instructions. If you ignore them, injury or death, or equipment malfunction can occur, and electromagnetic interference can increase.

- If you are not a qualified electrician, do not do grounding work.
- Always ground the drive, the motor and adjoining equipment. This is necessary for the personnel safety. Proper grounding also reduces electromagnetic emission and interference.
- Make sure that the conductivity of the grounding conductors is sufficient. See section *Selecting the power cables* (page 81). Obey the local regulations.
- Connect the power cable shields to protective earth (PE) of the drive to make sure of personnel safety.
- Make a 360° grounding of the power and control cable shields at the cable entries to suppress electromagnetic disturbances.
- In a multiple-drive installation, connect each drive separately to the protective earth (PE) busbar of the switch board or the transformer.

**Note:**
- You can use power cable shields as grounding conductors only when their conductivity is sufficient.
- As the normal touch current of the drive is higher than 3.5 mA AC or 10 mA DC, you must use a fixed protective earth connection. See standard IEC/EN 61800-5-1, 4.3.5.5.2.
Additional instructions for permanent magnet motor drives

Safety in installation, start-up and maintenance

These are additional warnings concerning permanent magnet motor drives. The other safety instructions in this chapter are also valid.

**WARNING!** Obey these instructions. If you ignore them, injury or death and damage to the equipment can occur.

- Do not do work on the drive when the permanent magnet motor is rotating. A rotating permanent magnet motor energizes the drive including its input power terminals.

Before installation, start-up and maintenance work on the drive:
- Stop the motor.
- Disconnect the motor from the drive with a safety switch or by other means.
- If you cannot disconnect the motor, make sure that the motor cannot rotate during work. Make sure that no other system, like hydraulic crawling drives, can rotate the motor directly or through any mechanical connection like felt, nip, rope, etc.
- Measure that the installation is de-energized.
  - Use a multimeter with an impedance of at least 1 Mohm.
  - Make sure that the voltage between the drive output terminals (U2, V2, W2) and the grounding (PE) busbar is close to 0 V.
  - Make sure that the voltage between the drive input power terminals (1L1, 1L2, 1L3) and the grounding (PE) busbar is close to 0 V.
  - Make sure that the voltage between the plus and minus busbars of the drive DC link and the grounding (PE) busbar is close to 0 V.
- Install temporary grounding to the drive output terminals (U2, V2, W2). Connect the output terminals together as well as to the PE.
- Make sure that the operator cannot run the motor over the rated speed. Motor overspeed causes overvoltage which can damage the capacitors in the intermediate circuit of the drive.
Introduction to the manual

Contents of this chapter
This chapter describes the manual. It contains a flowchart of steps in checking the delivery, installing and starting up the drive. The flowchart refers to chapters/sections in this manual and to other manuals.

Target audience
This manual is intended for people who plan the installation, install, start up, use and service the drive. Read the manual before working on the drive. You are expected to know the fundamentals of electricity, wiring, electrical components and electrical schematic symbols.

The manual is written for readers worldwide. Both SI and imperial units are shown.

Contents of the manual
This manual contains the instructions and information for the basic drive configuration. The chapters of the manual are briefly described below.

Safety instructions gives safety instructions for the installation, start-up, operation and maintenance of the drive.

Introduction to the manual gives an introduction to this manual.

Operation principle and hardware description describes the operation principle and construction of the drive.

Mechanical installation describes how to install the drive mechanically.

Guidelines for planning the electrical installation contains instructions for the motor and cable selection, protections and cable routing.
Introduction to the manual

Electrical installation gives instructions on wiring the drive.

Control units of the drive contains the default I/O connection diagrams, descriptions of the terminals and technical data for the control units of both the supply and inverter units.

Installation checklist contains a list for checking the mechanical and electrical installation of the drive.

Start-up describes the start-up procedure of the drive.

Fault tracing describes the fault tracing possibilities of the drive.

Maintenance contains preventive maintenance instructions.

Technical data contains the technical specifications of the drive, eg. the ratings, sizes and technical requirements, provisions for fulfilling the requirements for CE and other markings.

Dimensions contains example dimension drawings of the drive.

The Safe torque off function describes the Safe torque off function of the drive and gives instructions on its implementation.

Resistor braking describes selection, protection, wiring and start-up of optional brake choppers and resistors. The chapter also contains technical data.

Related documents

See List of related manuals on the inside of the front cover.

Categorization by frame size and option code

Some instructions, technical data and dimension drawings which concern only certain frame sizes are marked with the symbol of the frame size. The frame size indicates the number of power modules that form the supply and inverter units respectively. For example, the marking "2×R8i + 2×R8i" refers to a drive that has a supply unit consisting of two frame R8i IGBT supply modules and an inverter unit consisting of two frame R8i inverter modules. The frame size is marked on the type designation label (see page 54), and can also be determined from the type code (see table under Frame sizes and power module types, page 183).

The instructions, technical data and dimension drawings which only concern certain optional selections are marked with option codes (such as +B054). The options included in the drive can be identified from the option codes visible on the type designation label (see page 54). The option selections are listed in section Type designation key (page 55).
Quick installation, commissioning and operation flowchart

<table>
<thead>
<tr>
<th>Task</th>
<th>See</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plan the electrical installation and acquire the accessories needed (cables, fuses, etc.). Check the ratings, required cooling air flow, input power connection, compatibility of the motor, motor connection, and other technical data.</td>
<td>Guidelines for planning the electrical installation (page 75) Technical data (page 179)</td>
</tr>
<tr>
<td>Check the installation site.</td>
<td>Ambient conditions (page 190)</td>
</tr>
<tr>
<td>Unpack and check the drive (only intact units may be started up). Make sure that all necessary optional modules and equipment are present and correct. Install the drive mechanically.</td>
<td>Mechanical installation (page 59) If the drive has been non-operational for more than one year, the DC link capacitors need to be reformed (page 171)</td>
</tr>
<tr>
<td>Route the cables.</td>
<td>Routing the cables (page 86)</td>
</tr>
<tr>
<td>Check the insulation of the supply cable, the motor and the motor cable.</td>
<td>Checking the insulation of the assembly (page 95)</td>
</tr>
<tr>
<td>If the drive is about to be connected to an IT (ungrounded) system, check that the drive is not equipped with EMC filter +E202.</td>
<td>Checking the compatibility with IT (ungrounded) systems (page 96)</td>
</tr>
<tr>
<td>Connect the power cables. Connect the control cables.</td>
<td>Electrical installation (page 95),</td>
</tr>
<tr>
<td>Check the installation.</td>
<td>Installation checklist (page 143)</td>
</tr>
<tr>
<td>Start the drive up.</td>
<td>Start-up (page 145)</td>
</tr>
<tr>
<td>Operate the drive: start, stop, speed control etc.</td>
<td>ACS880 quick start-up guide, firmware manual</td>
</tr>
</tbody>
</table>
## Terms and abbreviations

<table>
<thead>
<tr>
<th>Term/Abbreviation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BCU</strong></td>
<td>Drive control unit. The drive contains two BCU control units. One controls the supply unit, the other controls the inverter unit. As standard, the external I/O control signals are connected to the control unit, or optional I/O extensions mounted on it.</td>
</tr>
<tr>
<td><strong>Drive</strong></td>
<td>Frequency converter for controlling AC motors. The drive consists of the supply unit (aka line-side converter) and the inverter unit (aka motor-side converter) connected together by the DC link. In this manual, the term refers to the ACS880-37 as a whole.</td>
</tr>
<tr>
<td><strong>EMC</strong></td>
<td>Electromagnetic compatibility</td>
</tr>
<tr>
<td><strong>EMI</strong></td>
<td>Electromagnetic interference</td>
</tr>
<tr>
<td><strong>EMT</strong></td>
<td>Electrical metallic tubing</td>
</tr>
<tr>
<td><strong>FAIO-01</strong></td>
<td>Optional analog I/O extension module</td>
</tr>
<tr>
<td><strong>FCAN-01</strong></td>
<td>Optional CANopen adapter module</td>
</tr>
<tr>
<td><strong>FCNA-01</strong></td>
<td>Optional ControlNet™ adapter module</td>
</tr>
<tr>
<td><strong>FDCO-01</strong></td>
<td>Optional DDCS communication module with two pairs of 10 Mbit/s DDCS channels</td>
</tr>
<tr>
<td><strong>FDIO-01</strong></td>
<td>Optional digital I/O extension module</td>
</tr>
<tr>
<td><strong>FDNA-01</strong></td>
<td>Optional DeviceNet™ adapter module</td>
</tr>
<tr>
<td><strong>FEA-03</strong></td>
<td>Optional I/O extension adapter</td>
</tr>
<tr>
<td><strong>FECA-01</strong></td>
<td>Optional EtherCAT adapter module</td>
</tr>
<tr>
<td><strong>FEN-01</strong></td>
<td>Optional TTL incremental encoder interface module</td>
</tr>
<tr>
<td><strong>FEN-11</strong></td>
<td>Optional TTL absolute encoder interface module</td>
</tr>
<tr>
<td><strong>FEN-21</strong></td>
<td>Optional resolver interface module</td>
</tr>
<tr>
<td><strong>FEN-31</strong></td>
<td>Optional HTL incremental encoder interface module</td>
</tr>
<tr>
<td><strong>FENA-11</strong></td>
<td>Optional Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols</td>
</tr>
<tr>
<td><strong>FENA-21</strong></td>
<td>Optional Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols, 2-port</td>
</tr>
<tr>
<td><strong>FEPL-02</strong></td>
<td>Optional Ethernet POWERLINK adapter module</td>
</tr>
<tr>
<td><strong>FIO-01</strong></td>
<td>Optional digital I/O extension module</td>
</tr>
<tr>
<td><strong>FIO-11</strong></td>
<td>Optional analog I/O extension module</td>
</tr>
<tr>
<td><strong>FLON-01</strong></td>
<td>Optional LonWorks® adapter module</td>
</tr>
<tr>
<td><strong>FPBA-01</strong></td>
<td>Optional PROFINET DP adapter module</td>
</tr>
<tr>
<td><strong>FPTC-01</strong></td>
<td>Optional thermistor protection module</td>
</tr>
<tr>
<td><strong>FPTC-02</strong></td>
<td>Optional ATEX-certified thermistor protection module for potentially explosive atmospheres</td>
</tr>
<tr>
<td><strong>Frame (size)</strong></td>
<td>Relates to the construction type of the component in question. For example, several drive types with different power ratings may have the same basic construction, and a frame size is used in reference to all those drive types. The frame size marking of the drive indicates the quantity and frame size of the supply modules, plus the quantity and frame size of the inverter modules, eg. “2×R8i + 2×R8i”. To determine the frame size of a drive type, see the rating tables in chapter Technical data.</td>
</tr>
<tr>
<td><strong>FSCA-01</strong></td>
<td>Optional RS-485 (Modbus/RTU) adapter</td>
</tr>
<tr>
<td><strong>FSO-xx</strong></td>
<td>Optional safety functions modules</td>
</tr>
<tr>
<td><strong>IGBT</strong></td>
<td>Insulated gate bipolar transistor; a voltage-controlled semiconductor type widely used in drives due to their easy controllability and high switching frequency.</td>
</tr>
</tbody>
</table>
Introduction to the manual

Safety data (SIL, PL)

<table>
<thead>
<tr>
<th>Term/Abbreviation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter unit</td>
<td>The part of the drive that converts DC to AC for the motor. Consists of one or more inverter modules and their auxiliary components. The inverter unit is also capable of feeding energy from a decelerating motor into the DC link.</td>
</tr>
<tr>
<td>I/O</td>
<td>Input/Output</td>
</tr>
<tr>
<td>Power module</td>
<td>Supply module or inverter module. See also Frame (size).</td>
</tr>
<tr>
<td>RDCO-0x</td>
<td>DDCS communication module</td>
</tr>
<tr>
<td>RFI</td>
<td>Radio-frequency interference</td>
</tr>
<tr>
<td>SAR</td>
<td>Safe acceleration range</td>
</tr>
<tr>
<td>SBC</td>
<td>Safe brake control</td>
</tr>
<tr>
<td>SLS</td>
<td>Safely-limited speed without encoder</td>
</tr>
<tr>
<td>SS1</td>
<td>Safe stop 1</td>
</tr>
<tr>
<td>SSE</td>
<td>Safe stop emergency</td>
</tr>
<tr>
<td>SSM</td>
<td>Safe speed monitor without encoder</td>
</tr>
<tr>
<td>STO</td>
<td>Safe torque off. See chapter The Safe torque off function (page 237).</td>
</tr>
<tr>
<td>Supply unit</td>
<td>The part of the drive that converts AC to DC. Consists of one or more supply modules and their auxiliary components such as the LCL filter.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Term/Abbreviation</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat.</td>
<td>EN ISO 13849-1 Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4.</td>
</tr>
<tr>
<td>CCF</td>
<td>EN ISO 13849-1 Common cause failure (%)</td>
</tr>
<tr>
<td>DC</td>
<td>EN ISO 13849-1 Diagnostic coverage</td>
</tr>
<tr>
<td>FIT</td>
<td>IEC 61508 Failure in time: 1E-9 hours</td>
</tr>
<tr>
<td>HFT</td>
<td>IEC 61508 Hardware fault tolerance</td>
</tr>
<tr>
<td>MTTF_D</td>
<td>EN ISO 13849-1 Mean time to dangerous failure: (The total number of life units) / (the number of dangerous, undetected failures) during a particular measurement interval under stated conditions</td>
</tr>
<tr>
<td>PFD_avg</td>
<td>IEC 61508 Average probability of dangerous failure on demand</td>
</tr>
<tr>
<td>PFH</td>
<td>IEC 61508 Average frequency of dangerous failures per hour</td>
</tr>
<tr>
<td>PL</td>
<td>EN ISO 13849-1 Performance level. Levels a...e correspond to SIL</td>
</tr>
<tr>
<td>SC</td>
<td>IEC 61508 Systematic capability</td>
</tr>
<tr>
<td>SFF</td>
<td>IEC 61508 Safe failure fraction (%)</td>
</tr>
<tr>
<td>SIL</td>
<td>IEC 61508 Safety integrity level (1...3)</td>
</tr>
<tr>
<td>SILCL</td>
<td>IEC/EN 62061 Maximum SIL (level 1...3) that can be claimed for a safety function or subsystem</td>
</tr>
<tr>
<td>SS1</td>
<td>IEC/EN 61800-5-2 Safe stop 1</td>
</tr>
<tr>
<td>STO</td>
<td>IEC/EN 61800-5-2 Safe torque off</td>
</tr>
<tr>
<td>T1</td>
<td>IEC 61508 Proof test interval. T1 is a parameter used to define the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of T1 is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. Note that any T1 values given cannot be regarded as a guarantee or warranty. See also section Maintenance (page 246).</td>
</tr>
</tbody>
</table>
Introduction to the manual
Operation principle and hardware description

Contents of this chapter

This chapter briefly describes the operation principle and construction of the drive.

Operation principle

The ACS880-37 is a low-harmonic, air-cooled, cabinet-installed drive for controlling asynchronous AC induction motors, permanent magnet synchronous motors, AC induction servomotors and ABB synchronous reluctance (SynRM) motors.

The drive consists of several cubicles that contain the supply and motor terminals, 1 to 6 IGBT supply module(s) forming the supply unit (line-side converter), 1 to 6 inverter modules forming the inverter unit (motor-side converter), and optional equipment. The actual arrangement of the cubicles varies from type to type and the selected options. Some optional equipment require additional cubicles. See chapter Dimensions for examples of cabinet line-ups.

Supply unit

The supply unit rectifies three-phase AC current to direct current for the intermediate DC link of the drive.
The following figure shows the simplified main circuit diagram of the supply unit. Larger drives have supply units that consist of multiple supply modules connected in parallel. The supply unit is controlled by a type BCU control unit [A51].

**AC voltage and current waveforms**

The AC current is sinusoidal at a unity power factor. The LCL filter suppresses the AC voltage distortion and current harmonics. The high AC inductance smooths the line voltage waveform distorted by the high-frequency switching of the converter. The capacitive component of the filter effectively filters the high-frequency (over 1 kHz) harmonics.

**Charging**

Charging is needed to power up the DC link capacitors smoothly. Discharged capacitors cannot be connected to the full supply voltage. The voltage must be increased gradually until the capacitors are charged and ready for normal use. The drive contains a resistive charging circuit consisting of fuses, contactor and charging resistors. The charging circuit is in use after start-up until the DC voltage has risen to a predefined level.

**Licensing**

Each supply module has a hardware license (+N8201) which allows the module to be used as an ACS880-37 supply module only. For example, a module with +N8201 cannot be used as an inverter module. On the other hand, it is possible to use a module without +N8201 as a spare part for an ACS880-37 supply module as long as the types of the modules are otherwise the same.

**Inverter unit**

The inverter unit converts the DC back to AC that rotates the motor. It is also able to feed the braking energy from a rotating motor back into the DC link. The inverter unit is controlled by a type BCU control unit [A41].
Overview circuit diagram of the drive

1. Auxiliary voltage transformer(s)
2. Auxiliary voltage switch [Q21]. Frame 1×R8i + 1×R8i has fuse disconnectors [F20.x] in place of an auxiliary voltage switch. The auxiliary voltage is switched by the main switch/disconnector.
3. *Main switch/disconnector [Q1.1]
4. *AC fuses [F1.x]. If the drive has multiple LCL filters, there are additional AC fuses at the input of each filter.
5. *Main contactor [Q2]

*With drive types ACS880-37-1210A-3, -1430A-3, -1530A-5, -1450-7 and -1680-7, these items can be replaced by an air circuit breaker [Q1] by selecting option +F255. Larger drive types have an air circuit breaker as standard equipment. Drives with an air circuit breaker have AC fuses only at the input of each LCL filter.

6. Charging switch fuse [Q3]
7. Charging contactor [Q4]
8. Charging resistors [R4.x]
9. LCL filter [R3.x]
10. Supply module [T1.x]
11. Common mode filters [R1.x] at the output of each supply module
12. DC fuses at the output of each supply module [F2.x], and at the input of each inverter module [F11.x]. Frame 1×R8i + 1×R8i drives do not have DC fuses.
13. Common mode filters [R11.x] at the input of each inverter module (except frame 1×R8i + 1×R8i)
14. Inverter unit consisting of one or several inverter modules [T11.x]
15. Motor
Cabinet line-up and layout examples

- Frame 1×R8i + 1×R8i

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Auxiliary control cubicle (ACU). Contains control electronics and customer I/O connections. See page 38.</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>Supply and inverter module cubicle. Contains the supply module, LCL filter, inverter module and switchgear, as well as the power cable terminals.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Main switch-disconnector [Q1.1].</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Charging switch [Q3]</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Drive control panel (see page 44)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Door switches and lights (see page 42)</td>
<td></td>
</tr>
</tbody>
</table>
### Cabinet layout example

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Auxiliary control cubicle (ACU). See page 38.</td>
</tr>
<tr>
<td>1</td>
<td>Input cable lead-throughs, PE busbar</td>
</tr>
<tr>
<td>2</td>
<td>LCL filter module</td>
</tr>
<tr>
<td>3</td>
<td>Input terminals (behind LCL filter module)</td>
</tr>
<tr>
<td>4</td>
<td>Main switch/disconnector [Q1.1] (behind mounting plate)</td>
</tr>
<tr>
<td>5</td>
<td>AC fuses (behind mounting plate)</td>
</tr>
<tr>
<td>6</td>
<td>Fuse disconnectors for auxiliary voltage [F20.x]</td>
</tr>
<tr>
<td>7</td>
<td>Main contactor [Q2.1]</td>
</tr>
<tr>
<td>8</td>
<td>Charging fuse switch [Q3]</td>
</tr>
<tr>
<td>9</td>
<td>Charging contactor</td>
</tr>
<tr>
<td>10</td>
<td>Charging resistors</td>
</tr>
<tr>
<td>11</td>
<td>Supply module</td>
</tr>
<tr>
<td>12</td>
<td>Inverter module</td>
</tr>
<tr>
<td>13</td>
<td>Output terminals (behind inverter module)</td>
</tr>
</tbody>
</table>
Frame 2×R8i + 2×R8i

Cabinet line-up example

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Auxilary control cubicle (ACU). Contains control electronics and customer I/O connections. See page 38.</td>
</tr>
<tr>
<td>B</td>
<td>Incoming cubicle. Contains the input terminals, switchgear and charging equipment.</td>
</tr>
<tr>
<td>C</td>
<td>Supply module cubicle. Contains two R8i supply modules together with an LCL filter module.</td>
</tr>
<tr>
<td>D</td>
<td>Inverter module cubicle. Contains two R8i inverter modules. As standard, the motor cables are run from each inverter module to the motor unless the drive is equipped with option +H359 (common motor terminal cubicle), +H366 (common output terminals) or +E206 (sine filters).</td>
</tr>
<tr>
<td>1</td>
<td>Main switch-disconnector [Q1.1]</td>
</tr>
<tr>
<td>2</td>
<td>Grounding/earthing switch [Q9.1] (option +F259)</td>
</tr>
<tr>
<td>3</td>
<td>Drive control panel (see page 44)</td>
</tr>
<tr>
<td>4</td>
<td>Door switches and lights (see page 42)</td>
</tr>
<tr>
<td>5</td>
<td>Auxiliary voltage switch [Q21]</td>
</tr>
<tr>
<td>6</td>
<td>Charging switch [Q3]</td>
</tr>
</tbody>
</table>
### Cabinet layout example

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Auxiliary control cubicle (ACU). See page 38:</td>
</tr>
<tr>
<td>1</td>
<td>Input cable lead-throughs, PE busbar</td>
</tr>
<tr>
<td>2</td>
<td>Input terminals</td>
</tr>
<tr>
<td>3</td>
<td>Main switch-disconnector [Q1.1]</td>
</tr>
<tr>
<td>4</td>
<td>Grounding/earthing switch [Q9.1] (option +F259)</td>
</tr>
<tr>
<td>5</td>
<td>AC fuses</td>
</tr>
<tr>
<td>6</td>
<td>Charging resistors and contactor</td>
</tr>
<tr>
<td>7</td>
<td>Main contactor (behind charging equipment)</td>
</tr>
<tr>
<td>8</td>
<td>Auxiliary voltage switch [Q21]</td>
</tr>
<tr>
<td>9</td>
<td>Charging switch [Q3]</td>
</tr>
<tr>
<td>10</td>
<td>Incoming cubicle cooling fan</td>
</tr>
<tr>
<td>11</td>
<td>DC fuses (at the output of each supply module and at the input of each inverter module)</td>
</tr>
<tr>
<td>12</td>
<td>LCL filter module</td>
</tr>
<tr>
<td>13</td>
<td>Supply modules</td>
</tr>
<tr>
<td>14</td>
<td>Inverter modules. The output terminals are located behind each module. Each module must be individually connected to the motor using separate cables unless the drive is equipped with option +H359 (common motor terminal cubicle), +H366 (common output terminals) or +E206 (sine filters).</td>
</tr>
</tbody>
</table>
Frame 3×R8i + 3×R8i (with main breaker)

Cabinet line-up example

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Auxiliary control cubicle (ACU). Contains control electronics and customer I/O connections. See page 38.</td>
</tr>
<tr>
<td>B</td>
<td>Incoming cubicle. Contains the input terminals, switchgear and charging equipment.</td>
</tr>
<tr>
<td>C</td>
<td>Supply module cubicle (1). Contains two LCL filter modules.</td>
</tr>
<tr>
<td>D</td>
<td>Supply module cubicle (2). Contains three R8i supply modules.</td>
</tr>
<tr>
<td>E</td>
<td>Inverter module cubicle. Contains three R8i inverter modules. As standard, the motor cables are run from each inverter module to the motor unless the drive is equipped with option +H359 (common motor terminal cubicle), +H366 (common output terminals) or +E206 (sine filters).</td>
</tr>
<tr>
<td>1</td>
<td>Main circuit breaker [Q1]</td>
</tr>
<tr>
<td>2</td>
<td>Grounding/earthing switch [Q9.1] (option +F259)</td>
</tr>
<tr>
<td>3</td>
<td>Drive control panel (see page 44)</td>
</tr>
<tr>
<td>4</td>
<td>Door switches and lights (see page 42)</td>
</tr>
<tr>
<td>5</td>
<td>Auxiliary voltage switch [Q21]</td>
</tr>
<tr>
<td>6</td>
<td>Charging switch [Q3]</td>
</tr>
</tbody>
</table>
Cabinet layout example

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Auxiliary control cubicle (ACU). See page 38.</td>
</tr>
<tr>
<td>1</td>
<td>Input cable lead-throughs, PE busbar</td>
</tr>
<tr>
<td>2</td>
<td>Input terminals</td>
</tr>
<tr>
<td>3</td>
<td>Charging resistors</td>
</tr>
<tr>
<td>4</td>
<td>Incoming cubicle cooling fans (behind the charging resistor mounting plate)</td>
</tr>
<tr>
<td>5</td>
<td>Main breaker [Q1]</td>
</tr>
<tr>
<td>6</td>
<td>Charging switch [Q3]</td>
</tr>
<tr>
<td>7</td>
<td>Auxiliary voltage switch [Q21]</td>
</tr>
<tr>
<td>8</td>
<td>Grounding/earthing switch [Q9.1] (option +F259)</td>
</tr>
<tr>
<td>9</td>
<td>Charging contactor (behind auxiliary equipment)</td>
</tr>
<tr>
<td>10</td>
<td>AC fuses</td>
</tr>
<tr>
<td>11</td>
<td>LCL filter modules</td>
</tr>
<tr>
<td>12</td>
<td>Supply modules</td>
</tr>
<tr>
<td>13</td>
<td>DC fuses (at the output of each supply module and at the input of each inverter module)</td>
</tr>
<tr>
<td>14</td>
<td>Inverter modules. The output terminals are located behind each module. Each module must be individually connected to the motor using separate cables unless the drive is equipped with option +H359 (common motor terminal cubicle), +H366 (common output terminals) or +E206 (sine filters).</td>
</tr>
</tbody>
</table>
### Auxiliary control cubicle (ACU) layout

A layout example of the auxiliary control cubicle (ACU) is shown below.

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fuse-disconnectors F101. On the primary of transformer T101 (item 27).</td>
</tr>
<tr>
<td>2</td>
<td>Fuse-disconnectors F27 for motor cooling fan outputs (options +M602...610)</td>
</tr>
<tr>
<td>3</td>
<td>Supply control unit [A51]. See chapter Control units of the drive (page 131)</td>
</tr>
<tr>
<td>4</td>
<td>Inverter control unit [A41]. Three optional I/O extension, encoder interface, or fieldbus adapter modules can be installed on the unit. Additional modules are installed on item 13. See chapter Control units of the drive (page 131)</td>
</tr>
<tr>
<td>5</td>
<td>Auxiliary voltage circuit breaker F112. On the secondary of transformer T111 (item 29). Mounted on the right-hand inside wall.</td>
</tr>
<tr>
<td>19</td>
<td>Lead-through for control cables</td>
</tr>
<tr>
<td>20</td>
<td>Terminal block X68 for FSO-xx safety functions module (option +Q973)</td>
</tr>
<tr>
<td>21</td>
<td>I/O terminal block (option +L504). The I/O of the inverter control unit is wired to this block.</td>
</tr>
<tr>
<td>22</td>
<td>Grounding/clamping point for control cables</td>
</tr>
<tr>
<td>23</td>
<td>24 V DC power supply and buffer module</td>
</tr>
<tr>
<td>24</td>
<td>Swing-out frame closed, detachable mounting plates in place</td>
</tr>
<tr>
<td>25</td>
<td>Swing-out frame open, without detachable mounting plates</td>
</tr>
</tbody>
</table>

[DiagramIllustration]
<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Switch F90 for ground fault monitoring (item 12)</td>
<td>24</td>
<td>Motor fan starters and contactors (options +M602...610)</td>
</tr>
<tr>
<td>7</td>
<td>FSO-xx safety functions module (option +Q973 and other options requiring FSO-xx)</td>
<td>25</td>
<td>Terminal blocks X601 for motor fan connections (options +M602...610)</td>
</tr>
<tr>
<td>8</td>
<td>Temperature monitoring relays (options +L505 and +L506). The terminals [X506] are located on the back of the detachable mounting plate.</td>
<td>26</td>
<td>24 V DC power supply for cabinet lighting (option +G301)</td>
</tr>
<tr>
<td>9</td>
<td>Swing-out frame</td>
<td>27</td>
<td>Transformer T101 (at the back of the cubicle, not visible). Supplies IP54, brake chopper and brake resistor cabinet cooling fans (options +B055, +D150 and +D151).</td>
</tr>
<tr>
<td>10</td>
<td>Mounting rail for additional equipment</td>
<td>28</td>
<td>Transformer T21 (at the back of the cubicle, not visible). Supplies the control circuitry and the cooling fans in both the incoming unit (ICU) and the auxiliary control unit (ACU). Also supplies the cooling fan of type BLCL-1x-x LCL filter modules.</td>
</tr>
<tr>
<td>11</td>
<td>Safety options (emergency stop, safe torque off)</td>
<td>29</td>
<td>Transformer T111.Supplies the cooling fans of LCL filter (BLCL-2x-x).</td>
</tr>
<tr>
<td>12</td>
<td>Ground fault monitoring equipment for ungrounded systems (option +Q954)</td>
<td>30</td>
<td>Auxiliary voltage circuit breakers F22 and F102. On the secondary of transformers T21 (item 28) and T101 (item 27) respectively.</td>
</tr>
<tr>
<td>13</td>
<td>FEA-03 extension adapter (option +L515). See item 4.</td>
<td>31</td>
<td>Input voltage setting for auxiliary voltage transformer T101 (item 27)</td>
</tr>
<tr>
<td>14</td>
<td>Switch and circuit breaker for externally-supplied motor space heater (option +G313). The terminals [X313] are located on the back of the detachable mounting plate.</td>
<td>32</td>
<td>Input voltage setting for auxiliary voltage transformer T21 (item 28)</td>
</tr>
<tr>
<td>15</td>
<td>Switch and circuit breaker for externally-supplied control voltage (option +G307), eg. UPS. The terminals [X307] are located on the back of the detachable mounting plate.</td>
<td>33</td>
<td>Input voltage setting for auxiliary voltage transformer T111 (item 29)</td>
</tr>
</tbody>
</table>
| 16 | Switch and circuit breaker for externally-supplied cabinet lighting and heating (options +G300 and +G301). The terminals [X300] are located on the back of the detachable mounting plate. | 34 | Terminal blocks  
  • X250: indication of main switch-disconnector and contactor status  
  • X951: connection of external emergency stop button  
  • X954: ground fault alarm indication  
  • X957: for connection of Prevention of unexpected start-up switch. Mounted on the left-hand side wall. |
| 18 | Fuse-disconnectors F111. On the primary of transformer T111 (item 29). Mounted on a detachable plate. |   |   |
Overview of power and control connections

The diagram shows the power connections and control interfaces of the drive.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Option modules can be inserted into slots 1, 2, 3 and 4 as follows:</td>
</tr>
<tr>
<td>2</td>
<td>Module type</td>
</tr>
<tr>
<td>3</td>
<td>Analog and digital I/O extension modules</td>
</tr>
<tr>
<td>4</td>
<td>Feedback interface modules</td>
</tr>
<tr>
<td>5</td>
<td>Fieldbus communication modules</td>
</tr>
<tr>
<td>6</td>
<td>RDCO-xx DDCS communication option module (standard equipment). As standard, a fiber optic link connects the supply and inverter control units.</td>
</tr>
<tr>
<td>7</td>
<td>See section <em>Type designation key</em>, page 55</td>
</tr>
</tbody>
</table>

Additional modules can be installed on an optional FEA-03 extension adapter connected to the RDCO module on slot 4.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Memory unit (see page 177)</td>
</tr>
<tr>
<td>6</td>
<td>Connection for FSO-xx safety functions module</td>
</tr>
<tr>
<td>7</td>
<td>See section <em>Control panel</em> (page 44)</td>
</tr>
<tr>
<td>8</td>
<td>Terminal blocks on the inverter control unit. See page 101, and <em>Control units of the drive</em> (page 131). These terminals are optionally wired to terminal block X504 in the auxiliary control cabinet of the drive.</td>
</tr>
<tr>
<td>9</td>
<td>Fiber optic link to each inverter module. Similarly, each supply module is connected to the supply control unit by fiber optic cables.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>10</td>
<td>Terminal blocks for customer connections installed in the drive cabinet. For the locations, see <em>Auxiliary control cubicle (ACU) layout</em> (page 38). Wiring details are given starting on page 103.</td>
</tr>
<tr>
<td>11</td>
<td>Supply unit (consisting of one or more supply modules and LCL filters)</td>
</tr>
<tr>
<td>12</td>
<td>DC link</td>
</tr>
<tr>
<td>13</td>
<td>Inverter unit (consisting of one or more inverter modules)</td>
</tr>
<tr>
<td>14</td>
<td>Optional brake chopper (+D150) and resistors (+D151)</td>
</tr>
</tbody>
</table>
Door switches and lights

<table>
<thead>
<tr>
<th></th>
<th>Label in English</th>
<th>Label in local language</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>READY</td>
<td>-</td>
<td>Ready light (option +G327)</td>
</tr>
<tr>
<td>2</td>
<td>RUN</td>
<td>-</td>
<td>Run light (option +G328)</td>
</tr>
<tr>
<td>3</td>
<td>FAULT</td>
<td>-</td>
<td>Fault light (option +G329)</td>
</tr>
<tr>
<td>4</td>
<td>RUN/ENBL</td>
<td>OFF</td>
<td>Run enable signal switch for the supply unit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>OFF: Run enable signal off (starting the supply unit not allowed)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ON: Run enable signal on (starting the supply unit allowed). Close the main contactor/breaker.</td>
</tr>
<tr>
<td>5</td>
<td>E-STOP RESET</td>
<td>-</td>
<td>Emergency stop reset push button (with emergency stop options only)</td>
</tr>
<tr>
<td>6</td>
<td>EARTH FAULT</td>
<td>-</td>
<td>Ground (earth) fault light with option +Q954</td>
</tr>
<tr>
<td>7</td>
<td>-</td>
<td>-</td>
<td>Reserved for application-engineered equipment</td>
</tr>
<tr>
<td>8</td>
<td>EMERGENCY STOP</td>
<td>-</td>
<td>Emergency stop push button (with emergency stop options only)</td>
</tr>
</tbody>
</table>

The layout depends on the options selected.
Main disconnecting device [Q1.1]

Depending on the configuration of the drive, the main disconnecting device of the drive is either a switch-disconnector or a main circuit breaker. Units with a switch-disconnector also have a main contactor.

The main disconnecting device switches the main supply to the drive on and off. To disconnect the main supply, turn the switch-disconnector to the 0 (OFF) position, or rack out the main breaker (whichever device is installed).

**WARNING!** The main disconnecting device does not isolate the input power terminals, AC voltage meters, or the *auxiliary voltage circuit from the power line. To isolate the auxiliary voltage circuit, open the auxiliary voltage switch (Q21). To isolate the input power terminals and AC voltage meters, open the main breaker of the supply transformer.

*With frame 1×R8i + 1×R8i units, the main switch-disconnector [Q1.1] also switches the auxiliary voltage on and off.*

To close the main disconnecting device, auxiliary voltage must be switched on, and the grounding switch (if present) must be open.

Auxiliary voltage switch [Q21]

The auxiliary voltage switch controls the supply to the auxiliary voltage transformers. The transformer feeds the control circuits inside the drive such as cooling fans, relays and measuring equipment. The switch is fitted with fuses.

**Note:** Frame 1×R8i + 1×R8i units are not fitted with an auxiliary voltage switch. The auxiliary voltage is switched on and off by the main disconnecting device [Q1], and protected by fuse disconnectors F20.1…F20.3.

Grounding (earthing) switch [Q9.x], optional

The grounding switch [Q9.1] (option +F259) connects the main AC power bus to the PE busbar.

To close the grounding switch, auxiliary voltage must be switched on, and the main disconnecting device must be open.

**WARNING!** The grounding switch does not ground the input power terminals of the drive or the auxiliary (control) voltage circuits.

Charging switch [Q3]

The DC capacitors of the drive must be charged smoothly before the drive can be started. A charging circuit is provided to limit the charging current with resistors until the capacitors are charged and main contactor/breaker can be closed.

Charging is enabled using the charging switch [Q3] – the charging itself is controlled by the supply control unit. The switch must be kept closed during operation.

Other devices on the door

- Voltmeter (option +G334); comes with a phase selector switch. **Note:** The voltage is measured on the supply side of the main switch or breaker.
- AC current meter (option +G335) on one phase.
Control panel

The ACS-AP-W is the user interface of the drive. It provides the essential controls such as Start/Stop/Direction/Reset/Reference, and the parameter settings for the inverter control program.

The control panel can be removed by pulling it forward by the top edge and reinstalled in reverse order. For the use of the control panel, see *ACX-AP-x assistant control panel user’s manual* (3AUA0000085685 [English]) and the firmware manual.

Control by PC tools

There is a USB connector on the front of the panel that can be used to connect a PC to the drive. When a PC is connected to the control panel, the control panel keypad is disabled.
Descriptions of options

**Note:** All options are not available for all drive types, do not coexist with certain other options, or may require additional engineering. Check actual availability with ABB.

### Degree of protection

**Definitions**

According to IEC/EN 60529, the degree of protection is indicated by an IP code where the first numeral means protection against ingress of solid foreign objects, and the second numeral protection against ingress of water. The IP codes of the standard cabinet and options covered in this manual are defined below.

<table>
<thead>
<tr>
<th>IP code</th>
<th>First numeral</th>
<th>The equipment is protected …</th>
<th>Second numeral</th>
</tr>
</thead>
<tbody>
<tr>
<td>IP22</td>
<td>against ingress of solid foreign objects ≥</td>
<td>against dripping (15° tilting) water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>12.5 mm diameter *</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IP42</td>
<td>against ingress of solid foreign objects ≥</td>
<td>against dripping (15° tilting) water</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IP54</td>
<td>dust-protected</td>
<td>against splashing water</td>
<td></td>
</tr>
</tbody>
</table>

* meaning for protection of persons: against access to hazardous parts with finger

**IP22 (standard)**

The degree of protection of the standard drive cabinet is IP22 (UL type 1). The air outlets at the top of the cabinet and the air inlet gratings are covered with metallic gratings. With doors open, the degree of protection of the standard cabinet and all cabinet options is IP20. The live parts inside the cabinet are protected against contact with clear plastic shrouds or metallic gratings.

**IP42 (option +B054)**

This option provides the degree of protection of IP42 (UL type 1). The air inlet gratings are covered with a metallic mesh between the inner and outer metallic gratings.

**IP54 (option +B055)**

This option provides the degree of protection of IP54 (UL type 12). It provides the cabinet air inlets with filter housings containing folded board air filter mats between the inner and outer metallic gratings. An additional fan and filtered outlets on the cabinet roof are also included.

**Cooling air intake through bottom of cabinet (option +C128)**

See page 72.

**Channeled air outlet (option +C130)**

This option provides a collar for connection to an air outlet duct. The collar is located on the cabinet roof. Depending on the equipment installed in each cubicle, the channeled air outlet either replaces, or adds to, the standard roof arrangement.

The option also provides the cabinet air inlets with filter housings containing folded board air filter mats between the inner and outer metallic gratings.

See also *Air outlet duct on the cabinet roof (option +C130)* on page 73.
Marine construction (option +C121)
The option includes the following accessories and features:
• reinforced mechanics
• grab railings
• door flush bolt which allows the door to open 90 degrees and prevents it from slamming close
• self-extinctive materials
• flat bars at base of the cabinet for fastening
• fastening braces at the top of the cabinet.
Additional wire markings (see page 48) may be required for classification.

UL Listed (option +C129)
The cabinet is built according to UL 508C and contains the following accessories and features:
• top entry and exit with US cable conduit entries (plain plate without ready-made holes)
• all components UL Listed/Recognized
• maximum supply voltage 600 V
• main (air circuit) breaker whenever available for the particular drive type.

CSA approved (option +C134)
The option includes the following accessories and features:
• bottom entry and exit of cables with US cable conduit entry (plain plate without ready-made holes)
• all components UL/CSA listed/recognized
• maximum supply voltage 600 V
• main (air circuit) breaker whenever available for the particular drive type.

Plinth height (options +C164 and +C179)
The standard height of the cabinet plinth is 50 mm. These options specify a plinth height of 100 mm (+C164) or 200 mm (+C179).

Seismic design (option +C180)
The option involves seismic capability according to International building code 2012, test procedure ICC-ES AC-156. The installation level must not exceed 25% of the height of the building, and $S_{DS}$ (installation site specific spectral acceleration response) must not exceed 2.0 g.

The option adds the following accessories and features:
• reinforced plinth
• flat bars at base of the cabinet for fastening.

Empty cubicles (options +C199, +C200, +C201)
The option adds an empty 400, 600 or 800 mm wide cubicle to the left end of the line-up. The cubicle is equipped with blank power cable lead-throughs both at the top and the bottom. See the dimension drawings on page 221.
Resistor braking (options +D150 and +D151)

See chapter Resistor braking on page 249.

EMC filters (option + E202)

See section Type designation key on page 55 and sections Compliance with the European EMC Directive on page 193 and Compliance with EN 61800-3:2004 on page 196.

More information: Technical Guide No. 3 – EMC Compliant Installation and Configuration for a Power Drive System (3AFE61348280 [English])

Sine output filter (option +E206)

A sine filter provides true sinusoidal voltage waveform at the drive output by suppressing the high-frequency voltage components of the output. These high-frequency components cause stress to motor insulation as well as output transformer saturation (if present). The sine filter option consists of three single-phase reactors and delta-connected capacitors at the output of the drive. The filter is fitted in a separate cubicle and has a dedicated cooling fan.

Cabinet heater with external supply (option +G300)

The option contains:
- heating elements in the cubicles or supply/inverter modules
- load switch for providing electrical isolation during service
- miniature circuit breaker for overcurrent protection
- terminal block for external power supply.

The heater prevents humidity condensation inside the cabinet when the drive is not running. The power output of the semiconductor-type heating elements depends on the environmental temperature. The customer must switch the heating off when it is not needed by cutting the supply voltage off.

The customer must supply the heater from an external 110…240 V AC power source.

See also
- Powering the heating and lighting equipment (options +G300, +G301 and +G313)
- circuit diagrams delivered with drive for the actual wiring.

Cabinet lighting (option +G301)

This option contains LED lighting fixtures in each cubicle (except joining and brake resistor cubicles) and a 24 V DC power supply. The lighting is powered from the same external 110…240 V AC power source as the cabinet heater (option +G300).

Terminals for external control voltage (option +G307)

The option provides terminals for connecting external, uninterruptible control voltage to the control unit and control devices when the drive is not powered.

See also
- Supplying power for the auxiliary circuits (page 90)
- Connecting a 230/115 V AC auxiliary voltage supply (UPS, option +G307) (page 103)
- circuit diagrams delivered with drive for the actual wiring.
Output for motor space heater (option +G313)

The option contains:
- load switch for providing electrical isolation during service
- miniature circuit breaker for overcurrent protection
- terminal block for external supply and heating element(s) connection

The heater is off when the drive is running. The customer controls the heating elements in the motor windings on and off with the external supply. The power and voltage of the motor heater depend on the motor.

See also
- Supplying power for the auxiliary circuits (page 90)
- Powering the heating and lighting equipment (options +G300, +G301 and +G313) (page 107)
- circuit diagrams delivered with drive for the actual wiring.

Supply connection by busbars (option +G317)

The option provides input (supply) terminals and a busbar entry that enable direct connection to busbar trunking systems.

Ready/Run/Fault lights (options +G327...G329)

These options provide “ready” (+G327, white), “run” (+G328, green) and “fault” (+G329, red) lights installed on the cabinet door.

Halogen-free wiring and materials (option +G330)

The option provides halogen-free cable ducts, control wires and wire sleeves, thus reducing toxic fire gases.

V-meter with selector switch (option +G334)

The option contains a voltmeter and a selector switch on the cabinet door. The switch selects the two input phases across which the voltage is measured.

A-meter in one phase (option +G335)

The option contains an ammeter that reads the current flowing through one (L1) input phase.

Additional wire markings (options +G340 and +G342)

Standard wire markings

As standard, wires and terminals are marked as follows:
- Plug-in connectors of wire sets: Connector labeled with designation (eg. "X1"). Both the connector and the individual wires are marked with pin numbers.
- Wires without a connector: Connector designation and pin number printed on wire (eg. “X1:7”).
- Fiber optic pairs: Component and connector designation printed on marker tape.
- Main input, output and PE terminals: Connector identifier (eg. “U1”, “PE”) printed on sticker on terminal, or on insulating material close to the terminal. PE cables marked with yellow/green tape.
Additional wire markings

The following additional wire markings are available.

<table>
<thead>
<tr>
<th>Option</th>
<th>Additional markings</th>
</tr>
</thead>
<tbody>
<tr>
<td>+G340</td>
<td>Equipment pin numbers are marked with snap-on markers on wires between modules and on wires connected to equipment, terminal blocks and detachable screw terminals. Plug-in connector identifications are marked on labels near the connectors. The label holders are attached around conductor bundles. Main circuit conductors are marked with white tape or printing.</td>
</tr>
<tr>
<td>+G342</td>
<td>Equipment identifications and terminal block pin numbers and remote addresses are marked with tubing or rings on wires between modules, and on wires connected to equipment, terminal blocks and detachable screw terminals. Plug-in connector identifications are marked on labels attached around the conductor bundles near the connectors. Main circuit conductors are marked with white tape or printing. <strong>Note:</strong> Even wires with equipment and pin identifiers ready printed on the wire insulation are marked with rings or tubing. Remote end addresses are <strong>not</strong> marked on wire ends that are connected to plug-in connectors. Short and obvious connections are marked with printing only.</td>
</tr>
</tbody>
</table>

**Bottom cable entry/exit (options +H350 and +H352)**

For UL Listed (+C129) units, the default input and output cabling direction is through the roof of the cabinet. The bottom entry (+H350) and bottom exit (+H352) options provide power and control cable entries at the floor of the cabinet. The entries are equipped with grommets and 360° grounding hardware.

For non-UL Listed units, bottom entry/exit is the default cabling arrangement.

**Top cable entry/exit (options +H351 and +H353)**

For non-UL Listed units, the default input and output cabling direction is through the bottom of the cabinet. The top entry (+H351) and top exit (+H353) options provide power and control cable entries at the roof of the cabinet. The entries are equipped with grommets and 360° grounding hardware.

For UL Listed (+C129) units, top entry/exit is the default cabling arrangement.

**Cable conduit entry (option +H358)**

The option provides US/UK conduit plates (plain 3 mm [0.12"] thick steel plates without any ready-made holes). US/UK conduit plates are provided as standard with options +C129 and +C134 instead of the normal cable entries.

**Common motor terminal cubicle (option +H359)**

As standard, each inverter module must be individually cabled to the motor. This option provides an additional cubicle containing a single set of terminals for the motor cables.

The width of the cubicle and the size of the terminals within depend on the power rating of the drive. See chapter *Dimensions* (page 201).
Note that this option is not available with option +E206 (sine filters) – in this case, the motor cables are connected to the sine filter cubicle.

- **Common output terminal (option +H366)**

As standard, each inverter module must be individually cabled to the motor. This option adds bridging that connects the outputs of multiple (in practice, two or three) inverter modules mounted in the same cubicle. The bridging balances the motor current between the modules, which allows more cabling options. For example, it is possible to use a number of cables that could not otherwise be evenly distributed between the inverter modules.

⚠️ **WARNING!** The bridging can carry the nominal output of one inverter module. In case of three parallel modules, ensure that the load capacity of the bridging is not exceeded. For example, if the cabling connects to the output busbars at one module only, use the module in the middle.

**Note:** The +H366 option only interconnects the outputs of inverter modules within the same cubicle, not modules installed in different cubicles. Therefore, when the drive has more than three inverter modules, make sure that the load is distributed evenly between the modules:

- In case of two inverter cubicles of two modules, connect the same number of cables to each cubicle.
- In case of one inverter cubicle with three modules and another with two, each cubicle requires a number of cables proportional to the number of modules within. For example, connect three out of five (or six out of ten, etc.) cables to the cubicle with three modules, the remaining two out of five (four out of ten) cables to the cubicle with two modules.

- **Additional terminal block X504 (option +L504)**

The standard terminal blocks of the drive control unit are wired to the additional terminal block at the factory for customer control wiring. The terminals are spring loaded.

Cables accepted by the terminals:
- solid wire 0.08 to 4 mm²
- stranded wire with ferrule 0.14 to 2.5 mm²
- stranded wire without ferrule 0.08 to 2.5 mm² (28 to 12 AWG).

Stripping length: 10 mm (0.4").

**Note:** The optional modules inserted in the slots of the control unit (or optional FEA-03 extension adapter) are not wired to the additional terminal block. The customer must connect the optional module control wires directly to the modules.

- **Thermal protection with PTC relays (options +L505, +2L505, +L513, +2L513, +L536, +L537)**

PTC thermistor relay options are used for overtemperature supervision of motors equipped with PTC sensors. When the motor temperature rises to the thermistor wake-up level, the resistance of the sensor increases sharply. The relay detects the change and indicates motor overtemperature through its contacts.
Option +L505 provides a thermistor relay and a terminal block. The terminal block has connections for the measuring circuit (one to three PTC sensors in series), the output indication of the relay, and an optional external reset button. The relay can be reset either locally or externally, or the reset circuit can be jumpered for automatic reset.

The output indication of the relay can be wired by the customer for example to:

- the main contactor or breaker control circuit of the drive, to open it in case of motor overtemperature,
- the appropriate digital input of the drive, to trip the drive and generate a fault message in case of motor overtemperature, or
- an external monitoring circuit.

Option +L513 is an ATEX-certified thermal protection function that has the same external connectivity as +L505. In addition, +L513 comes with +Q971 (ATEX-certified safe disconnection function) and is wired at the factory to activate the Safe torque off function of the drive in an overtemperature situation. A manual reset for the protection function is required by Ex/ATEX regulations. For more information, see "ATEX-certified motor thermal protection functions for cabinet-built ACS880 drives (options +L513+Q971 and +L514+Q971) user’s manual (3AXD50000014979 [English])."

Options +2L505 and +2L513 duplicate options +L505 and +L513 respectively, containing the relays and connections for two separate measurement circuits.

+L536, +L537

An alternative to a thermistor relay option is the FPTC-01 (option +L536) or FPTC-02 (+L537, also requires +Q971) thermistor protection module. The module mounts onto the inverter control unit, and has reinforced insulation to keep the control unit PELV-compatible. The connectivity of the FPTC-01 and the FPTC-02 is the same; FPTC-02 is Type Examined as a protective device within the scope of the European ATEX Product Directive.

For protection purposes, the FPTC has a "fault" input for the PTC sensor. An overtemperature situation executes the SIL/PL-capable SMT (Safe motor temperature) safety function by activating the Safe torque off function of the drive.

The FPTC also has a "warning" input for the sensor. When the module detects overtemperature through this input, it sends a warning indication to the drive.

For more information and wiring examples, see the module manuals and the circuit diagrams delivered with the drive.

See also:
- firmware manual for parameter settings
- "ATEX-certified motor thermal protection functions for cabinet-built ACS880 drives (options +L513+Q971 and +L514+Q971) user’s manual (3AXD50000014979 [English])"
- "FPTC-01 thermistor protection module (option +L536) for ACS880 drives user’s manual (3AXD5000027750 [English])"
- "FPTC-02 ATEX-certified thermistor protection module, Ex II (2) GD (option +L537 +Q971) for ACS880 drives user’s manual (3AXD50000027782 [English])"
- "Wiring the PTC thermistor relay(s) (options +L505, +2L505, +L513, +2L513) (page 104)"
- circuit diagrams delivered with the drive for the actual wiring.
Thermal protection with Pt100 relays (options +nL506 and +nL514)

Pt100 temperature monitoring relays are used for overtemperature supervision of motors equipped with Pt100 sensors. For example, there can be three sensors to measure the temperature of the motor windings and two sensors for the bearings.

The standard Pt100 relay options include two (+2L506), three (+3L506), five (+5L506) or eight (+8L506) relays. The monitoring relays are connected to one to three auxiliary relays whose outputs are wired at the factory to a terminal block. The sensors are to be connected by the customer to the same terminal block.

As the temperature rises, the sensor resistance increases linearly. At an adjustable wake-up level, the monitoring relay de-energizes its output which then trips one of the auxiliary relays.

The output indication of the auxiliary relays can be wired by the customer for example to:
- the main contactor or breaker control circuit of the drive, to open it in case of motor overtemperature,
- the appropriate digital input of the drive, to trip the drive and generate a fault message in case of motor overtemperature, or
- an external monitoring circuit.

Options +3L514 (3 relays), +5L514 (5 relays) and +8L514 (8 relays) are ATEX-certified thermal protection functions that have the same external connectivity as +nL506. In addition, each monitoring relay has a 0/4…20 mA output that is available on the terminal block. Option +nL514 comes with +Q971 (ATEX-certified safe disconnection function) as standard and is wired at the factory to activate the Safe torque off function of the drive in an overtemperature situation. As the monitoring relay does not have a reset functionality, the manual reset required by Ex/ATEX regulations must be implemented using drive parameters. For more information, see ATEX-certified motor thermal protection functions for cabinet-built ACS880 drives (options +L513+Q971 and +L514+Q971) user’s manual (3AXD50000014979 [English]).

See also
- firmware manual for parameter settings
- ATEX-certified motor thermal protection functions for cabinet-built ACS880 drives (options +L513+Q971 and +L514+Q971) user’s manual (3AXD50000014979 [English])
- Wiring the Pt100 relays (option +nL506) (page 105) or Wiring the Pt100 relays (option +nL514) (page 106)
- Pt100 relay alarm and trip limit setting instructions (page 146)
- circuit diagrams delivered with the drive for the actual wiring.
## Starter for auxiliary motor fan (options +M602…+M610)

### What the option contains

The option provides switched and protected connections for 3-phase auxiliary motor fans. Each fan connection is equipped with
- fuses
- a manual motor starter switch with an adjustable current limit
- a contactor controlled by the drive, and
- terminal block X601 for customer connections.

The number of connections must be specified when ordering. The maximum number of connections available depends on the current requirement. The lower current ratings allow up to four fan connections (eg. option +4M602), while the highest current rating only allows one (eg. +M610). For more information, refer to [ACS880-X7 single drives ordering information](3AXD10000052815, available on request).

### Description

The output for the auxiliary fan is wired from the 3-phase supply voltage to terminal block X601 through a motor starter switch and a contactor. The contactor is operated by the drive. The 230 V AC control circuit is wired through a jumper on the terminal block; the jumper can be replaced by an external control circuit.

The starter switch has an adjustable trip current limit, and can be opened to permanently switch the fan off.

The statuses of both the starter switch and the fan contactor are wired to the terminal block.

See the circuit diagrams delivered with the drive for the actual wiring.
Type designation label

The type designation label includes ratings, appropriate markings, a type designation and a serial number, which allow the identification of each unit. A sample label is shown below. Quote the complete type designation and serial number when contacting technical support.

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Type designation (see section Type designation key below)</td>
</tr>
<tr>
<td>2</td>
<td>Frame size</td>
</tr>
<tr>
<td>3</td>
<td>Short-time withstand current rating (see page 189); degree of protection; UL/CSA specifications</td>
</tr>
<tr>
<td>4</td>
<td>Ratings. See also sections Ratings (page 179) and Electrical power network specification (page 189).</td>
</tr>
<tr>
<td>5</td>
<td>Valid markings</td>
</tr>
<tr>
<td>6</td>
<td>Serial number. The first digit of the serial number refers to the manufacturing plant. The next four digits refer to the unit's manufacturing year and week, respectively. The remaining digits complete the serial number so that there are no two units with the same number.</td>
</tr>
</tbody>
</table>
Type designation key

The type designation contains information on the specifications and configuration of the drive. The first digits from left express the basic configuration (e.g., ACS880-37-12104-3). The optional selections are given thereafter, separated by plus signs, e.g., +E202. The main selections are described below. Not all selections are available for all types. For more information, refer to ACS880-X7 single drives ordering information (3AXD10000052815, available on request).

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Basic codes</strong></td>
<td></td>
</tr>
<tr>
<td>ACS880</td>
<td>Product series</td>
</tr>
<tr>
<td>37</td>
<td>When no options are selected: cabinet-installed drive, IP22 (UL Type 1), main switch-disconnector (and contactor) or breaker, aR fuses, ACS-AP-W Assistant control panel, EMC filter (category 3, 2nd Environment), du/dt filters, common mode filtering, ACS880 primary control program, Safe torque off function, coated circuit boards, bottom entry and exit of cables with lead-through-type entries, multilingual door device label sticker, USB memory stick containing circuit diagrams, dimension drawings and manuals.</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td></td>
</tr>
<tr>
<td>xxxxx</td>
<td>Refer to the rating tables (page 179)</td>
</tr>
<tr>
<td><strong>Input voltage range</strong></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>380…415 V AC. This is indicated in the type designation label as typical input voltage level (3~ 400 V AC)</td>
</tr>
<tr>
<td>5</td>
<td>380…500 V AC. This is indicated in the type designation label as typical input voltage levels (3~ 400/480/500 V AC)</td>
</tr>
<tr>
<td>7</td>
<td>525…690 V AC. This is indicated in the type designation label as typical input voltage levels (3~ 525/600/690 V AC)</td>
</tr>
<tr>
<td><strong>Option codes (plus codes)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Degree of protection</strong></td>
<td></td>
</tr>
<tr>
<td>B054</td>
<td>IP42 (UL Type 1)</td>
</tr>
<tr>
<td>B055</td>
<td>IP54 (UL Type 12)</td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td></td>
</tr>
<tr>
<td>C121</td>
<td>Marine construction (page 46)</td>
</tr>
<tr>
<td>C128</td>
<td>Air inlet through bottom of cabinet (page 45)</td>
</tr>
<tr>
<td>C129</td>
<td>UL Listed (page 46)</td>
</tr>
<tr>
<td>C130</td>
<td>Channeled air outlet (page 45)</td>
</tr>
<tr>
<td>C134</td>
<td>CSA approved (page 46)</td>
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<tr>
<td>C164</td>
<td>Plinth height 100 mm (page 46)</td>
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<tr>
<td>C179</td>
<td>Plinth height 200 mm (page 46)</td>
</tr>
<tr>
<td>C180</td>
<td>Seismic design (page 46)</td>
</tr>
<tr>
<td>C199</td>
<td>Empty 400 mm wide cubicle on left</td>
</tr>
<tr>
<td>C200</td>
<td>Empty 600 mm wide cubicle on left</td>
</tr>
<tr>
<td>C201</td>
<td>Empty 800 mm wide cubicle on left</td>
</tr>
<tr>
<td><strong>Resistor braking</strong></td>
<td></td>
</tr>
<tr>
<td>D150</td>
<td>Brake choppers (page 47)</td>
</tr>
<tr>
<td>D151</td>
<td>Brake resistors (page 47)</td>
</tr>
<tr>
<td><strong>Filters</strong></td>
<td></td>
</tr>
<tr>
<td>E202</td>
<td>EMC filter for first environment TN (grounded) system, category C2 (page 47)</td>
</tr>
<tr>
<td>E206</td>
<td>Sine output filter (page 47)</td>
</tr>
</tbody>
</table>
### Codification Description

**Line options**
- F255: Main (air circuit) breaker (instead of line contactor)
- F259: Grounding (earthing) switch

**Cabinet equipment**
- G300: Cabinet and module heating elements (external supply) (page 47)
- G301: Cabinet lighting (page 47)
- G307: Terminals for connecting external control voltage (230 V AC or 115 V AC, eg. UPS) (page 47)
- G313: Output for motor space heater (external supply) (page 48)
- G317: Supply connection by busbars (page 48)
- G327: Ready light on door, white (page 48)
- G328: Run light on door, green (page 48)
- G329: Fault light on door, red (page 48)
- G330: Halogen-free wiring and materials (page 48)
- G334: V-meter with selector switch (page 48)
- G335: A-meter in one phase (page 48)
- G340: Additional wire markings (page 48)

**Cabling**
- H350: Bottom entry (page 49)
- H351: Top entry (page 49)
- H352: Bottom exit (page 49)
- H353: Top exit (page 49)
- H358: Cable conduit entry (US/UK) (page 49)
- H359: Common motor terminal cubicle (page 49)
- H366: Common output terminals (for inverter modules mounted in the same cubicle) (page 50)

**Fieldbus adapters**
- K451: FDNA-01 DeviceNet™ adapter module
- K454: FPBA-01 PROFIBUS DP adapter module
- K457: FCAN-01 CANopen adapter module
- K458: FSCA-01 RS-485 (Modbus/RTU) adapter module
- K462: FCNA-01 ControlNet™ adapter module
- K469: FECA-01 EtherCat adapter module
- K470: FEPL-02 EtherPOWERLINK adapter module
- K473: FENA-11 Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols
- K475: FENA-21 Ethernet adapter module for EtherNet/IP™, Modbus TCP and PROFINET IO protocols, 2-port

**I/O extensions and feedback interfaces**
- L500: FIO-11 analog I/O extension module
- L501: FIO-01 digital I/O extension module
- L502: FEN-31 HTL incremental encoder interface module
- L503: FDCO-01 optical DDCS communication adapter module
- L504: Additional I/O terminal block (page 50)
- L505: Thermal protection with PTC relays (1 or 2 pcs) (page 50)
- L506: Thermal protection with Pt100 relays (2, 3, 5 or 8 pcs) (page 52)
- L508: FDCO-02 optical DDCS communication adapter module
- L513: ATEX-certified thermal protection with PTC relays (1 or 2 pcs) (page 50)
### Operation principle and hardware description

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>L514</td>
<td>ATEX-certified thermal protection with Pt100 relays (3, 5 or 8 pcs) (page 52)</td>
</tr>
<tr>
<td>L515</td>
<td>FEA-03 I/O extension adapter</td>
</tr>
<tr>
<td>L516</td>
<td>FEN-21 resolver interface module</td>
</tr>
<tr>
<td>L517</td>
<td>FEN-01 TTL incremental encoder interface module</td>
</tr>
<tr>
<td>L518</td>
<td>FEN-11 TTL absolute encoder interface module</td>
</tr>
<tr>
<td>L521</td>
<td>FSE-31 pulse encoder interface module</td>
</tr>
<tr>
<td>L525</td>
<td>FAIO-01 analog I/O extension module</td>
</tr>
<tr>
<td>L526</td>
<td>FDIO-01 digital I/O extension module</td>
</tr>
<tr>
<td>L536</td>
<td>FPTC-01 thermistor protection module (page 50)</td>
</tr>
<tr>
<td>L537</td>
<td>FPTC-02 ATEX-certified thermistor protection module (page 50)</td>
</tr>
</tbody>
</table>

**Starter for auxiliary motor fan** (page 53)

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<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>M602</td>
<td>Trip limit setting range: 2.5 … 4 A</td>
</tr>
<tr>
<td>M603</td>
<td>Trip limit setting range: 4 … 6.3 A</td>
</tr>
<tr>
<td>M604</td>
<td>Trip limit setting range: 6.3 … 10 A</td>
</tr>
<tr>
<td>M605</td>
<td>Trip limit setting range: 10…16 A</td>
</tr>
<tr>
<td>M606</td>
<td>Trip limit setting range: 16…20 A</td>
</tr>
<tr>
<td>M610</td>
<td>Trip limit setting range: 20…25 A</td>
</tr>
</tbody>
</table>

**Control program**

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>N5000</td>
<td>Winder control program</td>
</tr>
<tr>
<td>N5050</td>
<td>Crane control program</td>
</tr>
<tr>
<td>N5100</td>
<td>Winch control program</td>
</tr>
<tr>
<td>N5200</td>
<td>PCP/ESP control program</td>
</tr>
<tr>
<td>N5300</td>
<td>Test bench control program</td>
</tr>
<tr>
<td>N5450</td>
<td>Override control program</td>
</tr>
<tr>
<td>N7502</td>
<td>Control program for synchronous reluctance motors (SynRM)</td>
</tr>
<tr>
<td>N8010</td>
<td>IEC 61131-3 application programmability</td>
</tr>
</tbody>
</table>

**Specialties**

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>P902</td>
<td>Customized</td>
</tr>
<tr>
<td>P904</td>
<td>Extended warranty</td>
</tr>
<tr>
<td>P912</td>
<td>Seaworthy packaging</td>
</tr>
<tr>
<td>P913</td>
<td>Special color</td>
</tr>
<tr>
<td>P929</td>
<td>Container packaging</td>
</tr>
</tbody>
</table>

**Safety functions**

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q950</td>
<td>Prevention of unexpected start-up with FSO-xx safety functions module, by activating the Safe torque off function</td>
</tr>
<tr>
<td>Q951</td>
<td>Emergency stop (category 0) with safety relays, by opening the main breaker/contactor</td>
</tr>
<tr>
<td>Q952</td>
<td>Emergency stop (category 1) with safety relays, by opening the main breaker/contactor</td>
</tr>
<tr>
<td>Q954</td>
<td>Ground fault monitoring for IT (ungrounded) systems</td>
</tr>
<tr>
<td>Q957</td>
<td>Prevention of unexpected start-up with safety relays, by activating the Safe torque off function</td>
</tr>
<tr>
<td>Q963</td>
<td>Emergency stop (category 0) with safety relays, by activating the Safe torque off function</td>
</tr>
<tr>
<td>Q964</td>
<td>Emergency stop (category 1) with safety relays, by activating the Safe torque off function</td>
</tr>
<tr>
<td>Q965</td>
<td>Safely-limited speed with FSO-21 and encoder</td>
</tr>
<tr>
<td>Q971</td>
<td>ATEX-certified safe disconnection function</td>
</tr>
<tr>
<td>Q972</td>
<td>FSO-21 safety functions module</td>
</tr>
<tr>
<td>Q973</td>
<td>FSO-12 safety functions module</td>
</tr>
</tbody>
</table>
Emergency stop (configurable for category 0 or 1) with FSO-xx safety functions module, by opening the main breaker/contactor

Emergency stop (configurable for category 0 or 1) with FSO-xx safety functions module, by activating the Safe torque off function

PROFIsafe with FSO-xx safety functions module and FENA-21 Ethernet adapter module

**Full set of printed manuals in the selected language**

*Note*: The delivery may include manuals in English if the requested language is not available.

<table>
<thead>
<tr>
<th>CODE</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q978</td>
<td>Emergency stop (configurable for category 0 or 1) with FSO-xx safety functions module, by opening the main breaker/contactor</td>
</tr>
<tr>
<td>Q979</td>
<td>Emergency stop (configurable for category 0 or 1) with FSO-xx safety functions module, by activating the Safe torque off function</td>
</tr>
<tr>
<td>Q982</td>
<td>PROFIsafe with FSO-xx safety functions module and FENA-21 Ethernet adapter module</td>
</tr>
<tr>
<td>R700</td>
<td>English</td>
</tr>
<tr>
<td>R701</td>
<td>German</td>
</tr>
<tr>
<td>R702</td>
<td>Italian</td>
</tr>
<tr>
<td>R703</td>
<td>Dutch</td>
</tr>
<tr>
<td>R704</td>
<td>Danish</td>
</tr>
<tr>
<td>R705</td>
<td>Swedish</td>
</tr>
<tr>
<td>R706</td>
<td>Finnish</td>
</tr>
<tr>
<td>R707</td>
<td>French</td>
</tr>
<tr>
<td>R708</td>
<td>Spanish</td>
</tr>
<tr>
<td>R709</td>
<td>Portuguese</td>
</tr>
<tr>
<td>R711</td>
<td>Russian</td>
</tr>
</tbody>
</table>
Mechanical installation

Contents of this chapter

This chapter describes the mechanical installation procedure of the drive.

Examining the installation site

Examine the installation site:

• The installation site is sufficiently ventilated or cooled to transfer away the drive losses. ¹)

• The ambient conditions of the drive meet the specifications. ¹)

• The wall behind the unit is of non-flammable material.

• There is enough free space above the drive to enable cooling air flow, service and maintenance.

• The floor that the unit is installed on is of non-flammable material, as smooth as possible, and strong enough to support the weight of the unit. Check the floor flatness with a spirit level. The maximum allowed deviation from the surface level is 5 mm in every 3 meters. Level the installation site, if necessary, as the cabinet is not equipped with adjustable feet.

¹) The heat losses and ambient conditions are specified in chapter Technical data.

Note: The module extraction/installation ramp included with the drive is only suitable for a height difference of 50 mm maximum (ie. the standard plinth height of the drive).
Necessary tools

The tools required for moving the unit to its final position, fastening it to the floor and wall and tightening the connections are listed below:

- crane, fork-lift or pallet truck (check load capacity!), slate/spud bar, jack and rollers
- Pozidriv and Torx screwdrivers
- torque wrench
- set of wrenches or sockets.

Checking the delivery

The drive delivery contains:

- drive cabinet line-up
- optional modules (if ordered) installed onto the control unit at the factory
- appropriate drive and optional module manuals
- delivery documents.

Check that there are no signs of damage. Before attempting installation and operation, check the information on the type designation labels of the drive to verify that the delivery is of the correct type. See section *Type designation key* on page 55.
Moving and unpacking the drive

Move the drive in its original packaging to the installation site as shown below to avoid damaging the cabinet surfaces and door devices. When you are using a pallet truck, check its load capacity before you move the drive.

The drive cabinet is to be moved in the upright position.

WARNING! Be careful when moving the cabinet. Avoid tilting the cabinet as its center of gravity is high.

Moving the drive in its packaging

Lifting the crate with a forklift
Lifting the crate with a crane

Position each sling as close to a transverse board as possible. We recommend the use of transverse spreader bars.
Moving the crate with a forklift

Free width for fork tines: 750 mm (29.5")
■ Removing the transport package

Remove the transport package as follows:

1. Undo the screws that attach the wooden parts of the transport crate together.
2. Remove the wooden parts.
3. Remove the clamps with which the drive cabinet is mounted onto the transport pallet by undoing the fastening screws.
4. Remove the plastic wrapping.

■ Moving the unpacked drive cabinet

Lifting the cabinet with a crane

Lift the drive cabinet using its lifting eyes. The lifting eyes can be removed after the cabinet is in its final position, but their mounting holes must be blocked to retain the degree of protection.

Note: The minimum allowed height of the lifting slings with IP54 units is 2 meters (6'7").
**Moving the cabinet on rollers**

**WARNING:** Do not move marine versions (option +C121) on rollers.

Lay the cabinet on the rollers and move it carefully until close to its final location. Remove the rollers by lifting the unit with a crane, forklift, pallet truck or jack.

**Moving the cabinet on its back**

**WARNING:** Transportation of the cabinet on its back is only allowed with the BLCL (LCL filter) modules and sine filters (option +E206) removed from the cabinet.

Support the cabinet from below alongside the cubicle seams.
Final placement of the cabinet

Move the cabinet into its final position with a slate bar (spud bar). Place a piece of wood between the edge of the cabinet and the bar to protect the cabinet frame.
Fastening the cabinet to the floor and wall or roof (non-marine units)

- **General rules**
  - The drive must be installed in an upright vertical position.
  - The cabinet can be installed with its back against a wall (a), or back-to-back with another unit (b).
  - Leave 400 mm (15.75”) of free space above the basic roof level of the cabinet for cooling.
  - Leave some space (w) at the side where the cabinet outmost hinges are to allow the doors to open sufficiently. The doors must open 120° to allow supply or inverter module replacement.

**Note 1:** Any height adjustment must be done before fastening the units or shipping splits together. Height adjustment can be done by using metal shims between the cabinet bottom and floor.

**Note 2:** If the lifting eyes are removed, refasten the bolts to retain the degree of protection of the cabinet.
### Fastening methods

Fasten the cabinet to the floor by using the clamps included along the edge of the cabinet bottom, or by bolting the cabinet to the floor through the holes inside (if they are accessible).

#### Alternative 1 – Clamping

1. Insert the clamps into the twin slots along the front and rear edges of the cabinet frame body and fasten them to the floor with a bolt. The recommended maximum distance between the clamps in the front edge is 800 mm (31.5").

2. If floor mounting at the back is not possible, fasten the top of the cabinet to the wall with L-brackets (not included in the delivery) bolted to the lifting bar fastening holes.

#### Clamp dimensions

<table>
<thead>
<tr>
<th>M16</th>
</tr>
</thead>
</table>

#### Alternative 2 – Using the holes inside the cabinet

1. Fasten the cabinet to the floor through the bottom fastening holes with M10 to M12 (3/8” to 1/2”) bolts. The recommended maximum distance between the front edge fastening points is 800 mm (31.5").

2. If the back fastening holes are not accessible, fasten the cabinet at the top to wall with L-brackets (not included in the delivery) using the lifting bar fastening holes.
Fastening the cabinet to the floor and roof/wall (marine units, +C121)

Follow the general rules given in section **General rules** on page 67.

See the dimension drawing delivered with the drive for the locations of the fastening holes in the flat bars below the cabinet and for fastening points at the top of the cabinet.

Fasten the cabinet to the floor and roof (wall) as follows:

1. Bolt the unit to the floor through the flat bars at the base of the cabinet using M10 or M12 screws.

2. If there is not enough room behind the cabinet for installation, clamp (a) the rear edges of the flat bars (c) to the floor.

3. Remove the lifting lugs and bolt the corner brackets (d) to the lifting lug holes. Fasten the corner brackets to the rear wall and/or roof with suitable hardware such as U-brackets (e).

![Diagram of fastening process](image)
Joining shipping splits together

Wide cabinet line-ups are delivered in multiple parts called “shipping splits”. The connection is made using a 200 mm wide joining cubicle at the end of one shipping split (a common motor terminal cubicle can also act as a joining cubicle). The screws required for the joining are enclosed in a plastic bag inside the cabinet. The threaded bushings are already mounted on the cabinet posts.

1. Fasten the first shipping split to the floor.
2. Remove any plates covering the rear post of the joining cubicle.
3. Align the two shipping splits.
4. Fasten the front and rear posts of the joining cubicle to the posts of the other shipping split with 14 screws (7 per post). Tighten the screws to 5 N·m (3.7 lbf·ft).
5. Fasten the second shipping split to the floor.

6. Connect the PE busbars using the M10 bolts and nuts included. Tighten to 35…40 N·m (25…30 lbf·ft).
7. Remove the shroud covering the DC busbars in the joining cubicle.

8. Use the joint pieces to connect the DC busbars. Tighten the bolts to 55…70 N·m (40…50 lbf·ft).

**WARNING!** Make sure you install the washers in the correct order as shown. For example, placing an unpassivated zinc-coated spring washer directly against the joint piece will cause corrosion.

**WARNING!** Do not use any joining parts other than those delivered with the unit. The parts are carefully selected to match the material of the busbars. Other parts or materials can form a galvanic couple and cause corrosion.

9. Reinstall any covering plates removed earlier.

10. Repeat steps 2 to 9 for any further shipping splits.
Miscellaneous

- **Cable duct in the floor below the cabinet**

A cable duct can be constructed below the 500 mm wide middle part of the cabinet. The cabinet weight lies on the two 50 mm wide transverse sections which the floor must carry.

Prevent the cooling air flow from the cable duct to the cabinet by bottom plates. To ensure the degree of protection for the cabinet, use the original bottom plates delivered with the unit. With user-defined cable entries, take care of the degree of protection, fire protection and EMC compliance.

![Diagram of cable duct in the floor below the cabinet](image)

- **Air inlet through the bottom (option +C128)**

Drives with air intake through the bottom of the cabinet (option +C128) are intended for installation on an air duct in the floor. Each cubicle (except top entry adapter and joining cubicles) have an inlet through the bottom plate. The option also adds a 130 mm deep inlet area at the back of the cubicle.

An example of the air inlets in the cabinet bottom plate is shown below. Refer also to the dimension drawings delivered with the drive.

![Diagram of air inlets through the bottom](image)

Support the plinth of the cabinet all round.
The air duct must be able to supply a sufficient volume of cooling air. The minimum air flow values are given in section *Cooling data, noise* (page 187).

Top cable entry adapter and joining cubicles have no air inlet.

**WARNING!** Make sure that the incoming air is sufficiently clean. If not, dust goes into the cabinet. The outlet filter on the cabinet roof prevents dust from going out. The collected dust can cause drive malfunction and danger of fire.

**Air outlet duct on the cabinet roof (option +C130)**

The ventilation system must keep the static pressure in the air outlet duct sufficiently below the pressure of the room where the drive is located in order that the cabinet fans can produce the required air flow through the cabinet. Make sure that no dirty or moist air is able to flow backward to the drive in any case, even during off-time or while servicing the drive or the ventilation system.

**Calculating the required static pressure difference**

The required static pressure difference between the exit air duct and the drive installation room can be calculated as follows:

$$\Delta \rho_s = (1.5...2) \cdot \rho_d$$

where

- \(\rho_d\) \(\triangleq\) Dynamic pressure
- \(\rho\) \(\triangleq\) Air density (kg/m\(^3\))
- \(v_m\) \(\triangleq\) Average air velocity in the exit duct(s) (m/s)
- \(q\) \(\triangleq\) Rated air flow of the drive (m\(^3\)/s)
- \(A_c\) \(\triangleq\) Cross-sectional area of the exit duct(s) (m\(^2\))

**Example**

The cabinet has 3 exit openings of 315 mm diameter. The rated air flow of the cabinet is 4650 m\(^3\)/h = 1.3 m\(^3\)/s.

\[A_c = 3 \cdot 0.315^2 \cdot \pi / 4 = 0.234 \text{ m}^2\]
\[v_m = q / A_c = 1.3 / 0.234 = 5.5 \text{ m/s}\]
\[\rho_d = 0.5 \cdot \rho \cdot v_m^2 = 0.5 \cdot 1.1 \cdot 5.5^2 = 17 \text{ Pa}\]

The required pressure in the exit air duct is then, 1.5...2 \cdot 17 \text{ Pa} = 26...34 \text{ Pa}, below the pressure in the room.

For more information: Contact ABB.
Mechanical installation

**Arc welding**

Fastening the cabinet by arc welding is not recommended. However, if arc welding is the only mounting option, connect the return conductor of the welding equipment to the cabinet frame at the bottom within 0.5 meters (1’6") of the welding point.

**Note:** The thickness of the zinc coating of the cabinet frame is 100 to 200 micrometers (4 to 8 mil).

---

**WARNING!** Make sure that the return wire is connected correctly. Welding current must not return via any component or cabling of the drive. If the welding return wire is connected improperly, the welding circuit can damage electronic circuits in the cabinet.

---

**WARNING!** Do not inhale the welding fumes.
Guidelines for planning the electrical installation

Contents of this chapter

This chapter contains instructions for planning the electrical installation of the drive. Some instructions are mandatory to follow in every installation, others provide useful information that only concerns certain applications.

Limitation of liability

The installation must always be designed and made according to applicable local laws and regulations. ABB does not assume any liability whatsoever for any installation which breaches the local laws and/or other regulations. Furthermore, if the recommendations given by ABB are not followed, the drive may experience problems that the warranty does not cover.

Selecting the supply disconnecting device

The drive is equipped with a main disconnecting device. Depending on the size of the drive, the disconnecting device is a switch-disconnector or an air circuit breaker. The disconnecting device can be locked to the open position for installation and maintenance work.

Selecting the main contactor

Some drive types can be equipped with a line contactor. See Overview circuit diagram of the drive (page 31).
Examining the compatibility of the motor and drive

Use an asynchronous AC induction motor, permanent magnet synchronous motor or AC induction servomotor with the drive. Several induction motors can be connected to the drive at a time.

Select the motor size and drive type from the rating tables in chapter *Technical data* on basis of the AC line voltage and motor load. Use the DriveSize PC tool if you need to tune the selection more in detail.

Make sure that the motor withstands the maximum peak voltage in the motor terminals. See the *Requirements table* on page 77. For basics of protecting the motor insulation and bearings in drive systems, refer to section *Protecting the motor insulation and bearings* below.

**Note:**
- Consult the motor manufacturer before using a motor whose nominal voltage differs from the AC line voltage connected to the drive input.
- The voltage peaks at the motor terminals are relative to the supply voltage of the drive, not the drive output voltage.
- If the motor and drive are not of the same size, consider the following operation limits of the drive control program:
  - motor nominal voltage range $1/6 \ldots 2 \cdot U_N$
  - motor nominal current range $1/6 \ldots 2 \cdot I_N$ of the drive in DTC control and $0 \ldots 2 \cdot I_N$ in scalar control. The control mode is selected by a drive parameter.

**Protecting the motor insulation and bearings**

The drive employs modern IGBT inverter technology. Regardless of frequency, the drive output comprises pulses of approximately the drive DC bus voltage with a very short rise time. The pulse voltage can almost double at the motor terminals, depending on the attenuation and reflection properties of the motor cable and the terminals. This can cause additional stress on the motor and motor cable insulation.

Modern variable speed drives with their fast rising voltage pulses and high switching frequencies can generate current pulses that flow through the motor bearings. This can gradually erode the bearing races and rolling elements.

du/dt filters protect motor insulation system and reduce bearing currents. Common mode filters mainly reduce bearing currents. Insulated N-end (non-drive end) bearings protect the motor bearings.
### Requirements table

The following table shows how to select the motor insulation system and when a $du/dt$ filter, common mode filters and insulated N-end (non-drive end) motor bearings are required. Ignoring the requirements or improper installation may shorten motor life or damage the motor bearings and voids the warranty.

<table>
<thead>
<tr>
<th>Motor type</th>
<th>Nominal AC supply voltage</th>
<th>Requirement for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ABB $du/dt$ and common mode filters, insulated N-end motor bearings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$P_N &lt; 100 , \text{kW}$ and frame size $&lt; \text{IEC 315}$</td>
</tr>
<tr>
<td>Random-wound M2_, M3_ and M4_</td>
<td>$U_N \leq 500 , \text{V}$</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td>500 V $&lt; U_N \leq 600 , \text{V}$</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td>or</td>
<td>Reinforced</td>
</tr>
<tr>
<td></td>
<td>600 V $&lt; U_N \leq 690 , \text{V}$ (cable length $\leq 150 , \text{m}$)</td>
<td>Reinforced</td>
</tr>
<tr>
<td></td>
<td>600 V $&lt; U_N \leq 690 , \text{V}$ (cable length $&gt; 150 , \text{m}$)</td>
<td>Reinforced</td>
</tr>
<tr>
<td>Form-wound HX_ and AM_</td>
<td>380 V $&lt; U_N \leq 690 , \text{V}$</td>
<td>Standard</td>
</tr>
<tr>
<td></td>
<td>Check with the motor manufacturer.</td>
<td>+ N + $du/dt$ with voltages over 500 V + CMF</td>
</tr>
<tr>
<td>Old* form-wound HX_ and modular</td>
<td>380 V $&lt; U_N \leq 690 , \text{V}$</td>
<td>Check with the motor manufacturer.</td>
</tr>
<tr>
<td>Random-wound HX_ and AM_ **</td>
<td>0 V $&lt; U_N \leq 500 , \text{V}$</td>
<td>Enamelled wire with fiber glass taping</td>
</tr>
<tr>
<td></td>
<td>500 V $&lt; U_N \leq 690 , \text{V}$</td>
<td>Enamelled wire with fiber glass taping</td>
</tr>
<tr>
<td>HDP</td>
<td>Consult the motor manufacturer.</td>
<td></td>
</tr>
</tbody>
</table>

* manufactured before 1.1.1998
** For motors manufactured before 1.1.1998, check for additional instructions with the motor manufacturer.
### Guidelines for planning the electrical installation

The abbreviations used in the table are defined below.

<table>
<thead>
<tr>
<th>Abbr.</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>( U_N )</td>
<td>Nominal AC line voltage</td>
</tr>
<tr>
<td>( U_{LL} )</td>
<td>Peak line-to-line voltage at motor terminals which the motor insulation must withstand</td>
</tr>
<tr>
<td>( P_N )</td>
<td>Motor nominal power</td>
</tr>
<tr>
<td>( \frac{du}{dt} )</td>
<td>( \frac{du}{dt} ) filter at the output of the drive (standard equipment)</td>
</tr>
<tr>
<td>CMF</td>
<td>Common mode filter (standard equipment)</td>
</tr>
<tr>
<td>N</td>
<td>N-end bearing: insulated motor non-drive end bearing</td>
</tr>
<tr>
<td>n.a.</td>
<td>Motors of this power range are not available as standard units. Consult the motor manufacturer.</td>
</tr>
</tbody>
</table>

### Additional requirements for explosion-safe (EX) motors

If you will use an explosion-safe (EX) motor, follow the rules in the requirements table above. In addition, consult the motor manufacturer for any further requirements.
Additional requirements for ABB motors of types other than M2_, M3_, M4_, HX_ and AM_

Use the selection criteria given for non-ABB motors.

Additional requirements for braking applications

When the motor brakes the machinery, the intermediate circuit DC voltage of the drive increases, the effect being similar to increasing the motor supply voltage by up to 20 percent. Consider this voltage increase when specifying the motor insulation requirements if the motor will be braking a large part of its operation time.

Example: Motor insulation requirement for a 400 V AC line voltage application must be selected as if the drive were supplied with 480 V.

Additional requirements for ABB high-output and IP23 motors

The rated output power of high output motors is higher than what is stated for the particular frame size in EN 50347 (2001). This table shows the requirements for ABB random-wound motor series (for example, M3AA, M3AP and M3BP).

<table>
<thead>
<tr>
<th>Nominal mains voltage (AC line voltage)</th>
<th>Requirement for Motor insulation system</th>
<th>ABB du/dt and common mode filters, insulated N-end motor bearings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P_N &lt; 100 kW</td>
<td>100 kW ≤ P_N &lt; 200 kW</td>
</tr>
<tr>
<td></td>
<td>P_N &lt; 140 hp</td>
<td>140 hp ≤ P_N &lt; 268 hp</td>
</tr>
<tr>
<td></td>
<td>P_N ≥ 200 kW</td>
<td>P_N ≥ 268 hp</td>
</tr>
<tr>
<td>U_N ≤ 500 V</td>
<td>Standard</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ N + CMF</td>
</tr>
<tr>
<td>500 V &lt; U_N ≤ 600 V</td>
<td>Standard</td>
<td>+ du/dt</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ du/dt + N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ du/dt + N + CMF</td>
</tr>
<tr>
<td>or</td>
<td>Standard</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ N + CMF</td>
</tr>
<tr>
<td>600 V &lt; U_N ≤ 690 V</td>
<td>Reinforced</td>
<td>+ du/dt</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ du/dt + N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+ du/dt + N + CMF</td>
</tr>
</tbody>
</table>

Additional requirements for non-ABB high-output and IP23 motors

The rated output power of high-output motors is higher than what is stated for the particular frame size in EN 50347 (2001). If you plan to use a non-ABB high-output motor or an IP23 motor, consult the motor manufacturer.
Additional data for calculating the rise time and the peak line-to-line voltage

If you need to calculate the actual peak voltage and voltage rise time considering the actual cable length, proceed as follows:

- Peak line-to-line voltage: Read the relative $\frac{U_{LL}}{U_N}$ value from the diagram below and multiply it by the nominal supply voltage ($U_N$).

- Voltage rise time: Read the relative values $\frac{U_{LL}}{U_N}$ and $\frac{(du/dt)}{U_N}$ from the diagram below. Multiply the values by the nominal supply voltage ($U_N$) and substitute into equation $t = 0.8 \times \frac{U_{LL}}{(du/dt)}$.

![Graph showing $U_{LL}/U_N$ and $du/dt/U_N$ vs. cable length](image)

**Note:** $U_{LL}$ and $du/dt$ values are approximately 20% higher with resistor braking.

### Additional note for sine filters

A sine filter (option +E206) also protects the motor insulation system. The peak phase-to-phase voltage with a sine filter is approximately $1.5 \times U_N$. 
Selecting the power cables

- General rules

Select the input power and motor cables according to local regulations:

- Select a cable capable of carrying the drive nominal current. See section *Ratings* (page 179) for the rated currents, and section *Typical cable sizes* (page 82).
- Select a cable rated for at least 70 °C maximum permissible temperature of conductor in continuous use. For US, see *Additional US requirements*, page 85.
- The inductance and impedance of the PE conductor/cable (grounding wire) must be rated according to permissible touch voltage appearing under fault conditions (so that the fault point voltage will not rise excessively when a ground fault occurs).
- 600 V AC cable is accepted for up to 500 V AC. 750 V AC cable is accepted for up to 600 V AC. For 690 V AC rated equipment, the rated voltage between the conductors of the cable should be at least 1 kV.

Use symmetrical shielded motor cable (see page 84). Ground motor cable shields 360° at both ends. Keep the motor cable and its PE pigtail (twisted shield) as short as possible to reduce high-frequency electromagnetic emissions.

**Note:** When continuous metal conduit is employed, shielded cable is not required. The conduit must have bonding at both ends.

A four-conductor system is allowed for input cabling with restrictions, but shielded symmetrical cable is recommended (see page 84).

Compared to a four-conductor system, the use of symmetrical shielded cable reduces electromagnetic emission of the whole drive system as well as the stress on motor insulation, bearing currents and wear.

The protective conductor must always have an adequate conductivity. The table below shows the minimum cross-sectional area related to the phase conductor size according to IEC 61800-5-1 when the phase conductor and the protective conductor are made of the same metal.

<table>
<thead>
<tr>
<th>Cross-sectional area of the phase conductors S (mm²)</th>
<th>Minimum cross-sectional area of the corresponding protective conductor S_p (mm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S ≤ 16</td>
<td>S</td>
</tr>
<tr>
<td>16 &lt; S ≤ 35</td>
<td>16</td>
</tr>
<tr>
<td>35 &lt; S ≤ 400</td>
<td>S/2</td>
</tr>
</tbody>
</table>
## Typical cable sizes

### Input (supply) cable sizes

The table below gives copper and aluminum cable types with concentric copper shield for nominal current. For drawings of the terminals, see chapter *Dimensions* (page 201).

<table>
<thead>
<tr>
<th>Drive type</th>
<th>IEC ¹⁾</th>
<th>US ²⁾</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Al cable size</td>
<td>Cu cable size</td>
</tr>
<tr>
<td></td>
<td>mm²</td>
<td>mm²</td>
</tr>
<tr>
<td><strong>Uₐₙ = 400 V</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACS880-37-…</td>
<td>0450A-3</td>
<td>2 × (3 × 240 + 72 Cu)</td>
</tr>
<tr>
<td></td>
<td>0620A-3</td>
<td>3 × (3 × 185 + 57 Cu)</td>
</tr>
<tr>
<td></td>
<td>0870A-3</td>
<td>4 × (3 × 240 + 72 Cu)</td>
</tr>
<tr>
<td></td>
<td>1110A-3</td>
<td>4 × (3 × 300 + 88 Cu)</td>
</tr>
<tr>
<td></td>
<td>1210A-3</td>
<td>5 × (3 × 240 + 72 Cu)</td>
</tr>
<tr>
<td></td>
<td>1430A-3</td>
<td>6 × (3 × 240 + 72 Cu)</td>
</tr>
<tr>
<td></td>
<td>1700A-3</td>
<td>7 × (3 × 240 + 72 Cu)</td>
</tr>
<tr>
<td></td>
<td>2060A-3</td>
<td>9 × (3 × 240 + 72 Cu)</td>
</tr>
<tr>
<td></td>
<td>2530A-3</td>
<td>9 × (3 × 300 + 88 Cu)</td>
</tr>
<tr>
<td><strong>Uₐₙ = 500 V</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0420A-5</td>
<td>2 × (3 × 185 + 57 Cu)</td>
</tr>
<tr>
<td></td>
<td>0570A-5</td>
<td>3 × (3 × 185 + 57 Cu)</td>
</tr>
<tr>
<td></td>
<td>0780A-5</td>
<td>4 × (3 × 185 + 57 Cu)</td>
</tr>
<tr>
<td></td>
<td>1010A-5</td>
<td>5 × (3 × 185 + 57 Cu)</td>
</tr>
<tr>
<td></td>
<td>1110A-5</td>
<td>4 × (3 × 300 + 88 Cu)</td>
</tr>
<tr>
<td></td>
<td>1530A-5</td>
<td>7 × (3 × 240 + 72 Cu)</td>
</tr>
<tr>
<td></td>
<td>1980A-5</td>
<td>8 × (3 × 240 + 72 Cu)</td>
</tr>
<tr>
<td></td>
<td>2270A-5</td>
<td>8 × (3 × 300 + 88 Cu)</td>
</tr>
<tr>
<td><strong>Uₐₙ = 690 V</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0320A-7</td>
<td>2 × (3 × 150 + 41 Cu)</td>
</tr>
<tr>
<td></td>
<td>0390A-7</td>
<td>2 × (3 × 185 + 57 Cu)</td>
</tr>
<tr>
<td></td>
<td>0580A-7</td>
<td>3 × (3 × 185 + 57 Cu)</td>
</tr>
<tr>
<td></td>
<td>0660A-7</td>
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</tr>
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<td>0770A-7</td>
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<td></td>
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</tr>
<tr>
<td></td>
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<td>4 × (3 × 300 + 88 Cu)</td>
</tr>
<tr>
<td></td>
<td>1450A-7</td>
<td>6 × (3 × 240 + 72 Cu)</td>
</tr>
<tr>
<td></td>
<td>1680A-7</td>
<td>7 × (3 × 240 + 72 Cu)</td>
</tr>
<tr>
<td></td>
<td>1950A-7</td>
<td>8 × (3 × 240 + 72 Cu)</td>
</tr>
<tr>
<td></td>
<td>2230A-7</td>
<td>9 × (3 × 240 + 72 Cu)</td>
</tr>
<tr>
<td></td>
<td>2770A-7</td>
<td>10 × (3 × 300 + 88 Cu)</td>
</tr>
<tr>
<td></td>
<td>3310A-7</td>
<td>12 × (3 × 300 + 88 Cu)</td>
</tr>
</tbody>
</table>

1. The cable sizing is based on max. 9 cables laid on a cable ladder side by side, three ladder type trays one on top of the other, ambient temperature 30 °C, PVC insulation, surface temperature 70 °C (IEC/EN 60204-1 and IEC 60364-5-52/2001). For other conditions, size the cables according to local safety regulations, appropriate input voltage and the load current of the drive.

2. The cable sizing is based on NEC Table 310-15(B)(16) for copper wires, 75 °C (167 °F) wire insulation at 40 °C (104 °F) ambient temperature. Not more than three current-carrying conductors in raceway or cable.
or earth (directly buried). For other conditions, size the cables according to local safety regulations, appropriate input voltage and the load current of the drive.

**Output (motor) cable sizes**

The table below gives copper and aluminum cable types with concentric copper shield for nominal current. For drawings of the terminals, see chapter *Dimensions* (page 201).

**Note:** With no options selected, each inverter module of the drive is to be individually cabled to the motor. See also sections *Common motor terminal cubicle (option +H359)* (page 49) and *Common output terminal (option +H366)* (page 50).

<table>
<thead>
<tr>
<th>Drive type</th>
<th>IEC 1)</th>
<th>US 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACS880-37-...</td>
<td>Al cable size</td>
<td>Cu cable size</td>
</tr>
<tr>
<td></td>
<td>mm²</td>
<td>mm²</td>
</tr>
<tr>
<td><strong>U_N = 400 V</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0450A-3</td>
<td>2 × (3 × 240 + 72 Cu)</td>
<td>2 × (3 × 185 + 95)</td>
</tr>
<tr>
<td>0620A-3</td>
<td>4 × (3 × 150 + 41 Cu)</td>
<td>3 × (3 × 150 + 70)</td>
</tr>
<tr>
<td>0870A-3</td>
<td>4 × (3 × 240 + 72 Cu)</td>
<td>3 × (3 × 240 + 120)</td>
</tr>
<tr>
<td>1110A-3</td>
<td>6 × (3 × 185 + 57 Cu)</td>
<td>4 × (3 × 240 + 120)</td>
</tr>
<tr>
<td>1210A-3</td>
<td>6 × (3 × 240 + 72 Cu)</td>
<td>6 × (3 × 150 + 70)</td>
</tr>
<tr>
<td>1430A-3</td>
<td>8 × (3 × 185 + 57 Cu)</td>
<td>6 × (3 × 185 + 95)</td>
</tr>
<tr>
<td>1700A-3</td>
<td>8 × (3 × 240 + 72 Cu)</td>
<td>6 × (3 × 240 + 120)</td>
</tr>
<tr>
<td>2060A-3</td>
<td>9 × (3 × 240 + 72 Cu)</td>
<td>6 × (3 × 300 + 150)</td>
</tr>
<tr>
<td>2530A-3</td>
<td>12 × (3 × 240 + 72 Cu)</td>
<td>9 × (3 × 240 + 120)</td>
</tr>
<tr>
<td><strong>U_N = 500 V</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0420A-5</td>
<td>2 × (3 × 240 + 72 Cu)</td>
<td>2 × (3 × 150 + 70)</td>
</tr>
<tr>
<td>0570A-5</td>
<td>3 × (3 × 185 + 57 Cu)</td>
<td>2 × (3 × 240 + 120)</td>
</tr>
<tr>
<td>0780A-5</td>
<td>4 × (3 × 185 + 57 Cu)</td>
<td>3 × (3 × 150 + 70)</td>
</tr>
<tr>
<td>1010A-5</td>
<td>6 × (3 × 150 + 41 Cu)</td>
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<td>6 × (3 × 185 + 57 Cu)</td>
<td>4 × (3 × 240 + 120)</td>
</tr>
<tr>
<td>1530A-5</td>
<td>8 × (3 × 185 + 57 Cu)</td>
<td>6 × (3 × 185 + 95)</td>
</tr>
<tr>
<td>1980A-5</td>
<td>9 × (3 × 240 + 72 Cu)</td>
<td>6 × (3 × 300 + 150)</td>
</tr>
<tr>
<td>2270A-5</td>
<td>12 × (3 × 185 + 57 Cu)</td>
<td>9 × (3 × 185 + 95)</td>
</tr>
<tr>
<td><strong>U_N = 690 V</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0320A-7</td>
<td>2 × (3 × 150 + 41 Cu)</td>
<td>2 × (3 × 95 + 50)</td>
</tr>
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<td>2 × (3 × 185 + 57 Cu)</td>
<td>2 × (3 × 150 + 70)</td>
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<td>12 × (3 × 300 + 88 Cu)</td>
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</tr>
</tbody>
</table>

1. The cable sizing is based on max. 9 cables laid on a cable ladder side by side, three ladder type trays one
on top of the other, ambient temperature 30 °C, PVC insulation, surface temperature 70 °C (IEC/EN 60204-1 and IEC 60364-5-52/2001). For other conditions, size the cables according to local safety regulations, appropriate input voltage and the load current of the drive.

2. The cable sizing is based on NEC Table 310-15(B)(16) for copper wires, 75 °C (167 °F) wire insulation at 40 °C (104 °F) ambient temperature. Not more than three current-carrying conductors in raceway or cable or earth (directly buried). For other conditions, size the cables according to local safety regulations, appropriate input voltage and the load current of the drive.

Alternative power cable types

The recommended and not allowed power cable types to be used with the drive are presented below.

Recommended power cable types

| PE | Symmetrical shielded cable with three phase conductors and a concentric PE conductor as shield. The shield must meet the requirements of IEC 61800-5-1, see page 81. Check with local / state / country electrical codes for allowance. |
| PE | Symmetrical shielded cable with three phase conductors and a concentric PE conductor as shield. A separate PE conductor is required if the shield does not meet the requirements of IEC 61800-5-1, see page 81. |
| PE | Symmetrical shielded cable with three phase conductors and symmetrically constructed PE conductor, and a shield. The PE conductor must meet the requirements of IEC 61800-5-1. |

Power cable types for limited use

A four-conductor system consisting of unshielded single-core phase conductors and a protective conductor on a cable tray is **not allowed for input cabling on IT (ungrounded) networks**.

**WARNING!** Do not use unshielded single-core cables with drives on IT (ungrounded) networks. A dangerous voltage can become present on the non-conductive outer sheath of the cable. This can cause injury or death.

A four-conductor system consisting of separate phase conductors (regardless of the presence of shielding) and a protective conductor on a cable tray is **not allowed for motor cabling**.

Not allowed power cable types

Symmetrical shielded cable with individual shields for each phase conductor is **not allowed in any cable size for input and motor cabling**.
Motor cable shield

If the motor cable shield is used as the sole protective earth conductor of the motor, make sure that the conductivity of the shield is sufficient. See subsection General rules above, or IEC 61800-5-1. To effectively suppress radiated and conducted radio-frequency emissions, the cable shield conductivity must be at least 1/10 of the phase conductor conductivity. The requirements are easily met with a copper or aluminum shield. The minimum requirement of the motor cable shield of the drive is shown below. It consists of a concentric layer of copper wires with an open helix of copper tape or copper wire. The better and tighter the shield, the lower the emission level and bearing currents.

Additional US requirements

Use type MC continuous corrugated aluminum armor cable with symmetrical grounds or shielded power cable for the motor cables if metallic conduit is not used. For the North American market, 600 V AC cable is accepted for up to 500 V AC. 1000 V AC cable is required above 500 V AC (below 600 V AC). For drives rated over 100 amperes, the power cables must be rated for 75 °C (167 °F).

Conduit

Couple separate parts of a conduit together: bridge the joints with a ground conductor bonded to the conduit on each side of the joint. Also bond the conduits to the drive enclosure and motor frame. Use separate conduits for input power, motor, brake resistor, and control wiring. When conduit is employed, type MC continuous corrugated aluminum armor cable or shielded cable is not required. A dedicated ground cable is always required.

Note: Do not run motor wiring from more than one drive in the same conduit.

Armored cable / shielded power cable

Six conductor (3 phases and 3 ground) type MC continuous corrugated aluminum armor cable with symmetrical grounds is available from the following suppliers (trade names in parentheses):

- Anixter Wire & Cable (Philsheath)
- BICC General Corp (Philsheath)
- Rockbestos Co. (Gardex)
- Oaknite (CLX).

Shielded power cables are available from Belden, LAPPKABEL (ÖLFLEX) and Pirelli.
Planning the braking system

See chapter *Resistor braking*.

Selecting the control cables

- **Shielding**
  
  All control cables must be shielded.

  Use a double-shielded twisted pair cable for analog signals. This type of cable is recommended for the pulse encoder signals also. Employ one individually shielded pair for each signal. Do not use common return for different analog signals.

  A double-shielded cable (figure a below) is the best alternative for low-voltage digital signals but single-shielded (b) twisted pair cable is also acceptable.

  ![Diagram of shielded cables](image)

- **Signals in separate cables**
  
  Run analog and digital signals in separate, shielded cables. Never mix 24 V DC and 115/230 V AC signals in the same cable.

- **Signals allowed to be run in the same cable**
  
  Relay-controlled signals, providing their voltage does not exceed 48 V, can be run in the same cables as digital input signals. The relay-controlled signals should be run as twisted pairs.

- **Relay cable type**
  
  The cable type with braided metallic screen (for example ÖLFLEX by LAPPKABEL, Germany) has been tested and approved by ABB.

- **Control panel cable length and type**
  
  In remote use, the cable connecting the control panel to the drive must not be longer than three meters (10 ft). Cable type: shielded CAT 5e or better Ethernet patch cable with RJ-45 ends.

Routing the cables

Route the motor cable away from other cable routes. Motor cables of several drives can be run in parallel installed next to each other. The motor cable, input power cable and control cables should be installed on separate trays. Avoid long parallel runs of motor cables with other cables in order to decrease electromagnetic interference caused by the rapid changes in the drive output voltage.

Where control cables must cross power cables, make sure they are arranged at an angle as near to 90 degrees as possible. Do not run extra cables through the drive.

The cable trays must have good electrical bonding to each other and to the grounding electrodes. Aluminum tray systems can be used to improve local equalizing of potential.
A diagram of the cable routing is shown below.

- **Separate control cable ducts**

  Lead 24 V and 230 V (120 V) control cables in separate ducts unless the 24 V cable is insulated for 230 V (120 V) or insulated with an insulation sleeving for 230 V (120 V).

- **Continuous motor cable shield or enclosure for equipment on the motor cable**

  To minimize the emission level when safety switches, contactors, connection boxes or similar equipment are installed on the motor cable between the drive and the motor:
  - European Union: Install the equipment in a metal enclosure with 360 degree grounding for the shields of both the incoming and outgoing cable, or connect the shields of the cables otherwise together.
  - US: Install the equipment in a metal enclosure in a way that the conduit or motor cable shielding runs consistently without breaks from the drive to the motor.
Implementing thermal overload and short-circuit protection

- **Protecting the drive and input power cable in short-circuits**
  The drive is equipped with internal AC fuses as standard. Protect the input cable with fuses or a suitable circuit breaker. Size the input cable fuses according to the instructions given in chapter *Technical data*. The fuses will protect the input cable in short-circuit situations, restrict drive damage and prevent damage to adjoining equipment in case of a short-circuit inside the drive.

- **Protecting the motor and motor cable in short-circuits**
  The drive protects the motor cable and motor in a short-circuit situation when the motor cable is sized according to the nominal current of the drive. No additional protection devices are needed.

- **Protecting the drive and the power cables against thermal overload**
  The drive protects itself and the input and motor cables against thermal overload when the cables are sized according to the nominal current of the drive. No additional thermal protection devices are needed.

  **WARNING!** If the drive is connected to multiple motors, use a separate circuit breaker or fuses for protecting each motor cable and motor against overload. The drive overload protection is tuned for the total motor load. It may not trip due to an overload in one motor circuit only.

- **Protecting the motor against thermal overload**
  According to regulations, the motor must be protected against thermal overload and the current must be switched off when overload is detected. The drive includes a motor thermal protection function that protects the motor and switches off the current when necessary. Depending on a drive parameter value, the function either monitors a calculated temperature value (based on a motor thermal model) or an actual temperature indication given by motor temperature sensors. The user can tune the thermal model further by feeding in additional motor and load data.
  
  The most common temperature sensors are:
  - motor sizes IEC180...225: thermal switch, eg. Klixon
  - motor sizes IEC200...250 and larger: PTC or Pt100.
  
  See the firmware manual for more information on the motor thermal protection, and the connection and use of the temperature sensors.

- **Protecting the drive against ground faults**
  The drive is equipped with an internal ground fault protective function to protect the unit against ground faults in the motor and motor cable in TN (grounded) networks. This is not a personnel safety or a fire protection feature. The ground fault protective function can be disabled with a parameter, refer to the firmware manual.
  
  An optional ground fault monitoring device (+Q954) is available for IT (ungrounded) systems. The option includes a ground fault indicator on the drive cabinet door.
Residual current device compatibility

The drive is suitable to be used with residual current devices of Type B.

**Note**: The EMC filter of the drive includes capacitors connected between the main circuit and the frame. These capacitors and long motor cables increase the ground leakage current and may cause fault current circuit breakers to function.

Implementing the emergency stop function

The drive can be equipped with a category 0 or category 1 emergency stop function. For safety reasons, install the emergency stop devices at each operator control station and at other operating stations where emergency stop may be needed.

**Note**: Pressing the stop key  on the control panel of the drive, or turning the operating switch of the drive from position “1” to “0” does not generate an emergency stop of the motor or separate the drive from dangerous potential.

See the appropriate user’s manual for the wiring, start-up and operation instructions.

<table>
<thead>
<tr>
<th>Option code</th>
<th>User’s manual</th>
<th>Manual code (English)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+Q951</td>
<td>Emergency stop, stop category 0 (using main contactor/breaker)</td>
<td>3AUA0000119895</td>
</tr>
<tr>
<td>+Q952</td>
<td>Emergency stop, stop category 1 (using main contactor/breaker)</td>
<td>3AUA0000119896</td>
</tr>
<tr>
<td>+Q963</td>
<td>Emergency stop, stop category 0 (using Safe torque off)</td>
<td>3AUA0000119908</td>
</tr>
<tr>
<td>+Q964</td>
<td>Emergency stop, stop category 1 (using Safe torque off)</td>
<td>3AUA0000119909</td>
</tr>
<tr>
<td>+Q978</td>
<td>Emergency stop, stop category 0 or 1 (using main contactor/breaker and Safe torque off)</td>
<td>3AUA0000145920</td>
</tr>
<tr>
<td>+Q979</td>
<td>Emergency stop, stop category 0 or 1 (using Safe torque off)</td>
<td>3AUA0000145921</td>
</tr>
</tbody>
</table>

Implementing the Safe torque off function

See chapter *The Safe torque off function* (page 237).

Implementing the Prevention of unexpected start-up function

The drive can be equipped with a Prevention of unexpected start-up (POUS) function either with an FSO-xx safety functions module (option +Q950) or with a safety relay (option +Q957). The POUS function enables short-time maintenance work (like cleaning) on the non-electrical parts of the machinery without switching off and disconnecting the drive.

See the appropriate user’s manual for the wiring, start-up and operation instructions.

<table>
<thead>
<tr>
<th>Option code</th>
<th>User’s manual</th>
<th>Manual code (English)</th>
</tr>
</thead>
<tbody>
<tr>
<td>+Q950</td>
<td>Prevention of unexpected start-up, with FSO-xx safety functions module</td>
<td>3AUA0000145922</td>
</tr>
<tr>
<td>+Q957</td>
<td>Prevention of unexpected start-up, with safety relay</td>
<td>3AUA0000119910</td>
</tr>
</tbody>
</table>
Implementing the functions provided by the FSO-xx safety functions module (option +Q972 or +Q973)

The drive can be equipped with an FSO-xx safety functions module (option +Q972 or +Q973) which enables the implementation of functions such as Safe brake control (SBC), Safe stop 1 (SS1), Safe stop emergency (SSE), Safely limited speed (SLS) and Safe maximum speed (SMS).

The settings of the FSO-xx are at default when delivered from the factory. The connectors of the module are pre-wired to terminal block X68. The wiring of the external safety circuit and configuration of the FSO-xx module are the responsibility of the machine builder.

The FSO-xx reserves the standard Safe torque off (STO) connection of the inverter control unit. STO can still be utilized by other safety circuits through the FSO-xx.

For wiring instructions, safety data and more information on the functions provided by the FSO-xx, refer to its manual.

- Declaration of Conformity

See page 194.

Implementing the Power-loss ride-through function

Implement the power-loss ride-through function as follows:

Check that the power-loss ride-through function of the inverter unit is enabled with parameter 30.31 Undervoltage control in the ACS880 primary control program.

WARNING! Make sure that the flying restart of the motor will not cause any danger. If you are in doubt, do not implement the Power-loss ride-through function.

The main contactor of the drive opens in a power-loss situation. When the power returns, the contactor closes. However, if the power-loss situation lasts so long that the drive trips on undervoltage, it must be reset and started again to continue operation. If the power-loss situation lasts so long that the buffer module (see page 38) runs out, the main contactor remains open and the drive operates only after reset and a new start.

With external uninterruptible control voltage (option +G307), the main contactor remains closed in power-loss situations. If the power-loss situation lasts so long that the drive trips on undervoltage, it must be reset and started again to continue operation.

Supplying power for the auxiliary circuits

The drive is equipped with an auxiliary control voltage transformer which supplies control voltage, for example, for the control devices and cabinet fan(s).

The following options are to be supplied from external power sources:

- +G300/+G301: Cabinet heaters and/or lighting (230 or 115 V AC; external fuse: 16 A)
- +G307: Connection for an external uninterruptible power supply (230 or 115 V AC; external fuse: 16 A) to the control unit and control devices when the drive is not powered
- +G313: Power supply connection (230 V AC; external fuse 16 A) for a motor space heater output.
Using power factor compensation capacitors with the drive

Power factor compensation is not needed with AC drives. However, if a drive is to be connected in a system with compensation capacitors installed, note the following restrictions.

WARNING! Do not connect power factor compensation capacitors or harmonic filters to the motor cables (between the drive and the motor). They are not meant to be used with AC drives and can cause permanent damage to the drive or themselves.

If there are power factor compensation capacitors in parallel with the three phase input of the drive:

1. Do not connect a high-power capacitor to the power line while the drive is connected. The connection will cause voltage transients that may trip or even damage the drive.

2. If capacitor load is increased/decreased step by step when the AC drive is connected to the power line, make sure that the connection steps are low enough not to cause voltage transients that would trip the drive.

3. Check that the power factor compensation unit is suitable for use in systems with AC drives, ie, harmonic generating loads. In such systems, the compensation unit should typically be equipped with a blocking reactor or harmonic filter.

Implementing a safety switch between the drive and the motor

We recommend to install a safety switch between the permanent magnet synchronous motor and the drive output. The switch is needed to isolate the motor during any maintenance work on the drive.

Protecting the contacts of relay outputs

Inductive loads (relays, contactors, motors) cause voltage transients when switched off.

The relay contacts on the drive control unit are protected with varistors (250 V) against overvoltage peaks. In spite of this, it is highly recommended that inductive loads are equipped with noise attenuating circuits (varistors, RC filters [AC] or diodes [DC]) in order to minimize the EMC emission at switch-off. If not suppressed, the disturbances may connect capacitively or inductively to other conductors in the control cable and form a risk of malfunction in other parts of the system.

Install the protective component as close to the inductive load as possible. Do not install protective components at the relay outputs.
Connecting a motor temperature sensor to the drive I/O

WARNING! IEC 60664 requires double or reinforced insulation between live parts and the surface of accessible parts of electrical equipment which are either non-conductive or conductive but not connected to the protective earth.

To connect a motor temperature sensor and other similar components to the drive, you have four alternatives:

1. You can connect the sensor directly to the inputs of the drive if there is double or reinforced insulation between the sensor and the live parts of the motor.

2. If there is no double or reinforced insulation between the sensor and the live parts of the motor, you can connect the sensor to the inputs of the drive only if all circuits connected to the drive’s digital and analog inputs (typically low-voltage circuits) are protected against contact and insulated with basic insulation from other low-voltage circuits. The insulation must be rated for the same voltage level as the drive main circuit.

3. You can connect the sensor to an extension module with basic insulation (eg, FAIO-01) or reinforced insulation (eg, FPTC-xx) between the sensor connector and the other
connectors of the module. See the table below for the sensor insulation requirement. For sensor connection to the extension module, see its manual.

4. You can connect a sensor to an external thermistor relay the insulation of which is rated for the same voltage level as the main circuit of the drive.

- **Drive I/O, I/O extension and encoder interface modules**

  See
  - section *Al1 or Al2 as a Pt100, Pt1000, PTC or KTY84 sensor input* (page 137)
  - section *D16 as a PTC sensor input* (page 136)
  - *FPTC-01 thermistor protection module (option +L536) for ACS880 drives user’s manual* (3AXD50000027750 [English])
  - *FPTC-02 ATEX-certified thermistor protection module Ex II (2) GD (option +L537+Q971) for ACS880 drives user’s manual* (3AXD50000027782 [English]).

  This table shows what temperature sensor types you can connect to the drive I/O extension modules as well as the insulation requirement for the sensor.

<table>
<thead>
<tr>
<th>Extension module</th>
<th>Temperature sensor type</th>
<th>Temperature sensor insulation requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Insulation/Isolation</td>
<td>PTC</td>
</tr>
<tr>
<td>FIO-11</td>
<td>Galvanic isolation</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>between sensor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>connector and other</td>
<td></td>
</tr>
<tr>
<td></td>
<td>connectors (including</td>
<td></td>
</tr>
<tr>
<td></td>
<td>drive control unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>connector)</td>
<td></td>
</tr>
<tr>
<td>FEN-xx</td>
<td>Galvanic isolation</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>between sensor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>connector and other</td>
<td></td>
</tr>
<tr>
<td></td>
<td>connectors (including</td>
<td></td>
</tr>
<tr>
<td></td>
<td>drive control unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>connector)</td>
<td></td>
</tr>
<tr>
<td>FAIO-01</td>
<td>Basic insulation</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>between sensor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>connector and drive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>control unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>connector. No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>insulation between</td>
<td></td>
</tr>
<tr>
<td></td>
<td>sensor connector and</td>
<td></td>
</tr>
<tr>
<td></td>
<td>other I/O connectors.</td>
<td></td>
</tr>
<tr>
<td>FPTC-xx</td>
<td>Reinforced insulation</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>between sensor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>connector and other</td>
<td></td>
</tr>
<tr>
<td></td>
<td>connectors (including</td>
<td></td>
</tr>
<tr>
<td></td>
<td>drive control unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>connector)</td>
<td></td>
</tr>
</tbody>
</table>

**Note:** The inaccuracy of the drive analog inputs for Pt100 sensors is 10 °C (18 °F). If a better accuracy is needed, use the FAIO-01 analog I/O extension module (option +L525).
Electrical installation

Contents of this chapter
This chapter gives instructions on the wiring of the drive.

Warnings

**WARNING!** Only qualified electricians are allowed to carry out the work described in this chapter. Follow the Safety instructions on the first pages of this manual. Ignoring the safety instructions can cause injury or death.

Checking the insulation of the assembly

- **Drive**
  Do not make any voltage tolerance or insulation resistance tests on any part of the drive as testing can damage the drive. Every drive has been tested for insulation between the main circuit and the chassis at the factory. Also, there are voltage-limiting circuits inside the drive which cut down the testing voltage automatically.

- **Input cable**
  Check the insulation of the input cable according to local regulations before connecting it to the drive.
Motor and motor cable

1. Check that the motor cable is disconnected from the drive output terminals U2, V2 and W2.

2. Measure the insulation resistance between each phase conductor and the Protective Earth conductor using a measuring voltage of 1000 V DC. The insulation resistance of an ABB motor must exceed 100 Mohm (reference value at 25 °C or 77 °F). For the insulation resistance of other motors, consult the manufacturer’s instructions. Note: Moisture inside the motor casing will reduce the insulation resistance. If moisture is suspected, dry the motor and repeat the measurement.

Custom brake resistor assembly

See section Connection procedure (page 256).

Checking the compatibility with IT (ungrounded) systems

EMC filter +E202 is not suitable for use in an IT (ungrounded) system. If the drive is equipped with filter +E202, disconnect the filter before connecting the drive to the supply network. For instructions on how to do this, contact your local ABB representative.

![Diagram of motor connections]

WARNING! If a drive with EMC filter +E202 is installed on an IT system (an ungrounded power system or a high resistance-grounded [over 30 ohm] power system), the system will be connected to earth potential through the EMC filter capacitors of the drive. This may cause danger, or damage the unit.

Attaching the device stickers to the cabinet door

A multilingual device label sticker is delivered with the drive. Attach the stickers in the appropriate language on the English texts; see section Door switches and lights (page 42).

Checking the settings of transformers T21, T101 and T111

Check the tap settings of all auxiliary voltage transformers. Transformer T21 is standard equipment; T101 and T111 are present depending on drive configuration.

The voltage settings of transformers T21 and T101 are made at terminal blocks T21_X1/X2 and T101_X1/X2 respectively. The settings of transformer T111 are made on the transformer itself. The locations of the transformers and the terminal blocks are shown in section Auxiliary control cubicle (ACU) layout (page 38).
- **T21 and T101 tap settings (400…500 V units)**

  - **T21_X1 or T101_X1**
    - 500 V 1
    - 480 V 2
    - 460 V 3
    - 440 V 4
    - 415 V 5
    - 400 V 6
    - 380 V 7
    - U1 8
    - TP1 9
    - TP2 10

  - **T21_X2 or T101_X2**
    - 1 230 V

- **T21 and T101 tap settings (690 V units)**

  - **T21_X1 or T101_X1**
    - 690 V 1
    - 660 V 2
    - 600 V 3
    - 575 V 4
    - 540 V 5
    - 525 V 6
    - 7
    - U1 8
    - TP1 9
    - TP2 10

  - **T21_X2 or T101_X2**
    - 1 230 V

## T111 tap settings

<table>
<thead>
<tr>
<th>Supply voltage</th>
<th>Terminals</th>
<th>Tap settings</th>
<th>3~ input</th>
<th>3~ output</th>
</tr>
</thead>
<tbody>
<tr>
<td>690 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C2, A2, B2</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
<tr>
<td>660 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C2, A2, B2</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
<tr>
<td>600 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C3, A3, B3</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
<tr>
<td>575 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C3, A3, B3</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
<tr>
<td>540 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C4, A4, B4</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
<tr>
<td>525 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C4, A4, B4</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
<tr>
<td>500 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C4, A4, B4</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
<tr>
<td>480 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C5, A5, B5</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
<tr>
<td>460 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C5, A5, B5</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
<tr>
<td>440 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C5, A5, B5</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
<tr>
<td>415 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C6, A6, B6</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
<tr>
<td>400 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C6, A6, B6</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
<tr>
<td>380 V</td>
<td>A1, B1, C1</td>
<td>A1, A6, A5, A4, A3, A2</td>
<td>C6, A6, B6</td>
<td>a1, b1, c1, a2, b2, c2</td>
</tr>
</tbody>
</table>
Connecting the control cables

See chapter Control units of the drive (page 131) for the default I/O connections of the inverter unit (with the ACS880 primary control program). The default I/O connections can be different with some hardware options, see the circuit diagrams delivered with the drive for the actual wiring. For other control programs, see their firmware manuals.

* Control cable connection procedure

**WARNING!** Obey the instructions in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive (if running) and do the steps in section Electrical safety precautions (page 19) before you start the work.

2. Run the control cables into the auxiliary control cubicle (ACU) as described in section Grounding the outer shields of the control cables at the cabinet lead-through below.

3. Route the control cables as described in section Routing the control cables inside the cabinet (page 101).

4. Connect the control cables as described starting on page 101.

**Grounding the outer shields of the control cables at the cabinet lead-through**

Ground the outer shields of all control cables 360 degrees at the EMI conductive cushions as follows:

1. Loosen the tightening screws of the EMI conductive cushions and pull the cushions apart.

2. Cut adequate holes to the rubber grommets in the lead-through plate and lead the cables through the grommets and the cushions into the cabinet.

3. Strip off the cable plastic sheath above the lead-through plate just enough to ensure proper connection of the bare shield and the EMI conductive cushions.

4. Tighten the two tightening screws so that the EMI conductive cushions press tightly round the bare shield.

![Diagram of grounding process](image-url)
**Note 1:** Keep the shields continuous as close to the connection terminals as possible. Secure the cables mechanically at the lead-through strain relief.

**Note 2:** If the outer surface of the shield is non-conductive:
- Cut the shield at the midpoint of the bare part. Be careful not to cut the conductors or the grounding wire (if present).
- Turn the shield inside out to expose its conductive surface.
- Cover the turned shield and the stripped cable with copper foil to keep the shielding continuous.

**Note for top entry of cables:** When each cable has its own rubber grommet, sufficient IP and EMC protection can be achieved. However, if very many control cables come to one cabinet, plan the installation beforehand as follows:

1. Make a list of the cables coming to the cabinet.
2. Sort the cables going to the left into one group and the cables going to the right into another group to avoid unnecessary crossing of cables inside the cabinet.
3. Sort the cables in each group according to size.
4. Group the cables for each grommet as follows ensuring that each cable has a proper contact to the cushions on both sides.

<table>
<thead>
<tr>
<th>Cable diameter in mm</th>
<th>Max. number of cables per grommet</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 13</td>
<td>4</td>
</tr>
<tr>
<td>≤ 17</td>
<td>3</td>
</tr>
<tr>
<td>&lt; 25</td>
<td>2</td>
</tr>
<tr>
<td>≥ 25</td>
<td>1</td>
</tr>
</tbody>
</table>
5. Arrange the bunches according to size from thickest to the thinnest between the EMI conductive cushions.

![Diagram showing cable arrangement](image)

6. If more than one cable go through a grommet, seal the grommet by applying Loctite 5221 (catalogue number 25551) inside the grommet.

**Routing the control cables inside the cabinet**

Use the existing trunking in the cabinet wherever possible. Use sleeving if cables are laid against sharp edges. When running cables to or from the swing-out frame, leave enough slack at the hinge to allow the frame to open fully.

**Connecting to the inverter control unit [A41]**

Connect the conductors to the appropriate terminals (see page 131) of the control unit or terminal block X504 (option +L504).

Connect the inner twisted pair shields and all separate grounding wires to the grounding clamps below the control unit.

The drawing below represents a drive with additional I/O terminal block (option +L504). Without the block, the grounding is made the same way.

**Notes:**
- Do not ground the outer shield of the cable here since it is grounded at the lead-through.
- Keep any signal wire pairs twisted as close to the terminals as possible. Twisting the wire with its return wire reduces disturbances caused by inductive coupling.
At the other end of the cable, leave the shields unconnected or ground them indirectly via a high-frequency capacitor with a few nanofarads, eg. 3.3 nF / 630 V. The shield can also be grounded directly at both ends if they are in the same ground line with no significant voltage drop between the end points.
Connecting a 230/115 V AC auxiliary voltage supply (UPS, option +G307)

Wire the external control voltage to terminal block X307 at the back side of the mounting plate as shown below.

![Diagram of X307 terminal block]

1 Internal wiring of UPS supervision: circuit breaker or fuse off/fault = contact open.

Connecting emergency stop push buttons (options +Q951, +Q952, +Q963, +Q964, +Q978, +Q979)

Connect external emergency stop push buttons according to the circuit diagrams delivered with the drive.

Wiring the starter for auxiliary motor fan (options +M602…+M610)

Connect the power supply wires for the auxiliary motor fan to terminal blocks X601…X605 according to the circuit diagrams delivered with the drive.
Wiring the PTC thermistor relay(s) (options +L505, +2L505, +L513, +2L513)

The external wiring of option +2L505 and +2L513 (two thermistor relays) is shown below. For example, one relay can be used to monitor the motor windings, the other to monitor the bearings. The maximum contact load capacity is 250 V AC 10 A. For the actual wiring, see the circuit diagram delivered with the drive. For instructions on commissioning options +L513 and +2L513, see *ATEX-certified motor thermal protection functions for cabinet-built ACS880 drives (options +L513+Q971 and +L514+Q971) user’s manual* (3AXD50000014979 [English]).

![Diagram of X506 connection points](attachment:diagram.png)

1. PTC sensors monitored by relay K74.
   \[ R_G = R_1 + R_2 + R_N \leq 1.5 \text{ kohm} \]

2. External reset for relay K74.
   \[ R_G = R_1 + R_2 + R_N \leq 1.5 \text{ kohm} \]

3. External reset for relay K75.
   \[ R_G = R_1 + R_2 + R_N \leq 1.5 \text{ kohm} \]

4. Overheat indication from relay K74:
   Overtemperature = contact open.

5. Overheat indication from relay K75:
   Overtemperature = contact open.
Wiring the Pt100 relays (option +nL506)

External wiring of eight Pt100 sensors is shown below. The maximum contact load capacity is 250 V AC 10 A. For the actual wiring, see the circuit diagram delivered with the drive.

![Diagram of Pt100 sensor wiring](image)

Internal wiring for overheat indication.
Overtemperature = contact open.
**Wiring the Pt100 relays (option +nL514)**

External wiring of three Pt100 sensors is shown below. The maximum contact load capacity is 250 V AC 10 A. For the actual wiring, see the circuit diagram delivered with the drive. For instructions on commissioning option +nL514, see *ATEX-certified motor thermal protection functions for cabinet-built ACS880 drives (options +L513+Q971 and +L514+Q971) user’s manual* (3AXD50000014979 [English]).

![Diagram of Pt100 relays wiring](image)

- 1 × Pt100
- Sensor 1
- Sensor 2
- Sensor 3
- 0/4…20 mA current output from sensor 1
- 0/4…20 mA current output from sensor 2
- 0/4…20 mA current output from sensor 3

Internal wiring for overheat indication.
Overtemperature = contact open.

Sensors 1…3
Powering the heating and lighting equipment (options +G300, +G301 and +G313)

See the circuit diagrams delivered with drive.

Connect the external power supply wires for the cabinet heater and lighting to terminal block X300.

Connect the motor heater wiring to terminal block X313 as shown below. Maximum external power supply 16 A.
Wiring ground fault monitoring for IT ungrounded systems (option +Q954)

We recommend to connect Alarm 1 for drive tripping and Alarm 2 for alarm signals in order to avoid unnecessary trippings due to the ground fault monitor self testing with Alarm 2.

![Diagram of X954]

1 Internal wiring: Ground fault alarm 1. No ground fault = contact closed. Contact load capacity 250 V AC 2 A.

2 Internal wiring: Ground fault alarm 2: No ground fault = contact closed. Contact load capacity 250 V AC 8 A.
Connecting the motor cables (units without common motor terminal cubicle or sine output filter)

On units without a common motor terminal cubicle or a sine output filter, the motor cables connect to busbars located behind the inverter module(s). The location and dimensions of the busbars are visible in the dimension drawings delivered with the drive, as well as the example drawings presented in this manual (starting on page 227).

To allow the most room for the work, the modules can be removed completely from the cabinet. For instructions, see Removing the inverter module(s) (page 111).

Especially in the case of multiple inverter modules in the same cubicle, you can consider only removing the fan carriage of each module. This is faster than removing the entire module, but allows less room for the connecting work. For instructions, see section Removing and reinstalling the fan carriage of an inverter module (page 115).

If the drive is equipped with a common motor terminal cubicle (option +H359) or a sine output filter (option +E206), follow the procedure starting on page 120.

Note for frame 1×R8i + 1×R8i: It is practical to remove all three modules (LCL filter, supply, inverter) before making the motor and input power cable connections.

Connection diagram (without option +H366)

All parallel-connected inverter modules are to be cabled separately to the motor. 360° earthing is to be used at cable lead-throughs.

The recommended cable types are given in chapter Guidelines for planning the electrical installation.
WARNING! The cabling from all inverter modules to the motor must be physically identical considering cable type, cross-sectional area, and length.

**Connection diagram (with option +H366)**

With option +H366, the output busbars of the inverter modules within the same cubicle are connected by bridging busbars. The bridging balances the motor current between the modules, which allows more cabling options. For example, it is possible to use a number of cables that could not otherwise be evenly distributed between the inverter modules.

The recommended cable types are given in chapter *Guidelines for planning the electrical installation*.

WARNING! The bridging can carry the nominal output of one inverter module. In case of three parallel modules, ensure that the load capacity of the bridging is not exceeded. For example, if the cabling connects to the output busbars at one module only, use the module in the middle.

**Note:** The +H366 option only interconnects the outputs of inverter modules within the same cubicle, not modules installed in different cubicles. Therefore, when the drive has
multiple inverter cubicles (ie. two cubicles of two modules each), make sure that the motor
cabling is identical for both cubicles.

Procedure

Removing the inverter module(s)
To allow more room for cabling work, the inverter module can be removed completely
instead of only the fan carriage.

Refer to the drawings below.

---

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you
ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section *Electrical safety precautions* (page 19) before you start the
work.
2. Open the cubicle door.
3. Remove the shroud at the top of the cubicle.
4. Detach the terminal block [X50] at the top of the module.
5. Detach the DC busbars from the module. Make note of the order and position of the
screws and washers.
6. Detach the wiring connected to the terminals on the front of the module (including fiber
optic cabling). Move the disconnected wiring aside.
7. Attach the module extraction/installation ramp (included) to the base of the cabinet so
that the tabs on the mounting bracket enter the slots on the ramp.

---

**WARNING!** Do not use the module extraction/installation ramp with plinth heights
over 50 mm.

8. Remove the two screws at the bottom front of the module.

---

**WARNING!** Before you proceed, make sure the cabinet is level, or chock the
wheels of the module.

9. Remove the two screws at the top front of the module.
10. Pull the module carefully out along the ramp. While pulling on the handle with your
right hand, keep a constant pressure with one foot on the base of the module to
prevent the module from falling on its back.
11. Move the module into a safe location outside the immediate work area and make sure
it cannot topple over. Chock the wheels of the module if the floor is not completely
level.
12. Repeat the procedure for the other inverter modules (if any).
13. Frame 1×R8i + 1×R8i only: Repeat the procedure for the supply module.
14. Frame 1×R8i + 1×R8i only: Remove the LCL filter module as described on page 168.
Proceed to *Connecting the motor cables* (page 117).
Removing and reinstalling the fan carriage of an inverter module

Refer to the drawings below.

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section *Electrical safety precautions* (page 19) before you start the work.

2. Open the inverter module cubicle door.

3. Remove the screws holding the front cover plate. Lift the cover plate somewhat to release it.

4. Disconnect the wiring at the top of the fan carriage.

5. Remove the two screws at the bottom of the fan carriage.

**WARNING!** Before you proceed, make sure the two screws holding the top of the inverter module are in place.

6. Remove the two screws at the top of the fan carriage.

7. Pull the fan carriage out.

8. Repeat the procedure for other fan carriages in the same cubicle.

Proceed to *Connecting the motor cables* (page 117).
Connecting the motor cables

Refer to the drawings below.

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section *Electrical safety precautions* (page 19) before you start the work.
2. Remove the shroud in front of the output busbars.
3. For 360° grounding of the shield at the cable entry, remove the outer jacket of each cable where they pass through the cable entry (a).
4. Cut the cable to suitable length and strip the ends of the individual conductors. Twist the shield strands together to form a separate conductor and wrap it with tape.
5. Crimp suitable lug terminals onto the phase conductors and the ground conductor. The dimensions of the output busbars are shown in chapter *Technical data*.
6. Connect the phase conductors of the motor cable to the U2, V2 and W2 terminals. You can temporarily remove the plastic insulators (b) between the busbars to make the connecting work easier.

**WARNING!** The plastic insulators (b) between the busbars must be in place when the inverter is powered.

7. Connect the shield (and any grounding conductors) of the cable to the PE busbar close to the cable entries.
8. Secure the cable mechanically.
9. Repeat the procedure for each motor cable.
10. Refit the shroud removed earlier.
11. At the motor, connect the cables according to instructions from the motor manufacturer. Pay special attention to the phase order. For minimum radio-frequency interference, ground the cable shield 360 degrees at the cable entry of the motor terminal box, or ground the cable by twisting the shield so that the flattened shield is wider than 1/5 of its length.
Re-installing the fan carriage of an inverter module

(If the inverter module was removed completely instead of only the fan carriage, proceed to section Re-inserting the inverter module into the cubicle below.)

The re-installation of the fan carriage is the removal procedure in reverse. See section Removing and reinstalling the fan carriage of an inverter module (page 115).

Re-inserting the inverter module into the cubicle

Frame 1×R8i + 1×R8i only: This procedure applies to both the supply and inverter modules. However, do not insert the modules before connecting also the input power cables. See page 122.

WARNING! Obey the instructions in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

1. Make sure there are no tools, debris or any other foreign objects in the cubicle.
2. If not already in place, attach the module extraction/installation ramp (included) to the base of the cabinet so that the tabs on the mounting bracket enter the slots on the ramp.
3. Push the module up the ramp and back into the cubicle.
   • Keep your fingers away from the edge of the module front plate to avoid pinching.
   • Keep a constant pressure with one foot on the base of the module to prevent the module from falling on its back.
4. Secure the top front of the module with two screws. Tighten to 22 N·m (16 lbf·ft).
5. Secure the bottom front of the module with two screws. Tighten to 22 N·m (16 lbf·ft).
6. Remove the ramp.
7. Attach the DC busbars to the module. Tighten to 70 N·m (52 lbf·ft).
8. Reconnect terminal block [X50] at the top of the module.
9. Reconnect the wiring and fiber optic cables to the terminals on the front of the module.
10. Repeat the procedure for the other inverter modules (or, in the case of frame 1×R8i + 1×R8i, the supply module).
11. Reinstall the shroud near the top of the cubicle.
Connecting the motor cables (units with common motor terminal cubicle or sine filter)

- **Output busbars**

If the drive is equipped with option +H359, the motor cables connect to a common motor terminal cubicle. Similarly, if the drive is equipped with option +E206 (sine output filter), the motor cables connect to the output busbars in the sine filter cubicle.

The location and dimensions of the busbars for either case are visible in the dimensional drawings delivered with the drive, as well as the drawings starting on page 231.

- **Connection diagram**

![Connection diagram](image)

The recommended cable types are given in chapter *Guidelines for planning the electrical installation*.

- **Procedure**

1. **WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.
2. Do the steps in section *Electrical safety precautions* (page 19) before you start the work.
3. Open the door of the common motor terminal or sine filter cubicle and remove the shrouding.
3. Lead the cables into the cubicle. Make the 360° earthing arrangement at the cable entry as shown.

4. Cut the cables to suitable length. Strip the cables and conductors.

5. Twist the cable screens into bundles and connect the bundles to the PE busbar in the cubicle.

6. Connect any separate ground conductors/cables to the PE busbar in the cubicle.

7. Connect the phase conductors to the output terminals. Use the torques specified under *Tightening torques* (page 198).

8. Refit any shrouding removed earlier and close the cubicle doors.

9. At the motor, connect the cables according to instructions from the motor manufacturer. Pay special attention to the phase order. For minimum radio-frequency interference, ground the cable shield 360 degrees at the lead-through of the motor terminal box, or ground the cable by twisting the shield so that the flattened shield is wider than 1/5 of its length.

**Connecting an external brake resistor assembly**

See section *Electrical installation of custom brake resistors* (page 255).

For the location of the terminals, refer to the dimension drawings delivered with the unit or the dimension drawing examples in chapter *Dimensions.*
Connecting the input power cables

Connection diagram

Notes:
1) Fuses or other protection means.
Use a separate PE conductor in addition if the conductivity of the shield does not meet the requirement for the PE conductor. See section Selecting the power cables (page 81).

Layout of the input cable connection terminals and lead-throughs
The location and dimensions of the busbars are visible in the dimensional drawings delivered with the drive, as well as the drawings starting on page 223.

Connection procedure

**WARNING!** Obey the instructions in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section Electrical safety precautions (page 19) before you start the work.
2. Open the door of the incoming cubicle (or, in the case of frame 1×R8i + 1×R8i, the door of the supply and inverter module cubicle).
3. Remove the shrouding covering the input terminals.
4. Peel off 3 to 5 cm of the outer insulation of the cables above the lead-through plate for 360° high-frequency grounding.
5. Prepare the ends of the cables.

6. If fire insulation is used, make an opening in the mineral wool sheet according to the diameter of the cable.

7. Remove the rubber grommets from the lead-through plate for the cables to be connected. Cut adequate holes into the rubber grommets. Slide the grommets onto the cables. Slide the cables through the lead-throughs with the conductive sleeves and attach the grommets to the holes.

8. Fasten the conductive sleeves to the cable shields with cable ties.

9. Seal the slot between the cable and mineral wool sheet (if used) with sealing compound (e.g., CSD-F, ABB brand name DXXT-11, code 35080082).

10. Tie up the unused conductive sleeves with cable ties.

11. Connect the twisted shields of the cables to the PE busbar of the cabinet.

12. Connect the phase conductors of the input cable to the L1, L2 and L3 terminals. Tighten the screws to the torque given under *Tightening torques* (page 198).

13. Reinstall the shrouding removed earlier.

14. **Frame 1×R8i + 1×R8i only**: Reinstall the LCL filter module as described on page 168.

15. **Frame 1×R8i + 1×R8i only**: Re-insert the supply and inverter modules as described on page 119.

16. Close the cubicle door.
Electrical installation
Connecting a PC

A PC (with eg. the Drive composer PC tool) can be connected to the inverter unit as follows:

1. Connect an ACS-AP-x control panel to the inverter control unit either by using an Ethernet (eg. CAT5E) networking cable, or by inserting the panel into the panel holder (if present).

**WARNING!** Do not connect the PC directly to the control panel connector of the inverter unit as this can cause damage.

2. Remove the USB connector cover on the front of the control panel.

3. Connect an USB cable (Type A to Type Mini-B) between the USB connector on the control panel (3a) and a free USB port on the PC (3b).

4. The panel will display an indication whenever the connection is active.

5. See the documentation of the PC tool for setup instructions.
Panel bus (Control of several drives from one control panel)

One control panel (or PC) can be used to control several drives by constructing a panel bus. This is done by daisy-chaining the panel connections of the drives. Some drives have the necessary panel connectors in the control panel holder. Others, including the ACS880-37, require the installation of an FDPI-02 module (available separately). For further information, see *FDPI-02 diagnostics and panel interface user’s manual* (3AUA0000113618 [English]).

1. Connect the panel to one drive using an Ethernet (eg. CAT5E) cable.
   - Use Menu – Settings – Edit texts – Drive to give a descriptive name to the drive
   - Use parameter 49.01 to assign the drive with a unique node ID number
   - Set other parameters in group 49 if necessary
   - Use parameter 49.06 to validate any changes.
   Repeat the above for each drive.

2. Chain the panel and the drives together using Ethernet cables.

3. Switch on the bus termination on the drive that is farthest from the control panel in the chain.
   - With drives that have the panel mounted on the front cover, move the terminating switch into the outer position.
   - With an FDPI-02 module, move termination switch S2 into the TERMINATED position.
   Make sure that bus termination is off on all other drives.

4. On the control panel, switch on the panel bus functionality (Options – Select drive – Panel bus). The drive to be controlled can now be selected from the list under Options – Select drive.

5. If a PC is connected to the control panel, the drives on the panel bus are automatically displayed in the Drive composer tool.
Installing option modules

- **Mechanical installation of I/O extension, fieldbus adapter and pulse encoder interface modules**

See page 40 for the available slots for each module. Install the option modules as follows:

---

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive and do the steps in section *Electrical safety precautions* (page 19) before you start the work.
2. Open the door of the auxiliary control cubicle (ACU).
3. Remove the shrouding at the top of the cubicle.
4. Locate the inverter control unit [A41].
5. Insert the module carefully into its position on the control unit.
6. Fasten the mounting screw. **Note:** The screw tightens the connections and grounds the module. It is essential for fulfilling the EMC requirements and for proper operation of the module.
Mechanical installation of an FSO-xx safety functions module

This procedure describes the mechanical installation of an FSO-xx safety functions module onto the inverter control unit. (The FSO-xx can alternatively be installed beside the control unit, which is the standard with factory-installed FSO-xx modules. For instructions, see the FSO-xx manual.)

1. Fasten the module onto slot 3 of the inverter control unit [A41] with four screws.
2. Tighten the FSO-xx electronics grounding screw.
3. Connect the FSO-xx data cable between FSO-xx connector X110 and to BCU-x2 connector X12.

- **Wiring of option modules**

See the appropriate option module manual for specific installation and wiring instructions.
Electrical installation
Control units of the drive

What this chapter contains

This chapter

• describes the connections of the control units used in the drive,
• contains the specifications of the inputs and outputs of the control units.

General

The ACS880 drive utilizes BCU-x2 control units. The BCU-x2 consists of a BCON-12 control board (and a BIOC-01 I/O connector board and power supply board) built in a metal housing.

The supply and inverter units of the ACS880-37 are each controlled by a dedicated BCU-x2 control unit. The designation of the supply control unit is A51; the inverter control unit is A41. Both are located in the ACU cubicle (see the drawings in chapter Operation principle and hardware description), and connect to the power modules (i.e. supply and inverter modules respectively) by fiber optic cables.

In this manual, the name “BCU-x2” represents the control unit types BCU-02 and BCU-12. These have a different number of power module connections (2 and 7 respectively) but are otherwise similar.
Control units of the drive

Control unit layout and connections

<table>
<thead>
<tr>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I/O I/O terminals (see following diagram)</td>
</tr>
<tr>
<td>SLOT 1 I/O extension, encoder interface or</td>
</tr>
<tr>
<td>fieldbus adapter module connection. (This is</td>
</tr>
<tr>
<td>the sole location for an FDPI-02 diagnostics</td>
</tr>
<tr>
<td>and panel interface.)</td>
</tr>
<tr>
<td>SLOT 2 I/O extension, encoder interface or</td>
</tr>
<tr>
<td>fieldbus adapter module connection</td>
</tr>
<tr>
<td>SLOT 3 I/O extension, encoder interface, field-</td>
</tr>
<tr>
<td>bus adapter or FSO-xx safety functions module</td>
</tr>
<tr>
<td>connection</td>
</tr>
<tr>
<td>SLOT 4 RDCO-0x DDCS communication option</td>
</tr>
<tr>
<td>module connection</td>
</tr>
<tr>
<td>X205 Memory unit connection</td>
</tr>
<tr>
<td>BATTERY Holder for real-time clock battery</td>
</tr>
<tr>
<td>(BR2032)</td>
</tr>
<tr>
<td>AI1 Mode selector for analog input AI1 (I =</td>
</tr>
<tr>
<td>current, U = voltage)</td>
</tr>
<tr>
<td>AI2 Mode selector for analog input AI2 (I =</td>
</tr>
<tr>
<td>current, U = voltage)</td>
</tr>
<tr>
<td>D2D TERM Termination switch for drive-to-drive</td>
</tr>
<tr>
<td>link (D2D)</td>
</tr>
<tr>
<td>DICOM= DIOGND Ground selection. Determines</td>
</tr>
<tr>
<td>whether DICOM is separated from DIOGND (i.e.</td>
</tr>
<tr>
<td>the common reference for the digital inputs</td>
</tr>
<tr>
<td>floats). See the Ground isolation diagram (page</td>
</tr>
<tr>
<td>141).</td>
</tr>
</tbody>
</table>

7-segment display

Multicharacter indications are displayed as repeated sequences of characters

- "U" is indicated briefly before "o".
- Control program startup in progress
- (Flashing) Firmware cannot be started. Memory unit missing or corrupted
- Firmware download from PC to control unit in progress
- At power-up, the display may show short indications of eg. "1", "2", "b" or "U". These are normal indications immediately after power-up. If the display ends up showing any other value than those described, it indicates a hardware failure.
<table>
<thead>
<tr>
<th>Description</th>
<th>Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control units of the drive</td>
<td>XAI Analog inputs</td>
</tr>
<tr>
<td></td>
<td>XAO Analog outputs</td>
</tr>
<tr>
<td></td>
<td>XDI Digital inputs, Digital input interlock (DIIL)</td>
</tr>
<tr>
<td></td>
<td>XDIO Digital input/outputs</td>
</tr>
<tr>
<td></td>
<td>XD2D Drive-to-drive link</td>
</tr>
<tr>
<td></td>
<td>XD24 +24 V output (for digital inputs)</td>
</tr>
<tr>
<td></td>
<td>XETH Ethernet port (eg. for PC communication)</td>
</tr>
<tr>
<td></td>
<td>XPOW External power input</td>
</tr>
<tr>
<td></td>
<td>XRO1 Relay output RO1</td>
</tr>
<tr>
<td></td>
<td>XRO2 Relay output RO2</td>
</tr>
<tr>
<td></td>
<td>XRO3 Relay output RO3</td>
</tr>
<tr>
<td></td>
<td>XSTO Safe torque off connection (input signals)</td>
</tr>
<tr>
<td></td>
<td>XSTO OUT Safe torque off connection (to inverter modules)</td>
</tr>
<tr>
<td></td>
<td>X12 (On the opposite side) Connection for FSO-xx safety functions module (optional)</td>
</tr>
<tr>
<td></td>
<td>X13 Control panel / PC connection</td>
</tr>
<tr>
<td></td>
<td>X485 Not in use</td>
</tr>
<tr>
<td></td>
<td>V1T/V1R, V2T/V2R</td>
</tr>
<tr>
<td></td>
<td>Fiber optic connection to modules 1 and 2 (VxT = transmitter, VxR = receiver)</td>
</tr>
<tr>
<td></td>
<td>V3T/V3R, V7T/V7R</td>
</tr>
<tr>
<td></td>
<td>Fiber optic connection to modules 3...7 (BCU-12/22 only) (VxT = transmitter, VxR = receiver)</td>
</tr>
<tr>
<td></td>
<td>V8T/V8R, V12T/V12R</td>
</tr>
<tr>
<td></td>
<td>Fiber optic connection to modules 8...12 (BCU-22 only) (VxT = transmitter, VxR = receiver)</td>
</tr>
<tr>
<td></td>
<td>SD CARD Data logger memory card for inverter module communication</td>
</tr>
<tr>
<td></td>
<td>BATT OK Real-time clock battery voltage is higher than 2.8 V. If the LED is off when the control unit is powered, replace the battery.</td>
</tr>
<tr>
<td></td>
<td>FAULT The control program has generated a fault. See the firmware manual of the supply/inverter unit.</td>
</tr>
<tr>
<td></td>
<td>PWR OK Internal voltage supply is OK</td>
</tr>
<tr>
<td></td>
<td>WRITE Writing to memory card in progress. Do not remove the memory card.</td>
</tr>
</tbody>
</table>
The diagram below shows the default I/O connections on the supply control unit [A51], and describes the use of the signals/connections in the supply unit. Under normal circumstances, the factory-made wiring should not be changed.

### Relay outputs

**XRO1**
- **Charging** (energized = charging contactor closed)
  - 250 V AC / 30 V DC
  - 2 A
  - NO 3
  - COM 2
  - NC 1

**XRO2**
- **Fault (-1)** (energized = no fault)
  - 250 V AC / 30 V DC
  - 2 A
  - NO 3
  - COM 2
  - NC 1

**XRO3**
- **MCB ctrl** (energized = main contactor/breaker closed)
  - 250 V AC / 30 V DC
  - 2 A
  - NO 3
  - COM 2
  - NC 1

### Reference voltage and analog inputs

**XAI**
- 10 V DC, R_L 1…10 kohm
  - +VREF 1
  - -VREF 2
  - AGND 3
- Not in use
  - A11+ 4
  - A11- 5
  - A12+ 6
  - A12- 7

### Analog outputs

**XAO**
- Not in use
  - AO1 1
  - AGND 2
  - AO2 3
  - AGND 4

### Drive-to-drive link

**XD2D**
- Not in use
  - Shield 4
  - BGND 3
  - A 2
  - B 1

### Safe torque off

**XSTO**
- Safe torque off. Both circuits must be closed for the supply unit to start.
  - (IN1 and IN2 must be connected to OUT.)
  - IN2 4
  - IN1 3
  - SGND 2
  - OUT 1

### Digital inputs

**XDI**
- **Temperature fault** (0 = overtemperature)
  - DI1 1
- **Run / enable** (1 = run enabled)
  - DI2 2
- **MCB feedback** (1 = main contactor/breaker closed)
  - DI3 3
- **Circuit breaker fault** (0 = auxiliary circuit breaker or switch open)
  - DI4 4
- **Ground (earth) fault** (with optional ground fault monitoring)
  - DI5 5
- **Reset** (0 → 1 = fault reset)
  - DI6 6
- **Emergency stop** (0 = emergency stop activated) (units with em. stop option only)
  - DIIL 7

### Digital input/outputs

**XDOI**
- Not in use
  - DIO1 1
  - DIO2 2
### Default I/O diagram of the inverter control unit [A41]

#### Drive-to-drive link XD2D

| B   | 1        |
| A   | 2        |
| BGND| 3        |
| Shield | 4 |

#### RS485 connection X485

| B   | 5 |
| A   | 6 |
| BGND| 7 |
| Shield | 8 |

#### Relay outputs XRO1…XRO3

- **Ready**
  - 250 V AC / 30 V DC
  - 2 A
  - NC: 11
  - COM: 12
  - NO: 13

- **Running**
  - 250 V AC / 30 V DC
  - 2 A
  - NC: 21
  - COM: 22
  - NO: 23

- **Faulted(-1)**
  - 250 V AC / 30 V DC
  - 2 A
  - NC: 31
  - COM: 32
  - NO: 33

#### Safe torque off XSTO, XSTO OUT

- Safe torque off input. Both circuits must be closed for the drive to start. 2)
- Safe torque off output to inverter modules 2)

#### Digital inputs XDI1

- Stop (0) / Start (1) DI1: 1
- Forward (0) / Reverse (1) DI2: 2
- Reset DI3: 3
- Acceleration & deceleration select 3) DI4: 4
- Constant speed 1 select (1 = on) 4) DI5: 5
- By default not in use. DI6: 6
- Run enable 5) DIIL: 7

#### Digital input/outputs XDIO

- Output: Ready DIO1: 1
- Output: Running DIO2: 2
- Digital input/output ground DIOGND: 3
- Digital input/output ground DIOGND: 4

#### Auxiliary voltage output XD24

- +24 V DC 200 mA 6)
- Digital input ground DICOM: 5
- +24 V DC 200 mA 10)
- Digital input/output ground DIOGND: 7

#### Ground selection switch 7)

#### Analog inputs, reference voltage output AI

- 5 V DC, R<sub>L</sub> 1...10 kohm +VREF: 1
- -10 V DC, R<sub>L</sub> 1...10 kohm -VREF: 2
- Ground AGND: 3

#### Speed reference

- 0(2)...10 V, R<sub>n</sub> > 200 kohm 8)
- A1+: 4
- A1-: 5
- By default not in use.
- A2+: 6
- A2-: 7

#### Analog outputs AO

- Motor speed rpm 0...20 mA, R<sub>L</sub> < 500 ohm AO1: 1
- Motor current 0...20 mA, R<sub>L</sub> < 500 ohm AO2: 2
- AGND: 3

#### External power input

- 24 V DC, 2.05 A +24VI: 1
- Two supplies can be connected for redundancy.
- +24VI: 2
- GND: 3

#### Safety functions module connection X12

#### Control panel connection X13

#### Memory unit connection X205
Notes:
The wire size accepted by all screw terminals (for both stranded and solid wire) is
0.5 ... 2.5 mm² (24...12 AWG). The torque is 0.5 N·m (5 lbf·in).

1) See section Drive-to-drive link (XD2D) (page 137).
2) See chapter The Safe torque off function (page 237).
3) 0 = Acceleration/deceleration ramps defined by parameters 23.12/23.13 in use.
1 = Acceleration/deceleration ramps defined by parameters 23.14/23.15 in use.
4) Constant speed 1 is defined by parameter 22.26.
5) See section DIII input (page 137).
6) Total load capacity of these outputs is 4.8 W (200 mA at 24 V) minus the power taken by
DIO1 and DIO2.
7) Determines whether DICOM is separated from DIOGND (ie. common reference for
digital inputs floats; in practice, selects whether the digital inputs are used in current
sinking or sourcing mode). See also Ground isolation diagram on page 141.
DICOM=DIOGND ON: DICOM connected to DIOGND. OFF: DICOM and DIOGND
separate.
8) Current [0(4)...20 mA, $R_{\text{in}} = 100$ ohm] or voltage [0(2)...10 V, $R_{\text{in}} > 200$ kohm] input
selected by switch Al1. Change of setting requires reboot of control unit.
9) Current [0(4)...20 mA, $R_{\text{in}} = 100$ ohm] or voltage [0(2)...10 V, $R_{\text{in}} > 200$ kohm] input
selected by switch Al2. Change of setting requires reboot of control unit.

---

**External power supply for the control unit (XPOW)**
The BCU-x2 is powered from a 24 V DC, 2 A supply through terminal block XPOW. A
second supply can be connected to the same terminal block for redundancy.

**DI6 as a PTC sensor input**
A PTC sensor can be connected to this input for motor temperature measurement as
follows. The sensor can alternatively be connected to FEN-xx encoder interface module.
At the sensor end of the cable, leave the shields unconnected or ground them indirectly via
a high-frequency capacitor with a few nanofarads, eg. 3.3 nF / 630 V. The shield can also
be grounded directly at both ends if they are in the same ground line with no significant
voltage drop between the end points. See the firmware manual for parameter settings.
**WARNING!** As the inputs pictured above are not insulated according to IEC 60664, the connection of the motor temperature sensor requires double or reinforced insulation between motor live parts and the sensor. If the assembly does not fulfill the requirement, the I/O board terminals must be protected against contact and must not be connected to other equipment or the temperature sensor must be isolated from the I/O terminals.

### AI1 or AI2 as a Pt100, Pt1000, PTC or KTY84 sensor input

Three Pt100/Pt1000/PTC sensors or one KTY84 sensor for motor temperature measurement can be connected between an analog input and output as shown below. (Alternatively, you can connect the KTY to an FIO-11 or FAIO-01 analog I/O extension module or FEN-xx encoder interface module.) At the sensor end of the cable, leave the shields unconnected or ground them indirectly via a high-frequency capacitor with a few nanofarads, eg. 3.3 nF / 630 V. The shield can also be grounded directly at both ends if they are in the same ground line with no significant voltage drop between the end points.

1) For AI1, set input type to voltage with switch AI1. For AI2, set input type with switch AI2. Set the appropriate analog input unit to V (volt) in parameter group 12 Standard AI.

2) Select the excitation mode in parameter group 13 Standard AO.

### DIIL input

On both the supply and inverter units, the DIIL input is used for the connection of safety circuits. The input is parametrized to stop the unit when the input signal is lost.

### Drive-to-drive link (XD2D)

The drive-to-drive link is a daisy-chained RS-485 transmission line that allows basic master/follower communication with one master drive and multiple followers.

Enable bus termination on the inverters at the ends of the drive-to-drive link by setting switch D2D TERM on the control unit to ON. On intermediate inverters, disable bus termination.
Use shielded twisted-pair cable (~100 ohm, for example, PROFIBUS-compatible cable) for the wiring. For best immunity, high quality cable is recommended. Keep the cable as short as possible; the maximum length of the link is 50 meters (164 ft). Avoid unnecessary loops and running the cable near power cables (such as motor cables). Ground the cable shields as described in section Connecting the control cables (page 99).

The following diagram shows the wiring of the drive-to-drive link.

### Safe torque off (XSTO, XSTO OUT)

On the inverter control unit [A41], the XSTO input can be used to implement a safe torque off (STO) function. For the drive to start, both connections (OUT1 to IN1 and IN2) must be closed. By default, the terminal block has jumpers to close the circuit. Remove the jumpers before connecting an external Safe torque off circuit to the drive. For information on the implementation of a Safe torque off function, see chapter The Safe torque off function (page 237).

**Note:** The XSTO input only acts as a true Safe torque off input on the inverter control unit [A41]. De-energizing the IN1 and/or IN2 terminals on the supply control unit [A51] will stop the supply unit but not constitute a true safety function.

The XSTO OUT connector is wired to the STO IN connector of one inverter module. In case the inverter unit consists of multiple modules, the STO OUT connector of one module is wired to the STO IN connector of the next module etc. so that all modules are part of the chain.

### FSO-xx safety functions module connection (X12)

See section Implementing the functions provided by the FSO-xx safety functions module (option +Q972 or +Q973) (page 90), and the user manual of the FSO-xx module.

### SDHC memory card slot

The BCU-x2 has an on-board data logger that collects real-time data from the power modules to help fault tracing and analysis. The data is stored onto the SDHC memory card inserted into the SD CARD slot and can be analyzed by ABB service personnel.
Control unit connector data

**Power supply** *(XPOW)*

- Connector pitch 5 mm, wire size 2.5 mm²
- 24 V (±10%) DC, 2 A
- External power input. Two supplies can be connected for redundancy.

**Relay outputs RO1…RO3** *(XRO1…XRO3)*

- Connector pitch 5 mm, wire size 2.5 mm²
- 250 V AC / 30 V DC, 2 A
- Protected by varistors

**+24 V output** *(XD24:2 and XD24:4)*

- Connector pitch 5 mm, wire size 2.5 mm²
- 24 V (±10%) DC, 2 A
- Total load capacity of these outputs is 4.8 W (200 mA / 24 V) minus the power taken by DIO1 and DIO2.

**Digital inputs DI1…DI6** *(XDI:1…XDI:6)*

- Connector pitch 5 mm, wire size 2.5 mm²
- 24 V logic levels: “0” < 5 V, “1” > 15 V
- Input type: NPN/PNP (DI1...DI5), NPN (DI6)
- Hardware filtering: 0.04 ms, digital filtering up to 8 ms
- DI6 (XDI:6) can alternatively be used as an input for a PTC sensor.
- “0” > 4 kohm, “1” < 1.5 kohm
- I<sub>max</sub>: 15 mA (DI1...DI5), 5 mA (DI6)

**Start interlock input DIIL** *(XDI:7)*

- Connector pitch 5 mm, wire size 2.5 mm²
- 24 V logic levels: “0” < 5 V, “1” > 15 V
- Input type: NPN/PNP
- Hardware filtering: 0.04 ms, digital filtering up to 8 ms

**Digital inputs/outputs DIO1 and DIO2** *(XDIO:1 and XDIO:2)*

- Connector pitch 5 mm, wire size 2.5 mm²
- As inputs:
  - 24 V logic levels: “0” < 5 V, “1” > 15 V
  - R<sub>in</sub>: 2.0 kohm
  - Filtering: 1 ms

- As outputs:
  - Total output current from +24VD is limited to 200 mA

**Reference voltage for analog inputs** +VREF and -VREF *(XAI:1 and XAI:2)*

- Connector pitch 5 mm, wire size 2.5 mm²
- 10 V ±1% and –10 V ±1%, R<sub>load</sub> 1…10 kohm
- Maximum output current: 10 mA

**Analog inputs AI1 and AI2** *(XAI:4 ... XAI:7)*

- Current/voltage input mode selection by switches.
  - Current input: –20…20 mA, R<sub>in</sub> = 100 ohm
  - Voltage input: –10…10 V, R<sub>in</sub> > 200 kohm
  - Differential inputs, common mode range ±30 V
  - Sampling interval per channel: 0.25 ms
  - Hardware filtering: 0.25 ms, adjustable digital filtering up to 8 ms
  - Resolution: 11 bit + sign bit
  - Inaccuracy: 1% of full scale range

---

**Control units of the drive** 139
### Analog outputs AO1 and AO2 (XAO)

- Connector pitch 5 mm, wire size 2.5 mm$^2$
- 0…20 mA, $R_{\text{load}} < 500$ ohm
- Frequency range: 0…500 Hz
- Resolution: 11 bit + sign bit
- Inaccuracy: 2% of full scale range

### Drive-to-drive link (XD2D)

- Connector pitch 5 mm, wire size 2.5 mm$^2$
- Physical layer: RS-485
- Termination by switch

### RS-485 connection (X485)

- Connector pitch 5 mm, wire size 2.5 mm$^2$
- Physical layer: RS-485

### Safe torque off connection (XSTO)

- Connector pitch 5 mm, wire size 2.5 mm$^2$
- Physical layer: RS-485
- Input voltage range: -3…30 V DC
- Logic levels: “0” < 5 V, “1” > 17 V
- For the unit to start, both connections must be “1”
- Current consumption: 66 mA (continuous) per STO channel per R8i inverter module
- EMC (immunity) according to IEC 61326-3-1

### Safe torque off output (XSTO OUT)

- Connector pitch 5 mm, wire size 2.5 mm$^2$
- To STO IN connector of inverter module. See chapter *The Safe torque off function* (page 237).

### Control panel connection (X13)

- Connector: RJ-45
- Cable length < 3 m

### Ethernet connection (XETH)

- Connector: RJ-45

### SDHC memory card slot (SD CARD)

- Memory card type: SDHC
- Maximum memory size: 4 GB

The terminals of the control unit fulfill the Protective Extra Low Voltage (PELV) requirements. The PELV requirements of a relay output are not fulfilled if a voltage higher than 48 V is connected to the relay output.
Ground isolation diagram

*Ground selector (DICOM=DIOGND) settings*

<table>
<thead>
<tr>
<th>DICOM=DIOGND: ON</th>
<th>DICOM=DIOGND: OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>All digital inputs share a common ground (DICOM connected to DIOGND). This is the default setting.</td>
<td>Ground of digital inputs DI1…DI5 and DIIL (DICOM) is isolated from DIO signal ground (DIOGND). Isolation voltage 50 V.</td>
</tr>
</tbody>
</table>
Control units of the drive
Installation checklist

Contents of this chapter
This chapter contains an installation checklist which you must complete before you start up the drive.

Warnings

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

Checklist
Do the steps in section *Electrical safety precautions* (page 19) before you start the work. Go through the checklist together with another person.

<table>
<thead>
<tr>
<th>Check that …</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The ambient operating conditions meet the specifications given in chapter <em>Technical data</em>.</td>
<td>✓</td>
</tr>
<tr>
<td>The drive cabinet has been fixed to floor, and if necessary due to vibration etc, also from top to the wall or roof.</td>
<td>□</td>
</tr>
<tr>
<td>The cooling air will flow freely in and out of the drive cabinet,</td>
<td>□</td>
</tr>
<tr>
<td>If the drive will be connected to an IT (ungrounded) or a corner grounded TN network: The optional EMC filter (+E202) of the drive (if any) has been disconnected. See page 96.</td>
<td>□</td>
</tr>
<tr>
<td>If the drive has been stored over one year: The electrolytic DC capacitors in the DC link of the drive have been reformed. See <em>Converter module capacitor reforming instructions</em> (3BFE64059629 [English]).</td>
<td>□</td>
</tr>
</tbody>
</table>
There is an adequately sized protective earth (ground) conductor between the drive and the switchboard, and the conductor has been connected to appropriate terminal. Proper grounding has also been measured according to the regulations.

There is an adequately sized protective earth (ground) conductor between the motor and the drive, and the conductor has been connected to appropriate terminal. Proper grounding has also been measured according to the regulations.

Only for drives with option +D150: There is an adequately sized protective earth (ground) conductor between the user-installed brake resistor and the drive, and the conductor has been connected to appropriate terminal. Proper grounding has also been measured according to the regulations.

The supply voltage matches the nominal input voltage of the drive. Check the type designation label.

The voltage setting of the auxiliary voltage transformers T21 (standard), T101 (option-specific) and T111 (option-specific) is correct. See page 96.

The input power cable has been connected to the appropriate terminals, the phase order is correct, and the terminals have been tightened. (Pull on the conductors to check.)

The motor cable has been connected to the appropriate terminals, the phase order is right, and the terminals have been tightened. (Pull the conductors to check.)

The motor cable (and brake resistor cable, if present) has been routed away from other cables.

No power factor compensation capacitors have been connected to the motor cable.

If a drive bypass connection will be used: The direct-on-line contactor of the motor and the drive output contactor are either mechanically or electrically interlocked, ie, cannot be closed simultaneously.

The external brake resistor (if present) has been connected to the appropriate terminals, and the terminals have been tightened. (Pull on the conductors to check.)

The brake resistor cable has been routed away from other cables.

The control cables have been connected to the appropriate terminals, and the terminals have been tightened. (Pull the conductors to check.)

There are no tools, foreign objects or dust from drilling inside the drive.

All shrouds and cover of the motor connection box are in place. Cabinet doors have been closed.

The motor and the driven equipment are ready for start.
Start-up

Contents of this chapter

This chapter contains the start-up procedure of the drive.

Start-up procedure

The tasks which are needed in certain cases only are marked with underlining, and option codes are given in brackets. Default device designations (if any) are given in brackets after the name, for example “main switch-disconnector [Q1]”. The same device designations are typically also used in the circuit diagrams.

These instructions cannot and do not cover all possible start-up tasks of a customized drive. Always refer to the delivery-specific circuit diagrams when proceeding with the start-up.

WARNING! Only qualified electricians are allowed to do the work described in this chapter.

Note: For certain options (such as functional safety options +Q950, +Q951, +Q952, +Q957, +Q963, +Q964, +Q978, +Q979), additional start-up instructions are given in their separate manuals. See the listing of manuals inside the front cover.
# Safety

**WARNING!** Obey the safety instructions during the start-up procedure. See chapter *Safety instructions* on page 15.

## Checks/Settings with no voltage connected

Ensure that the disconnector of the supply transformer is locked to the off (0) position, i.e. no voltage is, and cannot be connected to the drive inadvertently.

Check that the main switch-disconnector [Q1.1] is switched off, or main breaker [Q1] racked out.

Check that the grounding switch [Q9.1] (option +F259) is switched on.

Check the mechanical and electrical installation of the drive. See *Installation checklist* (page 143).

Check the settings of breakers-switches in the auxiliary circuits. See the circuit diagrams delivered with the drive.

Check the tap settings of transformers T21, T101 (if present) and T111 (if present). See *Checking the settings of transformers T21, T101 and T111* (page 96).

Disconnect any unfinished or uninspected auxiliary voltage (115/230 V AC) cables that lead from the terminal blocks to the outside of the equipment.

Check that both channels of the Safe torque off circuit connected to the STO inputs of both the supply control unit [A51] and the inverter control unit [A41] are closed. Refer to the wiring diagrams delivered with the drive.

If the Safe torque off functionality is used, check that the STO OUT output on the inverter control unit [A41] is chained to the STO inputs of all inverter modules.

If the Safe torque off functionality is not used, check that the STO input on all inverter modules is correctly wired to +24 V and ground.

**Drives with ground fault monitoring for IT (ungrounded) systems (option +Q954):** Adjust the settings of the ground fault monitor to suit the installation. See the circuit diagrams of the delivery and *IRDH275B Ground Fault Monitor Operating Manual* by Bender (code: TGH1386en).

**Drives with Pt100 relays (options +nL506 and +nL514+Q971):**
- Check the connections against the circuit diagrams of the delivery.
- Set the alarm and trip levels of the Pt100 relays.

Set the alarm and trip levels of the Pt100 relay as low as possible based on the operating temperature and test results of the machine. The trip level can be set, for example, 10 °C higher than what the temperature of the machine is at maximal load in the maximum environmental temperature. We recommend to set the operating temperatures of the relay, typically for example, as follows:
- 120…140 °C when only tripping is in use
- alarm 120…140 °C and trip 130…150 °C when both alarm and tripping are used.

## Powering up the auxiliary circuit of the drive

Make sure that it is safe to connect voltage. Ensure that
- nobody is working on the drive or circuits that have been wired from outside into the drive cabinet
- the cover of the motor terminal box is in place.

**Drives with a voltmeter (option +G334):** Make sure that the circuit breaker of the measuring circuit [F5.1] is closed.

Close the circuit breakers and/or fuse disconnectors supplying the auxiliary voltage circuits.

Close the cabinet doors.

Close the main breaker of the supply transformer.
Start-up 147

| Action |  
|-----------------|-----------------|
| Switch on the auxiliary voltage [Q21]. | ☑ |
| Drives of frame size 1×R8i + 1×R8i: Close the main switch-disconnector [Q1.1]. This will power up the main circuit of the drive as well as the auxiliary voltage circuit. | ☐ |

| Setting up the supply unit parameters |  
|--------------------------------------|-----------------|
| Check the voltage range setting in parameter 195.01 Supply voltage. For more information on setting up the supply control program, see the ACS880 IGBT supply control program firmware manual (3AUA0000131562 [English]). If you need more information on the use of the control panel, see ACX-AP-x Assistant control panels user's manual (3AUA0000085685 [English]). | ☐ |

| Setting up the inverter unit parameters, and performing the first start |  
|-------------------------------------------------------------|-----------------|
| Set up the inverter control program. See the appropriate start-up guide and/or firmware manual. There is a separate start-up guide only for some control programs. | ☐ |
| Check that parameter 95.09 Fuse switch control is disabled. | ☐ |
| Drives with a brake chopper (option +D150): Refer also to chapter Resistor braking, section Start-up (page 256). | ☐ |
| Drives with a sine output filter (option +E206): Check that bit 1 of parameter 95.15 Special HW settings is activated. | ☐ |
| Drives with a fieldbus adapter module (optional): Set the fieldbus parameters. Activate the appropriate assistant (if present) in the control program, or see the user’s manual of the fieldbus adapter module, and the drive firmware manual. Check that the communication works between the drive and the PLC. | ☐ |
| Drives with an encoder interface module (optional): Set the encoder parameters. Activate the appropriate assistant (if present) in the control program, or see the user’s manual of the encoder interface module, and the drive firmware manual. | ☐ |

| Powering up the main circuit of the drive |  
|-------------------------------------------|-----------------|
| Switch off the grounding switch [Q9.1] (option +F259). | ☐ |
| Close the main switch-disconnector [Q1.1] or main breaker [Q1]. (With frame size 1×R8i + 1×R8i, this has already been done to power up the auxiliary circuit.) | ☐ |
| **Note:** Do not use excessive force. The main switch-disconnector (or main breaker) can only be closed when  
• the main input terminals (L1, L2, L3) are powered, and  
• auxiliary voltage is switched on [Q21], and  
• grounding switch is off [Q9.1] (option +F259). | ☐ |
| Close the charging switch [Q3]. This will enable the pre-charging of the DC capacitors of the drive. The charging itself is controlled by the supply control unit [A51]. | ☐ |
| Turn the operating switch [S21] to the ON (1) position to activate the run enable signal for the supply unit. Depending on control source settings, this may also close the main contactor (if present). If a main contactor is present and does not close, refer to the circuit diagrams delivered by the drive as well as the appropriate firmware manuals. | ☐ |

| On-load checks |  
|----------------|-----------------|
| Start the motor to perform the ID run. | ☐ |
| Check that the cooling fans rotate freely in the right direction, and the air flows upwards. | ☐ |
| Check that the motor starts, stops and follows the speed reference in the correct direction when controlled with the control panel. | ☐ |
Check that the motor starts, stops and follows the speed reference in the correct direction when controlled through the customer-specific I/O or fieldbus.

<table>
<thead>
<tr>
<th>Action</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drives in which the Safe torque off control circuit is in use: Test and validate the operation of the Safe torque off function. See <em>Start-up including acceptance test</em> (page 243).</td>
<td>☐</td>
</tr>
<tr>
<td>Drives with an emergency stop circuit (options +Q951, +Q952, +Q963, +Q964, +Q978, +Q979): Test and validate the operation of the emergency stop circuit. See the delivery specific circuit diagrams and wiring, start-up and operating instructions of the option (see page 89).</td>
<td>☐</td>
</tr>
<tr>
<td>Drives with the Prevention of unexpected start-up with safety relay (option +Q957): Test and validate the operation of the Prevention of unexpected start-up circuit. See the delivery specific circuit diagrams and wiring, start-up and operating instructions of the option (see page 89).</td>
<td>☐</td>
</tr>
<tr>
<td>Test and validate the operation of Prevention of unexpected start-up with FSO-xx (option +Q950)</td>
<td>☐</td>
</tr>
</tbody>
</table>
Fault tracing

Contents of this chapter

This chapter describes the fault tracing possibilities of the drive.

LEDs

<table>
<thead>
<tr>
<th>Where</th>
<th>LED</th>
<th>Color</th>
<th>Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control panel mounting platform</td>
<td>POWER</td>
<td>Green</td>
<td>Control unit is powered and +15 V is supplied to the control panel.</td>
</tr>
<tr>
<td></td>
<td>FAULT</td>
<td>Red</td>
<td>Drive in fault state.</td>
</tr>
<tr>
<td>Supply or inverter control unit (A51 or A41)</td>
<td>BATT OK</td>
<td>Green</td>
<td>Battery voltage of the real-time clock is OK (higher than 2.8 V). When the LED is not lit, • battery voltage is below 2.8 V, • the battery is missing, or • the control unit is not powered.</td>
</tr>
<tr>
<td></td>
<td>PWR OK</td>
<td>Green</td>
<td>Internal voltage OK</td>
</tr>
<tr>
<td></td>
<td>FAULT</td>
<td>Red</td>
<td>The control program indicates that the equipment is faulty. See the appropriate firmware manual.</td>
</tr>
<tr>
<td></td>
<td>WRITE</td>
<td>Yellow</td>
<td>Writing to SD card in progress.</td>
</tr>
</tbody>
</table>

Warning and fault messages

See the firmware manual for the descriptions, causes and remedies of the drive control program warning and fault messages.
Maintenance

Contents of this chapter

This chapter contains preventive maintenance instructions.
Maintenance intervals

The table below shows the maintenance tasks which can be done by the end user. The complete maintenance schedule is available on the Internet ([www.abb.com/driveservices](http://www.abb.com/driveservices)). For more information, consult your local ABB Service representative ([www.abb.com/searchchannels](http://www.abb.com/searchchannels)).

Legend
I  Inspection (visual inspection and maintenance action if needed)
R  Replacement
P  Performance of on/off-site work (commissioning, tests, measurements or other work)

<table>
<thead>
<tr>
<th>Recommended annual actions by the user</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Air inlet and outlet meshes (IP22/IP42)</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cabinet door filters (IP54)</td>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient conditions (dustiness, moisture, corrosion, temperature)</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleaning of heatsinks</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightness of terminals</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality of supply voltage</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air circuit breaker maintenance (if present)</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reforming DC circuit capacitors (spare modules and spare capacitors)</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spare parts</td>
<td>I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cooling</th>
<th>Years from start-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Supply and inverter module main cooling fans</td>
<td>R</td>
</tr>
<tr>
<td>LCL filter module cooling fans</td>
<td>R</td>
</tr>
<tr>
<td>Sine filter (option +E206) cooling fan</td>
<td>R</td>
</tr>
<tr>
<td>Supply and inverter modules: circuit board compartment fan</td>
<td>R</td>
</tr>
<tr>
<td>Internal cabinet cooling fans (internal, door and IP54)</td>
<td>R</td>
</tr>
</tbody>
</table>

| Batteries | |
|-----------|--|--|--|--|--|--|
| Control panel battery | R | R | R |
| Control unit battery | R | R | R |

Maintenance and component replacement intervals are based on the assumption that the equipment is operated within the specified ratings and ambient conditions. ABB recommends annual drive inspections to ensure the highest reliability and optimum performance.

**Note:** Long term operation near the specified maximum ratings or ambient conditions may require shorter maintenance intervals for certain components. Consult your local ABB Service representative for additional maintenance recommendations.
Cabinet

Cleaning the interior of the cabinet

WARNING! Obey the instructions in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

WARNING! Use a vacuum cleaner with an antistatic hose and nozzle, and wear a grounding wristband. Otherwise an electrostatic charge might build up and damage the circuit boards.

1. Stop the drive and do the steps in section Electrical safety precautions (page 19) before you start the work.
2. Open the cabinet doors.
3. Clean the interior of the cabinet. Use a vacuum cleaner and a soft brush.
4. Clean the air inlets of the fans and air outlets of the modules (top).
5. Clean the air inlet gratings on the doors (see below).
6. Close the doors.

Cleaning the door air inlets (IP22 and IP42)

1. Remove the fasteners at the top of the grating.
2. Lift the grating and pull it away from the door.
3. Vacuum clean or wash the grating on both sides.
4. Reinstall the grating in reverse order.
Cleaning the door air inlets (IP54)
1. Remove the fasteners at the top of the grating.
2. Lift the grating and pull it away from the door.
3. Remove the air filter mat.
4. Place the new filter mat in the grating the metal wire side facing the door.
5. Reinstall the grating in reverse order.

Replacing the outlet (roof) filters (IP54)
1. Remove the front and back gratings of the fan compartment by lifting them upwards.
2. Remove the air filter mat.
3. Place the new filter mat in the grating.
4. Reinstall the gratings in reverse order.

Module heatsinks
The module heatsink fins pick up dust from the cooling air. The drive runs into overtemperature warnings and faults if the heatsink is not clean. When necessary, clean the heatsink as follows.
WARNING! Obey the instructions in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

WARNING! Use a vacuum cleaner with antistatic hose and nozzle. Using a normal vacuum cleaner creates static discharges which can damage circuit boards.

1. Stop the drive and do the steps in section Electrical safety precautions (page 19) before you start the work.
2. Remove the module from the cabinet.
3. Remove the module cooling fan(s). See section Fans below.
4. Blow dry, clean compressed air from bottom to top and simultaneously use a vacuum cleaner at the air outlet to trap the dust. Note: If there is a risk of dust entering adjoining equipment, perform the cleaning in another room.
5. Reinstall the cooling fan.

Power connections and quick connectors

- Retightening the power connections

WARNING! Obey the instructions in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive (if running) and do the steps in section Electrical safety precautions (page 19) before you start the work.
2. Check the tightness of the cable connections. Use the tightening torques given in chapter Technical data.
Fans

The lifespan of the cooling fans of the drive depends on the running time, ambient temperature and dust concentration. See the firmware manual for the actual signal which indicates the running time of the cooling fan. Reset the running time signal after fan replacement.

Replacement fans are available from ABB. Do not use other than ABB specified spare parts.

- Replacing the cooling fan in the auxiliary control cubicle

WARNING! Obey the instructions in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive and do the steps in section Electrical safety precautions (page 19) before you start the work.
2. Remove the shrouding from in front of the fan.
3. Unplug the power supply cable of the fan.
4. Remove the fastening screws of the fan.
5. Install the new fan in reverse order.
**Replacing the fan(s) in the incoming cubicle**

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive and do the steps in section *Electrical safety precautions* (page 19) before you start the work.
2. Remove the shrouding (if any) in front of the fan.
3. Disconnect the fan wiring (a)
4. Remove the fastening screws (a) and finger guard (b) of the fan.
5. Install the new fan in reverse order.
Replacing a roof fan (IP54/UL type 12)

WARNING! Obey the instructions in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive and do the steps in section Electrical safety precautions (page 19) before you start the work.
2. Lift the front and back gratings upwards and remove them.
3. Loosen the mounting screws of the fan cover.
4. Lift the cover off.
5. Disconnect the fan supply wires.
6. Loosen the mounting screws of the fan.
7. Lift the fan off.
8. Install the new fan in reverse order.
**Replacing a supply or inverter module cooling fan**

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive and do the steps in section *Electrical safety precautions* (page 19) before you start the work.
2. Open the cubicle door.
3. Remove the shroud in front of the fan.
4. Remove the cover panel in front of the fan.
5. Unplug the wiring of the fan.
6. Remove the fan control box.
7. Undo the screws of the fan unit.
8. Pull the fan unit out.
9. Install the new fan in reverse order.
Replacing the circuit board compartment fan (frame R8i)

The R8i module is equipped with a fan blowing air through the circuit board compartment. The fan is accessible from the front of the module.

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive (if running) and do the steps in section *Electrical safety precautions* (page 19) before you start the work.
2. Open the door of the module cubicle.
3. Remove the two M4×12 (T20) screws which lock the fan holder.
4. Pull the fan holder out of the module.
5. Disconnect the fan cable.
6. Remove the four M3 (5.5 mm) nuts which hold the fan.
7. Remove the fan from the fan holder.
8. Put the fan onto the threaded studs on the fan holder with the airflow direction arrow pointing towards the fan holder.

9. Install and tighten the four nuts removed earlier.

10. Connect the fan cable.

11. Align and push the fan holder into the module.

12. Install and tighten the two M4×12 (T20) screws.
Replacing the fan of the LCL filter (BLCL-1x-x)

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive (if running) and do the steps in section *Electrical safety precautions* (page 19) before you start the work.
2. Open the door.
3. Remove the screw in front of the fan unit.
4. Unplug the fan power supply cable.
5. Pull the fan unit out.
6. Install a new fan in reverse order.
Replacing the fan of the LCL filter (BLCL-2x-x)

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive (if running) and do the steps in section *Electrical safety precautions* (page 19) before you start the work.
2. Open the door.
3. Remove the two screws in front of the fan unit.
4. Unplug the fan power supply cable.
5. Pull the fan unit out.
6. Install a new fan in reverse order.
Supply and inverter modules

- **Cleaning**

The module heatsink fins pick up dust from the cooling air. The module runs into overtemperature warnings and faults if the heatsink is not clean. In a “normal” environment (neither especially dusty nor clean), the heatsink should be checked annually, in a dusty environment more often.

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive (if running) and do the steps in section *Electrical safety precautions* (page 19) before you start the work.

2. Remove the cooling fan of the supply module as described under *Fans* elsewhere in this chapter.

3. Blow clean, dry and oilfree compressed air through the module from bottom to top, simultaneously using a vacuum cleaner at the air outlet to trap the dust. **Note:** Prevent the dust from entering adjoining equipment.

4. Refit the cooling fan.

- **Replacing a supply or inverter module**

**WARNING!** Make sure the replacement module has exactly the same type code as the old module. See also section *Licensing* (page 30).

Follow the module extraction and insertion procedures under *Connecting the motor cables (units without common motor terminal cubicle or sine output filter)* (page 109).
# Reduced run

A “reduced run” function is available for supply and inverter units consisting of parallel-connected modules. The function makes it possible to continue operation with limited current even if one (or more) module is out of service, for example, because of maintenance work.

In principle, reduced run is possible with only one module, but the physical requirements of operating the drive still apply; for example, the inverter modules remaining in use must be able to provide the motor with enough magnetizing current.

**Activation of the reduced run function**

---

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

Refer to the drawing below. The drawing represents the inverter unit, but the procedure is similar for the supply unit.

1. Stop the drive and do the steps in section *Electrical safety precautions* (page 19) before you start the work.
2. Remove the shrouding above the module bay.
3. Remove the DC busbar assembly (along with fuses) above the module. Store these parts – they are to be reinstalled only with the module. Make note of the order of washers.
4. Remove the faulty module from its bay according to section *Removing the inverter module(s)* (page 111).
5. Install the air baffle (included) to the underside of the top module guide:
   - Fasten the front edge of the baffle to the module mounting holes using the module mounting screws (2 × M8). Tighten to 9 N·m (6.6 lbf·ft).
   - Fasten the left/right sides of the baffle if wherever possible using M4 screws. (This depends on the location of the module in the cubicle.) Tighten to 1…2 N·m (0.7 … 1.5 lbf·ft).
6. If the control unit (A41 or A51) is powered from the faulty module, connect the power supply wiring using the extension wire set included to another module.

7. If the Safe torque off (STO) function is in use, install the jumper wire set included in the STO wiring in place of the missing module. (This is not needed if the module was the last on the STO wire chain.)

8. Reinstall all shrouding removed earlier. Note: Do not reinstall the DC fuses or busbars but store them elsewhere until the module can be reinstalled.

9. Switch on the power to the drive.

10. Enter the number of supply/inverter modules present into parameter 195.13/95.13 Reduced run mode.

11. Reset all faults and start the drive.

12. If the module removed was an inverter module and the Safe torque off function is in use, perform an acceptance test as described under Start-up including acceptance test (page 243).

The maximum current is now automatically limited according to the new configuration. A mismatch between the number of detected modules and the value set in 195.13/95.13 will generate a fault.
Returning the module

1. Remove the air baffle and install the module in reverse order. Use the following tightening torques:
   - DC busbar assembly to upper insulators (2 × M8): 9 N·m (6.6 lbf·ft)
   - DC busbar assembly to lower insulators (2 × M10): 18 N·m (13.3 lbf·ft)
   - Fuses to DC busbars: 50 N·m (37 lbf·ft) (Bussmann), 46 N·m (34 lbf·ft) (Mersen/Ferraz-Shawmut)
   - Module to cabinet frame (4 × M8): 22 N·m (16 lbf·ft)
   - DC busbar assembly to module DC input (2 × M12): 70 N·m (52 lbf·ft)

2. Restore the original wiring (STO and control unit power supply whenever needed).

3. Set parameter 195.13/95.13 to 0 to disable the reduced run function.

4. If the module reinstalled was an inverter module and the Safe torque off function is in use, perform an acceptance test as described under Start-up including acceptance test (page 243).
LCL filter

Replacing the LCL filter

**WARNING!** Ignoring the following instructions can cause physical injury, or damage to the equipment:

- Use extreme caution when maneuvering modules that run on wheels. The modules are heavy and have a high center of gravity. They topple over easily if handled carelessly.
- When removing a module on wheels, pull the module carefully out of the cubicle along the extraction/installation ramp. While pulling on the handle, keep a constant pressure with one foot on the base of the module to prevent the module from falling on its back.
- When reinserting the module, keep your fingers away from the edge of the module front plate to avoid pinching them between the module and the cubicle. Also, keep a constant pressure with one foot on the base of the module to prevent the module from falling on its back.
- Do not tilt the module. Do not leave the module unattended on a sloping floor.
- Do not use the module extraction/installation ramp with plinth heights over 50 mm. The ramp supplied with the drive system is designed for a plinth height of 50 mm (the standard plinth height of ABB cabinets).

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Stop the drive (if running) and do the steps in section *Electrical safety precautions* (page 19) before you start the work.
2. Open the cubicle door.
3. Undo the four screws of the shroud in the upper part of the cubicle. Remove the shroud.
4. Unplug the signal connector cable on top of the module.
5. Remove the screws in the busbars on top of the LCL filter module. Be careful not to drop the screws inside the module!
6. Remove the fan of the LCL filter module. Unplug the signal connector cable and remove the screws in front of the fan.
7. Remove the fastening screws in the busbar behind the module.
8. Remove the two screws that fasten the bottom of the module to the base of the cabinet.
9. Install the module extraction/installation ramp: lift the ramp against the cabinet base so that the hooks of the base go into the ramp’s holes.
10. Remove the two fastening screws that fasten the top of the module to the cabinet frame.
11. Pull the module carefully out of the cabinet along the ramp. While pulling on the handle, keep a constant pressure with one foot on the base of the module to prevent the module from falling on its back.
12. Replace the module: install the module in reverse order. Mind you fingers. Keep a constant pressure with one foot on the base of the module to prevent the module from falling on its back. **Note:** Be careful not to break the fastening screws: tighten the fastening screws of the module to 22 N·m (16.2 lbf.ft) and fastening bolts of the DC output busbars to 70 N·m (51.6 lbf.ft).
- Plug the module signal wire set to the module signal connector.
- Fasten the shrouds.

13. Remove the module extraction/installation ramp and close the cabinet doors.
Capacitors

The DC circuit of the power modules of the drive contain several electrolytic capacitors. Their lifespan depends on the operating time of the drive, loading and ambient temperature. Capacitor life can be prolonged by lowering the ambient temperature.

Capacitor failure is usually followed by damage to the unit and an input cable fuse failure, or a fault trip. Contact ABB if capacitor failure is suspected. Replacements are available from ABB. Do not use other than ABB-specified spare parts.

Reforming the capacitors

The capacitors must be reformed if the drive has been stored for a year or more. See page 55 for information on finding out the manufacturing date. For information on reforming the capacitors, see Converter module capacitor reforming instructions (3BFE64059629 [English]).
Fuses

Replacing the AC fuses in the incoming cubicle

Units without a main breaker have AC fuses in the incoming cubicle (or, in the case of frame 1×R8i + 1×R8i, in the combined supply and inverter module cubicle).

WARNING! Obey the instructions in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section Electrical safety precautions (page 19) before you start the work.
2. Open the cubicle door.
3. Remove the shrouding from in front of the fuses.
4. Slacken the nuts of the headless screws of the fuses so that you can slide out the fuse blocks. Make note of the order of the washers on the screws.
5. Remove the screws, nuts and washers from the old fuses and attach them to the new fuses. Make sure to keep the washers in the original order.
6. Insert the new fuses into their slots in the cubicle. Pre-tighten the nuts first by hand or by applying a torque of no more than 5 N•m (3.7 lbf•ft).
7. Tighten the nuts to torque as follows:
   - Cooper-Bussmann fuses: 50 N•m (37 lbf•ft)
   - Mersen (Ferraz Shawmut) fuses: 46 N•m (34 lbf•ft)
   - Other: Refer to the fuse manufacturer’s instructions.
8. Reinstall the shroud and close the door.

Replacing the AC fuses in the LCL filter module or supply module cubicle (frame 3×R8i + 3×R8i and up)

Frames 3×R8i + 3×R8i and up have AC fuses located above each LCL filter module. To replace, use the procedure Replacing the DC fuses in the supply module cubicle (frame 2×R8i + 2×R8i and up) below.
Replacing the DC fuses in the supply module cubicle (frame 2×R8i + 2×R8i and up)

There are DC fuses at the output of each supply module (labeled 4b in the drawing below). Note that there are also DC fuses at the input of each inverter module; see page 175. This procedure can also be used to replace the AC fuses located above the LCL filter modules (4a).

**WARNING!** Obey the instructions in chapter Safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section Electrical safety precautions (page 19) before you start the work.
2. Open the door of the supply module cubicle.
3. Remove the shrouding from in front of the fuses.
4. Slacken the nuts of the headless screws of the fuses so that you can slide out the fuse blocks. Make note of the order of the washers on the screws.
5. Remove the screws, nuts and washers from the old fuses and attach them to the new fuses. Make sure to keep the washers in the original order.
6. Insert the new fuses into their slots in the cubicle. Pre-tighten the nuts first by hand or by applying a torque of no more than 5 N·m (3.7 lbf·ft).
7. Tighten the nuts to torque as follows:
   - Cooper-Bussmann fuses: 50 N·m (37 lbf·ft)
   - Mersen (Ferraz-Shawmut): 46 N·m (34 lbf·ft)
   - Other: Refer to the fuse manufacturer’s instructions.
8. Reinstall the shroud and close the door.
Replacing the DC fuses in the inverter module cubicle (frame 2×R8i + 2×R8i and up)

Parallel-connected inverter modules have DC fuses fitted above each module.

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section *Electrical safety precautions* on page 19 before you start the work.
2. Open the door of the inverter module cubicle.
3. Remove the shrouding from in front of the fuses.
4. Slacken the nuts of the headless screws of the fuses so that you can slide out the fuse blocks. Make note of the order of the washers on the screws.
5. Remove the screws, nuts and washers from the old fuses and attach them to the new fuses. Make sure to keep the washers in the original order.
6. Insert the new fuses into their slots in the cubicle.
7. Tighten the nuts to torque as follows:
   - Bussmann fuses: 50 N·m (37 lbf·ft)
   - Mersen (Ferraz-Shawmut): 46 N·m (34 lbf·ft)
   - Other: Refer to the fuse manufacturer’s instructions.
8. Reinstall the shrouding removed earlier and close the cubicle door.
Control panel

- **Replacing the battery**
  1. Turn the lid on the back of the panel counter-clockwise until the lid opens.
  2. Replace the battery with a new CR2032 battery.
  3. Put the lid back and tighten it by turning it clockwise.
  4. Dispose of the old battery according to local disposal rules or applicable laws.

- **Cleaning**
  See *ACX-AP-x assistant control panels user’s manual [3AUA0000085685 (English)]*. 
Control units

■ BCU control unit types

There are three variants of the BCU control unit used in ACS880 drives: BCU-02, BCU-12 and BCU-22. These have a different number of converter module connections (2, 7 and 12 respectively) but are otherwise identical. The three BCU types are interchangeable as long as the number of connections is sufficient. For example, the BCU-22 can be used as a direct replacement for both BCU-02 and BCU-12.

■ Memory unit

After replacing a supply or inverter control unit, the existing parameter settings can be retained by transferring the memory unit from the defective control unit to the new control unit.

![Warning symbol]

**WARNING!** Do not remove or insert the memory unit when the control unit is powered.

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

1. Do the steps in section *Electrical safety precautions* (page 19) before you start the work.
2. Make sure that the control unit is not powered.
3. Undo the fastening screw and pull the memory unit out.
4. Install a memory unit in reverse order.

One end of the BCU control unit
Control unit battery

Replace the real-time clock battery if the BATT OK LED is not illuminated when the control unit is powered. For information on the LED, see Control unit layout and connections on page 132.

1. Do the steps in section Electrical safety precautions (page 19) before you start the work.
2. Undo the fastening screw and remove the battery
3. Replace the battery with a new BR2032 battery.
4. Dispose of the old battery according to local disposal rules or applicable laws.
5. Set the real-time clock.
## Technical data

### Contents of this chapter

This chapter contains the technical specifications of the drive, for example, the ratings, fuse data, sizes and technical requirements, provisions for fulfilling the requirements for CE and other markings.

### Ratings

The nominal ratings for the drives with 50 Hz and 60 Hz supply are given below. The symbols are described below the table.

<table>
<thead>
<tr>
<th>Drive type ACS880-37-</th>
<th>Input ratings</th>
<th>Output ratings</th>
</tr>
</thead>
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<td>$I_N$</td>
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<td>0450A-3</td>
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<td>2347</td>
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</tr>
</tbody>
</table>
### Definitions

$U_N$ Supply voltage range. See also section *Electrical power network specification* (page 189).

$I_1$ Nominal rms input current

$I_N$ Nominal output current (available continuously with no over-loading)

$I_{\text{max}}$ Maximum output current. Available for 10 seconds at start, then as long as allowed by drive temperature.

$P_N$ Typical motor power in no-overload use. The horsepower ratings are typical NEMA motor sizes at 460 V (ACS880-37-xxxxA-5) and 575 V (ACS880-37-xxxxA-7) respectively.

$S_N$ Apparent power in no-overload use

$I_{\text{ld}}$ Continuous rms output current allowing 10% overload for 1 minute every 5 minutes.

$P_{\text{ld}}$ Typical motor power in light-overload use

$I_{\text{hd}}$ Continuous rms output current allowing 50% overload for 1 minute every 5 minutes.

$P_{\text{hd}}$ Typical motor power in heavy-duty use

**Note 1:** The ratings apply at an ambient temperature of 40 °C (104 °F).

**Note 2:** To achieve the rated motor power given in the table, the rated current of the drive must be higher than or equal to the rated motor current.

The DriveSize dimensioning tool available from ABB is recommended for selecting the drive, motor and gear combination.

---

### Technical data

#### Drive type

ACS880-37-

<table>
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<th>Drive type</th>
<th>Input ratings</th>
<th>Output ratings</th>
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$U_N = 690$ V

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**Derating**

**Ambient temperature derating**

In the temperature range +40…50 °C (+104…122 °F), the rated output current is derated by 1% for every added 1 °C (1.8 °F). The output current can be calculated by multiplying the current given in the rating table by the derating factor \(k\):

\[ k = 1 - \frac{1}{100} \times (T - 40) \]

### Chart

![Graph showing derating factor \(k\) at different temperatures.](image)

**Altitude derating**

At altitudes from 1000 to 4000 m (3300 to 13123 ft) above sea level, the output current derating is 1% for every 100 m (328 ft). If ambient temperature is below +40 °C (+104 °F), the derating can be reduced by 1.5% for every 1 °C reduction in temperature. For a more accurate derating, use the DriveSize PC tool. A few altitude derating curves are shown below.
Switching frequency derating
Switching frequencies other than default can require output current derating. Contact ABB for more information.

Output frequency derating
Motor operation above 150 Hz can require type-specific output current derating. Contact ABB for more information.
### Frame sizes and power module types

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<td>0810A-5+E205+N8201</td>
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<tr>
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Fuses

AC fuses

Notes:
- See also Implementing thermal overload and short-circuit protection (page 88) and Electrical power network specification (page 189).
- Fuses with higher current rating than the recommended ones must not be used.
- Fuses from other manufacturers can be used if they meet the ratings and the melting curve of the fuse does not exceed the melting curve of the fuse mentioned in the table.

<table>
<thead>
<tr>
<th>Drive type</th>
<th>Qty</th>
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<th>$A^2 \text{s}$ at 660 V</th>
<th>V</th>
<th>Manufacturer</th>
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<td>395000</td>
<td>690</td>
<td>Bussmann</td>
<td>170M7062</td>
</tr>
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</table>

*Units with line contactor only. **All units
**DC fuses**

Drives with parallel-connected supply and inverter modules (i.e. frames 2×R8i + 2×R8i and above) have DC fuses at the output of each supply module and at the input of each inverter module.

**Notes:**
- Fuses with higher current rating than the recommended ones must not be used.
- Fuses from other manufacturers can be used if they meet the ratings and the melting curve of the fuse does not exceed the melting curve of the fuse mentioned in the table.

<table>
<thead>
<tr>
<th>Drive type</th>
<th>DC fuses at supply module output and inverter module input</th>
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<tr>
<td>1700A-3</td>
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<tr>
<td>2060A-3</td>
<td>6&lt;sup&gt;1)&lt;/sup&gt;</td>
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<tr>
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<td>12</td>
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<tr>
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<tr>
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</table>

<sup>1)</sup> At outputs of supply modules, <sup>2)</sup> At inputs of inverter modules, <sup>3)</sup> Clearing at 660 V, <sup>4)</sup> Clearing at 1000 V
Fuses on CVAR varistor board
The CVAR board is used in units for UL and CSA installations.
The fuse type is Ferraz A070GRB10T13/G330010 (10 A 700 V AC).

Brake chopper DC fuses
Optional (+D150) brake choppers have two DC fuses each.
The fuse type is Bussmann 170M8635 (630 A 1000 V).

Dimensions and weights
See chapter Dimensions (page 201).

Free space requirements
The values are as required by cooling. Also obey the general installation rules given under Fastening the cabinet to the floor and wall or roof (non-marine units) (page 67).

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<th>Front</th>
<th>Sides</th>
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<td>in.</td>
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<td>in.</td>
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*Measured from the base plate of the cabinet top.

![Diagram showing free space requirements]

\[ \geq 400 \text{ mm (15.75 in.)} \]
## Cooling data, noise

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<th>Drive type</th>
<th>Air flow</th>
<th>Heat dissipation</th>
<th>Noise</th>
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Sine output filter data

Sine output filters are available as option +E206. The table below shows the types and technical data of the filters and filter cubicles used in ACS880-37 drives. The standard filters listed require no current derating.

For availability of sine output filters for other types, contact your local ABB representative.

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<th>Sine filter(s) used</th>
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<th>Cooling data</th>
<th>Dimensions</th>
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<td>2</td>
</tr>
<tr>
<td>0620A-3</td>
<td>1</td>
<td>NSIN-0900-6</td>
<td>783</td>
<td>5</td>
</tr>
<tr>
<td>0870A-3</td>
<td>1</td>
<td>NSIN-1380-6</td>
<td>1201</td>
<td>7</td>
</tr>
<tr>
<td>1110A-3</td>
<td>1</td>
<td>NSIN-1380-6</td>
<td>1201</td>
<td>7</td>
</tr>
<tr>
<td>1210A-3</td>
<td>1</td>
<td>NSIN-1380-6</td>
<td>1201</td>
<td>7</td>
</tr>
<tr>
<td>U_N = 500 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0420A-5</td>
<td>1</td>
<td>NSIN-0485-6</td>
<td>447</td>
<td>2.5</td>
</tr>
<tr>
<td>0570A-5</td>
<td>1</td>
<td>NSIN-0900-6</td>
<td>783</td>
<td>6</td>
</tr>
<tr>
<td>0780A-5</td>
<td>1</td>
<td>NSIN-0900-6</td>
<td>783</td>
<td>6</td>
</tr>
<tr>
<td>1010A-5</td>
<td>1</td>
<td>NSIN-1380-6</td>
<td>1201</td>
<td>8</td>
</tr>
<tr>
<td>1110A-5</td>
<td>1</td>
<td>NSIN-1380-6</td>
<td>1201</td>
<td>8</td>
</tr>
<tr>
<td>U_N = 690 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0320A-7</td>
<td>1</td>
<td>NSIN-0485-6</td>
<td>447</td>
<td>3</td>
</tr>
<tr>
<td>0390A-7</td>
<td>1</td>
<td>NSIN-0485-6</td>
<td>447</td>
<td>3</td>
</tr>
<tr>
<td>0580A-7</td>
<td>1</td>
<td>NSIN-0900-6</td>
<td>783</td>
<td>7</td>
</tr>
<tr>
<td>0660A-7</td>
<td>1</td>
<td>NSIN-0900-6</td>
<td>783</td>
<td>7</td>
</tr>
<tr>
<td>0770A-7</td>
<td>1</td>
<td>NSIN-0900-6</td>
<td>783</td>
<td>7</td>
</tr>
<tr>
<td>0950A-7</td>
<td>1</td>
<td>NSIN-1380-6</td>
<td>1201</td>
<td>9</td>
</tr>
<tr>
<td>1130A-7</td>
<td>1</td>
<td>NSIN-1380-6</td>
<td>1201</td>
<td>9</td>
</tr>
</tbody>
</table>

Terminal and lead-through data for the power cables

The locations and sizes of lead-throughs are shown by the dimension drawings delivered with the drive, and the dimension drawing examples starting on page 207.

The location and size of power cable terminals are shown in the drawings starting on page 223.

Terminal data for the supply and inverter control units

See chapter Control units of the drive (page 131).
Electrical power network specification

Voltage ($U_1$)

- ACS880-37-xxxxx-3: 380…415 V AC 3-phase ± 10%. This is indicated in the type designation label as typical input voltage level (3~ 400 V AC).
- ACS880-37-xxxxx-5: 380…500 V AC 3-phase ± 10%. This is indicated in the type designation label as typical input voltage levels (3~ 400/480/500 V AC).
- ACS880-37-xxxxx-7: *525…690 V AC 3-phase ± 10%. This is indicated in the type designation label as typical input voltage levels (3~ 525/600/690 V AC).

*525…600 V AC in corner-grounded TN systems

Network type

- TN (grounded) and IT (ungrounded) systems

Frequency

- 50/60 Hz, variation ± 5% of nominal frequency

Imbalance

- Max. ± 3% of nominal phase-to-phase voltage

Short-circuit withstand strength (IEC 61439-1)

- Type gG according to IEC 60269
- Maximum allowed operating time is <0.1 s for fuses mentioned above.

Frame 1×R8i + 1×R8i:

- Maximum allowable prospective short-circuit current ($I_{cc}$): 65 kA. The input cable must be equipped with fuses as follows:
  - maximum 1250 A gG*
  - *) Type gG according to IEC 60269
- Maximum allowed operating time is <0.1 s for fuses mentioned above.

Frame 2×R8i + 2×R8i and above:

- Rated peak withstand current ($I_{pk}$): 105 kA (143 kA for units with air circuit breaker and no grounding/earthing switch)
- Rated short-time withstand current ($I_{cw}$): 50 kA/1 s (65 kA/1 s for units with air circuit breaker and no grounding/earthing switch)

Short-circuit current protection (UL 508A, CSA C22.2 No. 14-13)

- The drive is suitable for use on a circuit capable of delivering not more than 100,000 rms symmetrical amperes at 600 V maximum when the input cable is protected with class T fuses.

Power factor

- cosphi₁ = 1, cosphi (total) = 0.99

Harmonic distortion

- Harmonics are below the limits defined in IEEE519.

<table>
<thead>
<tr>
<th>$R_{sc}$</th>
<th>THD Voltage [%]</th>
<th>THD Current [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>3</td>
<td>2.5*</td>
</tr>
<tr>
<td>100</td>
<td>0.8</td>
<td>2.5*</td>
</tr>
</tbody>
</table>

\[ \sqrt{\sum_{n=2}^{N} \left( \frac{I_n}{I_N} \right)^2} \]

$R_{sc}$ = short-circuit ratio
$I_{nc}$ = short-circuit current at point of common coupling (PCC)
$I_N$ = IGBT supply unit nominal current

$*\text{Other loads may influence the THD value.}$

Motor connection data

Motor types

- Asynchronous AC induction motors, permanent magnet synchronous motors, AC induction servomotors, ABB synchronous reluctance (SynRM) motors

Voltage ($U_2$)

- 0 to $U_1$, 3-phase symmetrical, $U_{max}$ at the field weakening point
Frequency

0…±598 Hz (0…±120 Hz with sine output filters [option +E206])
- For higher operational output frequencies, please contact your local ABB representative.
- Operation above 150 Hz may require type-specific derating. For more information, contact your local ABB representative.

Current

See section Ratings.

Switching frequency

3 kHz (typical). The switching frequency can vary per frame and voltage. For exact values, please contact your local ABB representative.

Maximum recommended motor cable length

500 m (1640 ft).

**Note:** With motor cables longer than 150 m (492 ft) the EMC Directive requirements may not be fulfilled.

Control unit connection data

See chapter Control units of the drive (page 131).

Efficiency

97.2 … 98.0% at nominal power level depending on drive type

Protection classes

**Degrees of protection (IEC/EN 60529)**
IP22 (standard), IP42 (option +B054), IP54 (option +B055)

**Enclosure types (UL50)**
UL Type 1 (standard), UL Type 1 (option +B054), UL Type 12 (option +B055). For indoor use only.

**Overvoltage category (IEC/EN 60664-1)**
III

**Protective class (IEC/EN 61800-5-1)**
I

Ambient conditions

Environmental limits for the drive system are given below. The drive is to be used in a heated, indoor, controlled environment.

<table>
<thead>
<tr>
<th></th>
<th>Operation installed for stationary use</th>
<th>Storage in the protective package</th>
<th>Transportation in the protective package</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Installation site altitude</strong></td>
<td>0…2000 m (0…6562 ft) above sea level. For altitudes over 2000 m, contact ABB. Output derated above 1000 m (3281 ft). See section Derating.</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Air temperature</strong></td>
<td>0 … +40 °C (+32 … +104 °F). No condensation allowed. Output derated in the range +40 … +50 °C (+104 … +122 °F). See section Derating.</td>
<td>-40 to +70 °C (-40 to +158 °F)</td>
<td>-40 to +70 °C (-40 to +158 °F)</td>
</tr>
<tr>
<td><strong>Relative humidity</strong></td>
<td>Max. 95%</td>
<td>Max. 95%</td>
<td>Max. 95%</td>
</tr>
</tbody>
</table>

No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.
## Contamination

<table>
<thead>
<tr>
<th>Chemical gases</th>
<th>Solid particles</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC/EN 60721-3-3:2002: Classification of environmental conditions - Part 3-3: Classification of groups of environmental parameters and their severities - Stationary use of weather protected locations</td>
<td>IEC 60721-3-1:1997 IEC 60721-3-2:1997</td>
</tr>
<tr>
<td>Class 3C2</td>
<td>Class 1C2</td>
</tr>
<tr>
<td>Class 3S2. No conductive dust allowed.</td>
<td>Class 1S3 (packing must support this, otherwise 1S2)</td>
</tr>
<tr>
<td>Class 2S2</td>
<td>Class 2C2</td>
</tr>
</tbody>
</table>

## Vibration

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC 60721-3-1:1997</td>
<td>IEC/EN 60721-3-2:1997 10…57 Hz: max. 0.075 mm amplitude 57…150 Hz: 1 g 57…150 Hz: 1 g 10…57 Hz: max. 0.075 mm amplitude 57…150 Hz: 1 g 10…57 Hz: max. 0.075 mm amplitude 57…150 Hz: 1 g 57…150 Hz: 1 g</td>
</tr>
<tr>
<td>2…3 Hz: max. 3.5 mm amplitude 9…200 Hz: 10 m/s² (32.8 ft/s²)</td>
<td>2…9 Hz: max. 3.5 mm amplitude 9…200 Hz: 10 m/s² (32.8 ft/s²)</td>
</tr>
</tbody>
</table>

## Shock

<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IEC/EN 60721-3-1:1997 2…9 Hz: max. 3.5 mm amplitude 9…200 Hz: 10 m/s² (32.8 ft/s²)</td>
</tr>
<tr>
<td>100 m/s² (330 ft/s²) 11 ms</td>
</tr>
</tbody>
</table>

## Materials

### Cabinet

- Hot-dip zinc coated 1.5 mm thick steel sheet (thickness of coating approximately 20 micrometers). Polyester thermosetting powder coating (thickness approximately 80 micrometers) on visible surfaces, color RAL 7035 and RAL 9017.

### Busbars

- Tin-plated copper

### Fire safety of materials (IEC 60332-1)

- Insulating materials and non-metallic items mostly self-extinctive
Package

Standard package:
• timber, polyethylene sheet (thickness 0.15 mm), stretch film (thickness 0.023 mm), PP tape, PET strap, sheet metal (steel)
• for land and air transport when planned storage time is less than 2 months or when storage can be arranged in clean and dry conditions less than 6 months
• can be used when products will not be exposed to corrosive atmosphere during transport or storage

Container package:
• timber, VCI sheet film (PE, thickness 0.10 mm), VCI stretch film (PE, thickness 0.04 mm), VCI emitter bags, PP tape, PET strap, sheet metal (steel)
• for sea transport in containers
• recommended for land and air transport when storage time prior to installation exceeds 6 months or storage is arranged in partially weather-protected conditions

Seaworthy package:
• timber, plywood, VCI sheet film (PE, thickness 0.10 mm), VCI stretch film (PE, thickness 0.04 mm), VCI emitter bags, PP tape, PET strap, sheet metal (steel)
• for sea transport with or without containerization
• for long storage periods in environments where roofed and humidity-controlled storage cannot be arranged

Cabinets are fastened to the pallet with screws and braced from the top end to the package walls to prevent swaying inside the package. Package elements are attached to each other with screws. For handling the packages, see section Moving and unpacking the drive on page 61.

Disposal

The main parts of the drive can be recycled to preserve natural resources and energy. Product parts and materials should be dismantled and separated.

Generally all metals, such as steel, aluminum, copper and its alloys, and precious metals can be recycled as material. Plastics, rubber, cardboard and other packaging material can be used in energy recovery. Printed circuit boards and DC capacitors (C1-1 to C1-x) need selective treatment according to IEC 62635 guidelines. To aid recycling, plastic parts are marked with an appropriate identification code.

Contact your local ABB distributor for further information on environmental aspects and recycling instructions for professional recyclers. End of life treatment must follow international and local regulations.
Applicable standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Information</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>European electrical safety requirements product standards</strong></td>
<td></td>
</tr>
<tr>
<td>IEC/EN 61800-5-1:2007</td>
<td>Adjustable speed electrical power drive systems. Part 5-1: Safety requirements – electrical, thermal and energy</td>
</tr>
<tr>
<td>IEC 60146-1-1:2009 EN 60146-1-1:2010</td>
<td>Semiconductor converters – General requirements and line commutated converters – Part 1-1: Specification of basic requirements</td>
</tr>
<tr>
<td>IEC/EN 60664-1:2007</td>
<td>Insulation coordination for equipment within low-voltage systems. Part 1: Principles, requirements and tests</td>
</tr>
<tr>
<td>IEC/EN 61439-1:2009</td>
<td>Low-voltage switchgear and controlgear assemblies -- Part 1: General rules</td>
</tr>
<tr>
<td><strong>EMC performance</strong></td>
<td></td>
</tr>
<tr>
<td>IEC/EN 61800-3:2004</td>
<td>Adjustable speed electrical power drive systems. Part 3: EMC requirements and specific test methods</td>
</tr>
<tr>
<td><strong>Product requirements in North America</strong></td>
<td></td>
</tr>
<tr>
<td>UL 50 12th edition:2007</td>
<td>Enclosures for Electrical Equipment, Non-Environmental Considerations</td>
</tr>
<tr>
<td>CSA C22.2 No. 14-13:2013</td>
<td>Industrial control equipment</td>
</tr>
<tr>
<td>CSA C22.2 No. 274-13:2013</td>
<td>Adjustable speed drives</td>
</tr>
</tbody>
</table>

**CE marking**

A CE mark is attached to the drive to verify that the drive complies with the provisions of the European Low Voltage and EMC Directives. The CE marking also verifies that the drive, in regard to its safety functions (such as Safe torque off), conforms with the Machinery Directive as a safety component.

- **Compliance with the European Low Voltage Directive**
  The compliance with the European Low Voltage Directive has been verified according to standard EN 61800-5-1.

- **Compliance with the European EMC Directive**
  The EMC Directive defines the requirements for immunity and emissions of electrical equipment used within the European Union. The EMC product standard (EN 61800-3:2004) covers requirements stated for drives. See section Compliance with EN 61800-3:2004 below.

- **Compliance with the European Machinery Directive**
  The drive is an electronic product which is covered by the European Low Voltage Directive. However, the drive includes the Safe torque off function and can be equipped with other safety functions for machinery which, as safety components, are in the scope of
the Machinery Directive. These functions of the drive comply with European harmonized standards such as EN 61800-5-2. The related declarations of conformity are shown below.

Declaration of Conformity

EU Declaration of Conformity
Machinery Directive 2006/42/EC

We

Manufacturer: ABB Oy
Address: Hiomotie 13, 00380 Helsinki, Finland.
Phone: +358 10 22 11

declare under our sole responsibility that the following products:

**Frequency converters and frequency converter components**

- ACS880-04, -14, -34 (frames nxR8i)
- ACS880-04XT
- ACS880-07
- ACS880-17, -37 (frames nxR8i)
- ACS880-104, -107
- ACS880 multidrives

identified with serial numbers beginning with 1 or 8

with regard to the safety functions

**Safe torque off**

**Safe motor temperature** with FPTC-01 module (option code +L536)

**Safe stop 1, Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Prevention of unexpected start-up,** with FSO-12 module (option code +Q973)

**Safe stop 1, Safe stop emergency, Safely-limited speed, Safe maximum speed, Safe brake control, Safe Speed monitor, Safe direction, Prevention of unexpected start-up,** with FSO-21 and FSE-31 modules (option codes +Q972 and +L521)

**ACS880-07, -17, -37 and ACS880 multidrives: Prevention of unexpected start-up** (option codes +Q950; +Q957), **Emergency stop** (option codes +Q951; +Q952; +Q953; +Q954; +Q976; +Q978), **Safely-limited speed** (option codes +Q965; +Q966)

are in conformity with all the relevant safety component requirements of EU Machinery Directive 2006/42/EC, when the listed safety functions are used for safety component functionality.
The following harmonized standards have been applied:

<table>
<thead>
<tr>
<th>Standard Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 61800-5-2:2007</td>
<td>Adjustable speed electrical power drive systems – Part 5-2: Safety</td>
</tr>
<tr>
<td></td>
<td>requirements – Functional</td>
</tr>
<tr>
<td></td>
<td>electronic and programmable electronic control systems</td>
</tr>
<tr>
<td>EN ISO 13849-1:2015</td>
<td>Safety of machinery – Safety-related parts of control systems. Part 1:</td>
</tr>
<tr>
<td></td>
<td>General principles for design</td>
</tr>
<tr>
<td>EN ISO 13849-2:2012</td>
<td>Safety of machinery – Safety-related parts of the control systems. Part 2:</td>
</tr>
<tr>
<td></td>
<td>Validation</td>
</tr>
<tr>
<td></td>
<td>requirements</td>
</tr>
</tbody>
</table>

The following other standards have been applied:

<table>
<thead>
<tr>
<th>Standard Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>safety-related systems</td>
</tr>
</tbody>
</table>

The products referred in this Declaration of conformity fulfill the relevant provisions of other European Union Directives which are notified in Single EU Declaration of conformity 3AXD10000497305.

Person authorized to compile the technical file:
Name and address: Vesa Tihonen, Hiomotie 13, 00380 Helsinki, Finland.

Helsinki, 28 Jun 2016

Manufacturer representative:

Peter Lindgren
Vice President, ABB Oy
Compliance with EN 61800-3:2004

### Definitions

EMC stands for **Electromagnetic Compatibility**. It is the ability of electrical/electronic equipment to operate without problems within an electromagnetic environment. Likewise, the equipment must not disturb or interfere with any other product or system within its locality.

*First environment* includes establishments connected to a low-voltage network which supplies buildings used for domestic purposes.

*Second environment* includes establishments connected to a network not supplying domestic premises.

*Drive of category C2:* drive of rated voltage less than 1000 V and intended to be installed and started up only by a professional when used in the first environment. **Note:** A professional is a person or organization having necessary skills in installing and/or starting up power drive systems, including their EMC aspects.

*Drive of category C3:* drive of rated voltage less than 1000 V and intended for use in the second environment and not intended for use in the first environment.

*Drive of category C4:* drive of rated voltage equal to or above 1000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment.

### Category C2

The drive complies with the standard with the following provisions:

1. The drive is equipped with EMC filter (option +E202).
2. The motor and control cables are selected as specified in the hardware manual.
3. The drive is installed according to the instructions given in the hardware manual.
4. Maximum motor cable length is 100 meters (328 ft).

**WARNING!** The drive may cause radio interference if used in a residential or domestic environment. The user is required to take measures to prevent interference, in addition to the requirements for CE compliance listed above, if necessary.

**Note:** Do not install a drive equipped with EMC filter +E202 on IT (ungrounded) systems. The supply network becomes connected to ground potential through the EMC filter capacitors which may cause danger or damage the unit.

### Category C3

The drive complies with the standard with the following provisions:

1. The motor and control cables are selected as specified in the hardware manual.
2. The drive is installed according to the instructions given in the hardware manual.
3. Maximum motor cable length is 100 meters (328 ft).

**WARNING!** A drive of category C3 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.
Category C4

If the provisions under Category C3 cannot be met, the requirements of the standard can be met as follows:

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

2. An EMC plan for preventing disturbances is drawn up for the installation. A template is available from the local ABB representative.

3. The motor and control cables are selected as specified in the hardware manual.

4. The drive is installed according to the instructions given in the hardware manual.

**WARNING!** A drive of category C4 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

**UL and CSA markings**

The drive is C-UL-US Listed (with option +C129) and CSA certified (with option +C134). The approvals are valid with rated voltages up to 600 V. The appropriate marking is attached to the drive when either option is selected.

**UL and CSA checklist**

- Use the drive in a heated, indoor controlled environment.
- Install the drive in clean air according to enclosure classification. The cooling air must be clean, and free from corrosive materials and electrically conductive dust.
- The maximum ambient air temperature is 40 °C (104 °F) at rated current. The current is derated for 40 to 50 °C (104 to 122 °F).
- The drive is suitable for use in a circuit capable of delivering not more than 100,000 rms symmetrical amperes, 600 V maximum when the input cable is protected with UL classified fuses given. The ampere rating is based on tests done according to UL 508A.
- The cables located within the motor circuit must be rated for at least 75 °C in UL-compliant installations.
• Protect the input cable with fuses. Suitable IEC (class aR) fuses and UL fuses are listed starting on page 184. Circuit breakers must not be used without fuses in the USA. For suitable circuit breakers, contact your local ABB representative.

• For installation in the United States, provide branch circuit protection in accordance with the National Electrical Code (NEC) and any applicable local codes. To fulfill this requirement, the drive must have option +C129.

• For installation in Canada, provide branch circuit protection in accordance with the Canadian Electrical Code and any applicable provincial codes. To fulfill this requirement, the drive must have option +C129 or +C134.

• The drive provides overload protection in accordance with the National Electrical Code (NEC).

⚠️ RCM marking

RCM marking is required in Australia and New Zealand. An RMC mark is attached to each drive in order to verify compliance with the relevant standard (IEC 61800-3:2004), mandated by the Trans-Tasman Electromagnetic Compatibility Scheme.

For fulfilling the requirements of the standard, see section Compliance with EN 61800-3:2004.

EAC (Eurasian Conformity) marking

The drive has EAC certification. EAC marking is required in Russia, Belarus and Kazakhstan.

Tightening torques

Unless a tightening torque is specified in the text, the following torques can be used.

**Electrical connections**

<table>
<thead>
<tr>
<th>Size</th>
<th>Torque</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>M3</td>
<td>0.5 N·m (4.4 lbf·in)</td>
<td>Strength class 4.6...8.8</td>
</tr>
<tr>
<td>M4</td>
<td>1 N·m (9 lbf·in)</td>
<td>Strength class 4.6...8.8</td>
</tr>
<tr>
<td>M5</td>
<td>4 N·m (35 lbf·in)</td>
<td>Strength class 8.8</td>
</tr>
<tr>
<td>M6</td>
<td>9 N·m (6.6 lbf·ft)</td>
<td>Strength class 8.8</td>
</tr>
<tr>
<td>M8</td>
<td>22 N·m (16 lbf·ft)</td>
<td>Strength class 8.8</td>
</tr>
<tr>
<td>M10</td>
<td>42 N·m (31 lbf·ft)</td>
<td>Strength class 8.8</td>
</tr>
<tr>
<td>M12</td>
<td>70 N·m (52 lbf·ft)</td>
<td>Strength class 8.8</td>
</tr>
<tr>
<td>M16</td>
<td>120 N·m (90 lbf·ft)</td>
<td>Strength class 8.8</td>
</tr>
</tbody>
</table>

**Mechanical connections**

<table>
<thead>
<tr>
<th>Size</th>
<th>Max. torque</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>M5</td>
<td>6 N·m (53 lbf·in)</td>
<td>Strength class 8.8</td>
</tr>
<tr>
<td>M6</td>
<td>10 N·m (7.4 lbf·ft)</td>
<td>Strength class 8.8</td>
</tr>
<tr>
<td>M8</td>
<td>24 N·m (17.7 lbf·ft)</td>
<td>Strength class 8.8</td>
</tr>
</tbody>
</table>
**Insulation supports**

<table>
<thead>
<tr>
<th>Size</th>
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<th>Note</th>
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<tr>
<td>M12</td>
<td>31 N·m (23 lbf·ft)</td>
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**Cable lugs**

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<td>32 N·m (23.5 lbf·ft)</td>
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</tr>
<tr>
<td>M12</td>
<td>50 N·m (37 lbf·ft)</td>
<td>Strength class 8.8</td>
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</table>

**Disclaimers**

**Generic disclaimer**
The manufacturer shall have no obligation with respect to any product which (i) has been improperly repaired or altered; (ii) has been subjected to misuse, negligence or accident; (iii) has been used in a manner contrary to the manufacturer’s instructions; or (iv) has failed as a result of ordinary wear and tear.

**Cybersecurity disclaimer**
This product is designed to be connected to and to communicate information and data via a network interface. It is Customer's sole responsibility to provide and continuously ensure a secure connection between the product and Customer network or any other network (as the case may be). Customer shall establish and maintain any appropriate measures (such as but not limited to the installation of firewalls, application of authentication measures, encryption of data, installation of anti-virus programs, etc) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB and its affiliates are not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.
Dimensions

What this chapter contains

This chapter contains the following dimension data:

• Composition of cabinet line-ups in tabular form for each frame size with options (page 202)
• Approximate weights of basic line-ups (page 206)
• Dimension drawing examples of selected line-ups (page 207)
• Dimensions of empty cubicles (options +C199, +C200, +C201) (page 221)
• Location and size of input terminals (page 223)
• Location and size of output terminals for drives without common motor terminal cubicle (page 227)
• Location and size of output terminals for drives with common motor terminal cubicle (+H359) (page 231).
Cabinet line-up dimensions

The drive consists of cubicles built into a cabinet line-up. The tables below show the composition of cabinet line-ups for each frame size and the standard combinations of options. The dimensions are in millimeters (for inches, divide by 25.4).

Notes:

- The side panels at the left and right ends of the line-up increase the total line-up width by 30 millimeters (1.2”).
- The standard depth of the cabinet line-up is 644 mm (25.35”) excluding equipment such as handles and air inlet gratings. This is increased by 200 mm (7.87”) with top cable exit units, or by 130 mm with option +C128 (cooling air intake through bottom of cabinet).
- UL Listed (+C129) units are top entry/exit by default.
- Not all possible configurations are presented. For information on unlisted configurations, contact ABB.
- The data given is preliminary. ABB reserves the right to modify the design at any time without notice. Consult ABB for up-to-date, drive-specific information.

The tables are followed by selected dimension drawing examples.

### Dimension tables

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<th>1×R8i + 1×R8i</th>
<th>Auxiliary control (ACU)</th>
<th>Supply and inverter module cubicle</th>
<th>Common motor terminal cubicle</th>
<th>*Sine filter cubicle</th>
<th>Joining cubicle</th>
<th><strong>Brake chopper 1</strong></th>
<th><strong>Brake resistor 1</strong></th>
<th><strong>Brake chopper 2</strong></th>
<th><strong>Brake resistor 2</strong></th>
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*400 mm with ACS880-37-0450A-3, -0420-5, -0320A-7 and -0390A-7, 1000 mm with other types.
**The number of brake choppers depends on required braking power. See chapter [Resistor braking](#).
| Auxiliary control cubicle (ACU) | Supply module cubicle | Inverter module cubicle | Joining cubicle | Common motor terminal cubicle | Sine filter cubicle | Joining cubicle | Brake chopper 1 | Brake resistor 1 | Brake chopper 2 | Brake resistor 2 | Brake chopper 3 | Brake resistor 3 | Shipping split widths | Line-up width |
|---------------------------------|-----------------------|-------------------------|-----------------|-------------------------------|-------------------|-----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------------|-----------|
| 400 400 800 600                 |                       |                         |                 |                               |                   |                 | 1000           | 400            | 400            | 400            | 400            | 400            | 400                 | 400       |
| 400 400 800 600                 |                       |                         |                 |                               |                   |                 | 300            | 400            | 400            | 400            | 400            | 400            | 400                 | 400       |
| 400 400 800 600                 |                       |                         |                 |                               |                   |                 | 1000           | 400            | 400            | 400            | 400            | 400            | 400                 | 400       |
| 400 400 800 600 200             |                       |                         |                 |                               |                   |                 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 2400 + 2400 4800 |
| 400 400 800 600                 |                       |                         |                 |                               |                   |                 | 300            | 400            | 400            | 400            | 400            | 400            | 400                 | 400       |
| 400 400 800 600                 |                       |                         |                 |                               |                   |                 | 1000 200 400 800 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 3400 + 3400 5800 |
| 400 400 800 600                 |                       |                         |                 |                               |                   |                 | 300            | 400            | 400            | 400            | 400            | 400            | 400                 | 1200      |
| 400 400 800 600                 |                       |                         |                 |                               |                   |                 | 300            | 400            | 400            | 400            | 400            | 400            | 400                 | 1200      |
| 400 400 800 600 200             |                       |                         |                 |                               |                   |                 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 | 400 800 400 800 3400 + 3400 7000 |

*The number of brake choppers depends on required braking power. See chapter [Resistor braking](#).
### Dimensions

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**The number of brake choppers depends on required braking power. See chapter Resistor braking.

### 3×R8i + 3×R8i

| **Auxiliary control cubicle (ACU)** | **Incoming cubicle (ICU)** | **Adapter for top entry** | **Supply (LCL filter) cubicle** | **Supply module cubicle** | **Inverter module cubicle** | **Common motor terminal cubicle** | **Shipping split widths** | **Line-up width** |
|-----------------------------------------------|
| 400 600 600 800 800 1000 400 400 1000 | 3200 3200 | 3500 3500 | 3600 3600 | 3400 3400 | 3700 3700 | 3800 3800 | 300 mm double-busbar version with ACS880-37-1450A-7 and -1680A-7. 600 mm with ACS880-37-2530A-3+H353 (top exit). 400 mm with other types |
### 4×R8i + 4×R8i

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<th>Auxiliary control cubicle (ACU)</th>
<th>Incoming cubicle (ICU)</th>
<th>Adapter for top entry</th>
<th>Supply module cubicle 1</th>
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<th>Inverter module cubicle 1</th>
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</table>

*1000 mm with UL Listed (+C129) and CSA Approved (+C134) units, otherwise 600 mm.

### 6×R8i + 5×R8i

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<th>Auxiliary control cubicle (ACU)</th>
<th><em>Incoming-cubicle (ICU)</em></th>
<th>Adapter for top entry</th>
<th>Supply module cubicle 1</th>
<th>Supply module cubicle 2</th>
<th>Supply module cubicle 3</th>
<th>Joining cubicle</th>
<th>Inverter module cubicle 1</th>
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*1000 mm with UL Listed (+C129) and CSA Approved (+C134) units, otherwise 600 mm.

### 6×R8i + 6×R8i

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*1000 mm with UL Listed (+C129) and CSA Approved (+C134) units, otherwise 600 mm.
The table below lists the approximate basic weights of the drive types.

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<tr>
<td>1700A-3</td>
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</tr>
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<td>2090</td>
</tr>
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</tr>
<tr>
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</tr>
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<tr>
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</tr>
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</tr>
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<td>6020</td>
</tr>
<tr>
<td>1950A-7</td>
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<td>2230A-7</td>
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<tr>
<td>2230A-7</td>
<td>2930</td>
</tr>
<tr>
<td>3700</td>
<td>8160</td>
</tr>
<tr>
<td>3700</td>
<td>8160</td>
</tr>
<tr>
<td>2770A-7</td>
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</tr>
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<td>3310A-7</td>
<td></td>
</tr>
<tr>
<td>2770A-7</td>
<td>4830</td>
</tr>
<tr>
<td>3310A-7</td>
<td>4830</td>
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<tr>
<td>4980</td>
<td>10980</td>
</tr>
<tr>
<td>4980</td>
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</tr>
</tbody>
</table>
Dimension drawing examples

Frame 1×R8i + 1×R8i
Frame 1×R8i + 1×R8i, top cable entry/exit (+H351+H353)
Frame 1×R8i + 1×R8i with brake choppers and resistors (+D150+D151)
210  Dimensions

Frame 1×R8i + 1×R8i with sine output filter (+E206)
Frame 2×R8i + 2×R8i (eg. ACS880-37-1110A-3), IP22
Frame 2×R8i + 2×R8i (eg. ACS880-37-1210A-3), IP54
Frame 2×R8i + 2×R8i with main breaker (+F255) and common motor terminal cubicle (+H359), 1/2
Frame 2×R8i + 2×R8i with main breaker (+F255) and common motor terminal cubicle (+H359), 2/2
Frame 2×R8i + 2×R8i with main breaker (+F255) and top entry/top exit (+H351+H353), 1/2
Frame 2×R8i + 2×R8i with main breaker (+F255) and top entry/top exit (+H351+H353), 2/2
Frame 3×R8i + 3×R8i, 1/2
Frame 3×R8i + 3×R8i, 2/2
Frame 3×R8i + 3×R8i with common motor terminal cubicle (+H359), 1/2
Frame 3×R8i + 3×R8i with common motor terminal cubicle (+H359), 2/2
Dimensions of empty cubicles (options +C199, +C200, +C201)

IP22/IP42

Dimensions:

- 400 mm
- 600 mm
- 800 mm

- Dimensions of empty cubicles (options +C199, +C200, +C201)
- IP22/IP42

- Dimensions:
  - 400 mm
  - 600 mm
  - 800 mm

- Diagram showing dimensions A-A, B-B, C-C.
Location and size of input terminals

- Frame 1×R8i + 1×R8i, bottom cable entry

- Frame 1×R8i + 1×R8i, top cable entry
- Frame 2×R8i + 2×R8i with main switch/disconnector (400 mm), bottom cable entry

- Frame 2×R8i + 2×R8i with main switch/disconnector (400 mm), top cable entry
- Frame 2×R8i + 2×R8i with main switch/disconnector (600 mm), bottom cable entry

- Frame 2×R8i + 2×R8i with main switch/disconnector (600 mm), top cable entry
- Units with main breaker (600 mm), bottom cable entry

- Units with main breaker (600 mm), top cable entry
Location and size of output terminals (units without common motor terminal cubicle)

- Frame 1×R8i + 1×R8i (without sine output filter)
  See page 223.

- Inverter module cubicle with two R8i modules, bottom cable exit
- **Inverter module cubicle with two R8i modules, top cable exit**

- **Inverter module cubicle with three R8i modules, bottom cable exit**
- Inverter module cubicle with three R8i modules, top cable exit

- Sine filter (+E206) cubicle, 1000 mm, bottom cable exit
Sine filter (+E206) cubicle, 1000 mm, top cable exit
Location and size of output terminals (units with common motor terminal cubicle)

Note: See the dimension tables starting on page 202 as to which common motor terminal cubicle width is used with which drive type.

- Cubicle width 300 mm, bottom cable exit
- Cubicle width 300 mm (double-busbar version), bottom cable exit

- Cubicle width 300 mm, top cable exit
- Cubicle width 300 mm (double-busbar version), top cable exit

- Cubicle width 400 mm, bottom cable exit
Dimensions

- Cubicle width 400 mm, top cable exit

- Cubicle width 600 mm, bottom cable exit
■ Cubicle width 600 mm, top cable exit
The Safe torque off function

Contents of this chapter

This chapter describes the Safe torque off (STO) function of the inverter (ie. the inverter unit of the drive) and gives instructions for its use.

Description

The Safe torque off function can be used, for example, to construct safety or supervision circuits that stop the inverter in case of danger (such as an emergency stop circuit). Another possible application is a prevention of unexpected start-up switch that enables short-time maintenance operations like cleaning or work on non-electrical parts of the machinery without switching off the power supply to the inverter.

When activated, the Safe torque off function disables the control voltage of the power semiconductors of the inverter output stage (A, see diagram below), thus preventing the inverter from generating the torque required to rotate the motor. If the motor is running when Safe torque off is activated, it coasts to a stop.

The Safe torque off function has a redundant architecture, that is, both channels must be used in the safety function implementation. The safety data given in this manual is calculated for redundant use, and does not apply if both channels are not used.

The Safe torque off function of the inverter complies with these standards:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN 60204-1:2016</td>
<td>Safety of machinery – Electrical equipment of machines – Part 1: General requirements</td>
</tr>
<tr>
<td>IEC 61326-3-1:2008</td>
<td>Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications</td>
</tr>
</tbody>
</table>
The function also corresponds to Prevention of unexpected start-up as specified by EN 1037:1995 + A1:2008 and Uncontrolled stop (stop category 0) as specified in EN/IEC 60204-1.

### Compliance with the European Machinery Directive

See page 193.
Wiring

The following diagrams present examples of Safe torque off wiring for
• a frame n×R8i inverter unit (page 240)
• multiple inverter units (page 241)
• multiple inverter units when an external 24 V DC power supply is used (page 242).

For information on the specifications of the STO input, see chapter Control units of the drive (page 131).

Activation switch

In the wiring diagrams below, the activation switch has the designation [K]. This represents a component such as a manually operated switch, an emergency stop push button switch, or the contacts of a safety relay or safety PLC.

• In case a manually operated activation switch is used, the switch must be of a type that can be locked out to the open position.
• The contacts of the switch or relay must open/close within 200 ms of each other.
• An FSO-xx safety functions module or an FPTC-0x thermistor protection module can also be used. For more information, see the module documentation.

Cable types and lengths

• Double-shielded twisted-pair cable is recommended.
• Maximum cable lengths:
  • 300 m (1000 ft) between activation switch [K] and inverter control unit
  • 60 m (200 ft) between multiple inverter units
  • 60 m (200 ft) between external power supply and first inverter unit
  • With frame n×R8i inverter units: 30 m (100 ft) between BCU control unit and last inverter module in the chain.

Note: The voltage at the INx terminals of each inverter control unit (or frame R8i inverter module) must be at least 17 V DC to be interpreted as “1”.

Grounding of protective shields

• Ground the shield in the cabling between the activation switch and the control unit at the control unit.
• Ground the shield in the cabling between two control units at one control unit only.
• Do not ground the shield in the cabling between BCU and R8i module, or between R8i modules.
Frame n×R8i inverter unit (internal power supply)

**WARNING!** Frame R8i inverter modules are as standard delivered with a jumper wire set that supplies 24 V from connector X53 to connector X52. The jumper wire set must be removed before wiring the Safe torque off circuit.
Multiple inverter units (internal power supply)
Multiple inverter units (external power supply)
Operation principle

1. The Safe torque off activates (the activation switch is opened, or safety relay contacts open).
2. The STO inputs on the inverter control unit de-energize.
3. The control unit cuts off the control voltage from the inverter IGBTs.
4. The control program generates an indication as defined by parameter 31.22 (refer to the firmware manual of the inverter).
5. Motor coasts to a stop (if running). The inverter cannot restart while the activation switch or safety relay contacts are open. After the contacts close, a new start command is required to start the drive.

Start-up including acceptance test

To ensure the safe operation of a safety function, validation is required. The final assembler of the machine must validate the function by performing an acceptance test. The acceptance test must be performed
• at initial start-up of the safety function
• after any changes related to the safety function (circuit boards, wiring, components, settings, etc.)
• after any maintenance work related to the safety function.

Competence

The acceptance test of the safety function must be carried out by a competent person with adequate expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6. The test procedures and report must be documented and signed by this person.

Acceptance test reports

Signed acceptance test reports must be stored in the logbook of the machine. The report shall include documentation of start-up activities and test results, references to failure reports and resolution of failures. Any new acceptance tests performed due to changes or maintenance shall be logged into the logbook.
Acceptance test procedure

After wiring the Safe torque off function, validate its operation as follows.

Notes:
• If the drive is equipped with safety option +Q950, +Q951, +Q952, +Q957, +Q963, +Q964, +Q978 or +Q979, do the procedure shown in the documentation of the option. If the drive is equipped with safety option +Q972 or Q973, do the procedure shown in the FSO module documentation.
• All inverter modules must be powered and connected to the STO circuit during the acceptance test.

<table>
<thead>
<tr>
<th>Action</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WARNING!</strong> Follow the safety instructions given in chapter Safety instructions (page 15). Ignoring the instructions can cause physical injury or death, or damage to the equipment.</td>
<td>☑</td>
</tr>
<tr>
<td>Ensure that the inverter can be run and stopped freely during start-up.</td>
<td>☐</td>
</tr>
<tr>
<td>Stop the inverter (if running), switch the input power off and isolate the inverter from the power line by a disconnector.</td>
<td>☐</td>
</tr>
<tr>
<td>Check the Safe torque off circuit connections against the wiring diagram.</td>
<td>☐</td>
</tr>
<tr>
<td>Close the disconnector and switch the power on.</td>
<td>☐</td>
</tr>
<tr>
<td>Test the operation of the STO function when the motor is stopped.</td>
<td>☐</td>
</tr>
<tr>
<td>• Give a stop command for the inverter (if running) and wait until the motor shaft is at a standstill. Ensure that the inverter operates as follows:</td>
<td></td>
</tr>
<tr>
<td>• Open the STO circuit. The inverter generates an indication if one is defined for ‘stopped’ state in parameter 31.22 (see the firmware manual).</td>
<td></td>
</tr>
<tr>
<td>• Give a start command to verify that the STO function blocks the inverter’s operation. The motor should not start.</td>
<td></td>
</tr>
<tr>
<td>• Close the STO circuit.</td>
<td></td>
</tr>
<tr>
<td>• Reset any active faults. Restart the inverter and check that the motor runs normally.</td>
<td></td>
</tr>
<tr>
<td>Test the operation of the STO function when the motor is running.</td>
<td>☐</td>
</tr>
<tr>
<td>• Start the inverter and ensure the motor is running.</td>
<td></td>
</tr>
<tr>
<td>• Open the STO circuit. The motor should stop. The inverter generates an indication if one is defined for ‘running’ state in parameter 31.22 (see the firmware manual).</td>
<td></td>
</tr>
<tr>
<td>• Reset any active faults and try to start the inverter.</td>
<td></td>
</tr>
<tr>
<td>• Ensure that the motor stays at a standstill and the inverter operates as described above in testing the operation when the motor is stopped.</td>
<td></td>
</tr>
<tr>
<td>• Close the STO circuit.</td>
<td></td>
</tr>
<tr>
<td>• Reset any active faults. Restart the inverter and check that the motor runs normally.</td>
<td></td>
</tr>
</tbody>
</table>
**Use**

1. Open the activation switch, or activate the safety functionality that is wired to the STO connection.

2. STO inputs on the inverter control unit de-energize, and the inverter control unit cuts off the control voltage from the inverter IGBTs.

3. The control program generates an indication as defined by parameter 31.22 (refer to the firmware manual of the inverter).

4. The motor coasts to a stop (if running). The drive will not restart while the activation switch or safety relay contacts are open.

5. Deactivate the STO by closing the activation switch, or resetting the safety functionality that is wired to the STO connection.

6. Reset any faults before restarting.

**WARNING!** The Safe torque off function does not disconnect the voltage of the main and auxiliary circuits from the drive. Therefore maintenance work on electrical parts of the drive or the motor can only be carried out after isolating the drive from the main supply.

**WARNING!** The Safe torque off functionality is only achieved through the XSTO connector of the inverter control unit (A41). True Safe torque off functionality is not achieved through the XSTO connectors of other control units (such as the supply control unit or the brake control unit).

The Safe torque off function is supported by any ACS880 inverter unit firmware. It is not supported by supply or brake firmware.

**WARNING!** (With permanent magnet or synchronous reluctance [SynRM] motors only) In case of a multiple IGBT power semiconductor failure, the inverter system can produce an alignment torque which maximally rotates the motor shaft by $180/p$ (with permanent magnet motors) or $180/2p$ (with synchronous reluctance [SynRM] motors) degrees regardless of the activation of the Safe torque off function. $p$ denotes the
The Safe torque off function

number of pole pairs.

Notes:

• If a running drive is stopped by using the Safe torque off function, the drive will cut off the motor supply voltage and the motor will coast to a stop. If this causes danger or is not otherwise acceptable, stop the drive and machinery using the appropriate stop mode before activating the Safe torque off function.

• The Safe torque off function overrides all other functions of the inverter unit.

• The Safe torque off function is ineffective against deliberate sabotage or misuse.

• The Safe torque off function has been designed to reduce the recognized hazardous conditions. In spite of this, it is not always possible to eliminate all potential hazards. The assembler of the machine must inform the final user about the residual risks.

Maintenance

After the operation of the circuit is validated at start-up, the STO function shall be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 5 or 2 years; see section Safety data (page 247). It is assumed that all dangerous failures of the STO circuit are detected by the proof test. To perform the proof test, do the Acceptance test procedure (page 244).

Note: See also the Recommendation of Use CNB/M/11.050 (published by the European co-ordination of Notified Bodies) concerning dual-channel safety-related systems with electromechanical outputs:

• When the safety integrity requirement for the safety function is SIL 3 or PL e (cat. 3 or 4), the proof test for the function must be performed at least every month.

• When the safety integrity requirement for the safety function is SIL 2 (HFT = 1) or PL d (cat. 3), the proof test for the function must be performed at least every 12 months.

The STO function of the drive does not contain any electromechanical components.

In addition to proof testing, it is a good practice to check the operation of the function when other maintenance procedures are carried out on the machinery.

Include the Safe torque off operation test described above in the routine maintenance program of the machinery that the inverter runs.

If any wiring or component change is needed after start up, or the parameters are restored, follow the test given in section Acceptance test procedure (page 244).

Use only ABB approved spare parts.

Record all maintenance and proof test activities in the machine logbook.

Competence

The maintenance and proof test activities of the safety function must be carried out by a competent person with adequate expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6.

Fault tracing

The indications given during the normal operation of the Safe torque off function are selected by inverter control program parameter 31.22.
The diagnostics of the Safe torque off function cross-compare the status of the two STO channels. In case the channels are not in the same state, a fault reaction function is performed and the inverter trips on an "STO hardware failure" fault. An attempt to use the STO in a non-redundant manner, for example activating only one channel, will trigger the same reaction.

See the firmware manual of the inverter control program for the indications generated by the inverter, and for details on directing fault and warning indications to an output on the control unit for external diagnostics.

Any failures of the Safe torque off function must be reported to ABB.

**Safety data**

The safety data for the Safe torque off function is given below.

**Note:** The safety data is calculated for redundant use, and does not apply if both STO channels are not used.

<table>
<thead>
<tr>
<th>Frame size</th>
<th>SIL/SILCL</th>
<th>SC</th>
<th>PL</th>
<th>SFF (%)</th>
<th>PFH (T1 = 20 a) (1/h)</th>
<th>PFDavg (T1 = 2 a)</th>
<th>PFDavg (T1 = 5 a)</th>
<th>MTTFD DC (% (a))</th>
<th>PFDavg (T1 = 2 a)</th>
<th>Cat.</th>
<th>HFT</th>
<th>CCF</th>
<th>Lifetime (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1×R8i</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>&gt;99</td>
<td>5.0E-11</td>
<td>4.5E-07</td>
<td>1.1E-06</td>
<td>23970 ≥90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>2×R8i</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>&gt;99</td>
<td>6.2E-11</td>
<td>5.5E-07</td>
<td>1.3E-06</td>
<td>16330 ≥90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>3×R8i</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>&gt;99</td>
<td>7.3E-11</td>
<td>6.5E-07</td>
<td>1.6E-06</td>
<td>12390 ≥90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>4×R8i</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>&gt;99</td>
<td>8.4E-11</td>
<td>7.6E-07</td>
<td>1.9E-06</td>
<td>9980 ≥90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>5×R8i</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>&gt;99</td>
<td>9.5E-11</td>
<td>8.6E-07</td>
<td>2.1E-06</td>
<td>8360 ≥90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>6×R8i</td>
<td>3</td>
<td>3</td>
<td>e</td>
<td>&gt;99</td>
<td>1.1E-10</td>
<td>9.6E-07</td>
<td>2.4E-06</td>
<td>7190 ≥90</td>
<td>3</td>
<td>1</td>
<td>80</td>
<td>20</td>
<td></td>
</tr>
</tbody>
</table>

- The following temperature profile is used in safety value calculations:
  - 670 on/off cycles per year with \( \Delta T = 71.66 \) °C
  - 1340 on/off cycles per year with \( \Delta T = 61.66 \) °C
  - 30 on/off cycles per year with \( \Delta T = 10.0 \) °C
  - 32 °C board temperature at 2.0% of time
  - 60 °C board temperature at 1.5% of time
  - 85 °C board temperature at 2.3% of time.

- The STO is a type B safety component as defined in IEC 61508-2.

- Relevant failure modes:
  - The STO trips spuriously (safe failure)
  - The STO does not activate when requested

A fault exclusion on the failure mode “short circuit on printed circuit board” has been made (EN 13849-2, table D.5). The analysis is based on an assumption that one failure occurs at one time. No accumulated failures have been analyzed.

- STO reaction time (shortest detectable break): 1 ms
- STO response time: 2 ms (typical), 25 ms (maximum)
- Fault detection time: Channels in different states for longer than 200 ms
- Fault reaction time: Fault detection time + 10 ms
- STO fault indication (parameter 31.22) delay: < 500 ms
- STO warning indication (parameter 31.22) delay: < 1000 ms
## Abbreviations

<table>
<thead>
<tr>
<th>Abbr.</th>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat.</td>
<td>EN ISO 13849-1</td>
<td>Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4.</td>
</tr>
<tr>
<td>CCF</td>
<td>EN ISO 13849-1</td>
<td>Common cause failure (%)</td>
</tr>
<tr>
<td>DC</td>
<td>EN ISO 13849-1</td>
<td>Diagnostic coverage</td>
</tr>
<tr>
<td>FIT</td>
<td>IEC 61508</td>
<td>Failure in time: 1E-9 hours</td>
</tr>
<tr>
<td>HFT</td>
<td>IEC 61508</td>
<td>Hardware fault tolerance</td>
</tr>
<tr>
<td>$MTTF_D$</td>
<td>EN ISO 13849-1</td>
<td>Mean time to dangerous failure: (The total number of life units) / (the number of dangerous, undetected failures) during a particular measurement interval under stated conditions</td>
</tr>
<tr>
<td>PFD$_{avg}$</td>
<td>IEC 61508</td>
<td>Average probability of dangerous failure on demand</td>
</tr>
<tr>
<td>PFH</td>
<td>IEC 61508</td>
<td>Average frequency of dangerous failures per hour</td>
</tr>
<tr>
<td>PL</td>
<td>EN ISO 13849-1</td>
<td>Performance level. Levels a…e correspond to SIL</td>
</tr>
<tr>
<td>SC</td>
<td>IEC 61508</td>
<td>Systematic capability</td>
</tr>
<tr>
<td>SFF</td>
<td>IEC 61508</td>
<td>Safe failure fraction (%)</td>
</tr>
<tr>
<td>SIL</td>
<td>IEC 61508</td>
<td>Safety integrity level (1…3)</td>
</tr>
<tr>
<td>SILCL</td>
<td>IEC/EN 62061</td>
<td>Maximum SIL (level 1…3) that can be claimed for a safety function or subsystem</td>
</tr>
<tr>
<td>SS1</td>
<td>IEC/EN 61800-5-2</td>
<td>Safe stop 1</td>
</tr>
<tr>
<td>STO</td>
<td>IEC/EN 61800-5-2</td>
<td>Safe torque off</td>
</tr>
<tr>
<td>T1</td>
<td>IEC 61508-6</td>
<td>Proof test interval. T1 is a parameter used to define the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of T1 is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. Note that any T1 values given cannot be regarded as a guarantee or warranty. See also section Maintenance (page 246).</td>
</tr>
</tbody>
</table>

## Declaration of conformity

See section *Compliance with the European Machinery Directive* (page 193).
Resistor braking

Contents of this chapter

This chapter tells how to select, protect and wire brake choppers and resistors. The chapter also contains the related technical data.

Operating principle

The brake chopper handles the energy generated by a decelerating motor. The chopper connects the brake resistor to the intermediate DC circuit whenever the voltage in the circuit exceeds the limit defined by the control program. Energy consumption by the resistor losses lowers the voltage until the resistor can be disconnected.
Factory-installed brake choppers and resistors

The following brake choppers (option +D150) and resistors (+D151) are available for the ACS880-37 as factory-installed. It is also possible to use option +D150 with a custom resistor assembly.

<table>
<thead>
<tr>
<th>$U_N$</th>
<th>ACS880-37 type</th>
<th>Brake chopper type (+D150)</th>
<th>Brake resistor type (+D151)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 V</td>
<td>ACS880-37-0450A-3</td>
<td>NBRA-659</td>
<td>2 × SAFUR180F460</td>
</tr>
<tr>
<td></td>
<td>ACS880-37-0620A-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACS880-37-0870A-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACS880-37-1110A-3</td>
<td>2 × NBRA-659</td>
<td>2 × (2 × SAFUR180F460)</td>
</tr>
<tr>
<td></td>
<td>ACS880-37-1210A-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACS880-37-1430A-3</td>
<td>3 × NBRA-659</td>
<td>3 × (2 × SAFUR180F460)</td>
</tr>
<tr>
<td></td>
<td>ACS880-37-1700A-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>500 V</td>
<td>ACS880-37-0420A-5</td>
<td>NBRA-659</td>
<td>2 × SAFUR200F500</td>
</tr>
<tr>
<td></td>
<td>ACS880-37-0570A-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACS880-37-0780A-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACS880-37-1010A-5</td>
<td>2 × NBRA-659</td>
<td>2 × (2 × SAFUR200F500)</td>
</tr>
<tr>
<td></td>
<td>ACS880-37-1110A-5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACS880-37-1530A-5</td>
<td>3 × NBRA-659</td>
<td>3 × (2 × SAFUR200F500)</td>
</tr>
<tr>
<td>690 V</td>
<td>ACS880-37-0320A-7</td>
<td>NBRA-669</td>
<td>2 × SAFUR200F500</td>
</tr>
<tr>
<td></td>
<td>ACS880-37-0390A-7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACS880-37-0580A-7</td>
<td>2 × NBRA-669</td>
<td>2 × (2 × SAFUR200F500)</td>
</tr>
<tr>
<td></td>
<td>ACS880-37-0660A-7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACS880-37-0770A-7</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ACS880-37-0950A-7</td>
<td>3 × NBRA-669</td>
<td>3 × (2 × SAFUR200F500)</td>
</tr>
<tr>
<td></td>
<td>ACS880-37-1130A-7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Consult your local ABB representative for availability of brake choppers and resistors for other drive types.
## Technical data

### Ratings of chopper/resistor combinations

<table>
<thead>
<tr>
<th>$U_N$ (V)</th>
<th>Chopper(s)</th>
<th>Resistors</th>
<th>$R$ (ohm)</th>
<th>$P_{brmax}$ (kW)</th>
<th>$P_{brcont}$ (kW)</th>
<th>$I_{max}$ (A)</th>
<th>Duty Cycle (10/60 s)</th>
<th>Duty Cycle (1/5 min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 V</td>
<td>NBRA-659</td>
<td>2 × SAFUR180F460</td>
<td>1.2</td>
<td>353</td>
<td>54</td>
<td>545</td>
<td>287</td>
<td>444</td>
</tr>
<tr>
<td></td>
<td>2 × NBRA-659</td>
<td>2 × (2 × SAFUR180F460)</td>
<td>1.2</td>
<td>706</td>
<td>108</td>
<td>1090</td>
<td>575</td>
<td>888</td>
</tr>
<tr>
<td></td>
<td>3 × NBRA-659</td>
<td>3 × (2 × SAFUR180F460)</td>
<td>1.2</td>
<td>1058</td>
<td>162</td>
<td>1635</td>
<td>862</td>
<td>1332</td>
</tr>
<tr>
<td>500 V</td>
<td>NBRA-659</td>
<td>2 × SAFUR200F500</td>
<td>1.35</td>
<td>403</td>
<td>54</td>
<td>605</td>
<td>287</td>
<td>355</td>
</tr>
<tr>
<td></td>
<td>2 × NBRA-659</td>
<td>2 × (2 × SAFUR200F500)</td>
<td>1.35</td>
<td>806</td>
<td>108</td>
<td>1210</td>
<td>575</td>
<td>710</td>
</tr>
<tr>
<td></td>
<td>3 × NBRA-659</td>
<td>3 × (2 × SAFUR200F500)</td>
<td>1.35</td>
<td>1208</td>
<td>162</td>
<td>1815</td>
<td>862</td>
<td>1065</td>
</tr>
<tr>
<td>690 V</td>
<td>NBRA-669</td>
<td>2 × SAFUR200F500</td>
<td>1.35</td>
<td>404</td>
<td>54</td>
<td>835</td>
<td>287</td>
<td>257</td>
</tr>
<tr>
<td></td>
<td>2 × NBRA-669</td>
<td>2 × (2 × SAFUR200F500)</td>
<td>1.35</td>
<td>807</td>
<td>108</td>
<td>1670</td>
<td>575</td>
<td>514</td>
</tr>
<tr>
<td></td>
<td>3 × NBRA-669</td>
<td>3 × (2 × SAFUR200F500)</td>
<td>1.35</td>
<td>1211</td>
<td>162</td>
<td>2505</td>
<td>862</td>
<td>771</td>
</tr>
</tbody>
</table>

$U_N$ = Nominal voltage  
$R$ = Resistance of specified resistors (per chopper). This is also the minimum allowed resistance of the resistor assembly.  
$P_{brmax}$ = Maximum short-term (1 min every 10 mins) braking power  
$P_{brcont}$ = Maximum continuous braking power  
$I_{max}$ = Maximum peak current  
$P_{br}$ = Braking power for the specified duty cycle  
$I_{rms}$ = Corresponding rms current

### SAFUR resistors

The SAFUR resistors available as factory-installed (option +D151) are also available separately.

<table>
<thead>
<tr>
<th>Type</th>
<th>$U_N$ (V)</th>
<th>$R$ (ohm)</th>
<th>$E_R$ (kJ)</th>
<th>$P_{Rcont}$ (kW)</th>
<th>IPxx</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAFUR125F500</td>
<td>500</td>
<td>4.0</td>
<td>3600</td>
<td>9.0</td>
<td>IP00</td>
</tr>
<tr>
<td>SAFUR210F575</td>
<td>575</td>
<td>3.4</td>
<td>4200</td>
<td>10.5</td>
<td>IP00</td>
</tr>
<tr>
<td>SAFUR200F500</td>
<td>500</td>
<td>2.7</td>
<td>5400</td>
<td>13.5</td>
<td>IP00</td>
</tr>
<tr>
<td>SAFUR180F460</td>
<td>460</td>
<td>2.4</td>
<td>6000</td>
<td>15.0</td>
<td>IP00</td>
</tr>
</tbody>
</table>

$U_N$ = Nominal voltage  
$R$ = Resistance  
$E_R$ = Short energy pulse that the resistor assembly will withstand each 400 seconds  
$P_{Rcont}$ = Continuous power (heat) dissipation of the resistor when placed correctly. Energy $E_R$ dissipates in 400 seconds.  
IPxx = Degree of protection

### Terminals and cable lead-through data of factory-installed chopper/resistor cubicles

See the dimension drawings delivered with the unit.
Planning the braking system

### Verifying the capacity of the braking equipment

1. Calculate the maximum power generated by the motor during braking ($P_{\text{max}}$).

2. Ensure that the braking power of the chopper is equal to or greater than $P_{\text{max}}$.

   The $P_{\text{br max}}$ values specified in the ratings table on page 251 are for the reference braking cycle (1 minute of braking, 9 minutes of rest). If the actual duty cycle does not correspond to the reference cycle, the maximum allowed braking power ($P_{\text{br}}$) must be used instead. In the ratings table, $P_{\text{br}}$ is given for two additional braking cycles. See below for instructions on calculating $P_{\text{br}}$ for other braking cycles.

3. Check the resistor selection. The energy generated by the motor during a 400-second period must not exceed the heat dissipation capacity of the resistor ($E_R$).

   If the $E_R$ of the resistor is not sufficient, it is possible to use a four-resistor assembly in which two resistors are connected in parallel, two in series. The $E_R$ value of the four-resistor assembly is four times that of a single resistor.

#### Custom resistors

Resistors other than those available as option +D151 can be used provided that

- the resistance is not lower than the value given in the ratings table (page 251)

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**WARNING!** Never use a brake resistor with a resistance below the value specified for the particular drive / brake chopper / resistor combination. The drive and the chopper would not be able to handle the overcurrent caused by the low resistance.

- the resistance of the custom resistor does not restrict the braking capacity needed, i.e.

  \[ P_{\text{max}} < \frac{U_{\text{DC}}^2}{R} \]

  where

  - $P_{\text{max}}$ Maximum power generated by the motor during braking
  - $U_{\text{DC}}$ Voltage over the resistor during braking. $U_{\text{DC}}$ equals
    - $1.35 \cdot 1.25 \cdot 415$ V DC (when supply voltage is 380 to 415 V AC)
    - $1.35 \cdot 1.25 \cdot 500$ V DC (when supply voltage is 440 to 500 V AC)
    - $1.35 \cdot 1.25 \cdot 690$ V DC (when supply voltage is 525 to 690 AC)
  - $R$ Resistor resistance (ohm)

- the heat dissipation capacity $E_R$ of the resistor is sufficient for the application (see step 3 above).
Calculating the maximum braking power \( (P_{\text{br}}) \)

- Braking energy transferred during any ten minute period must be less than or equal to the energy transferred during the reference braking cycle.
- The braking power must not exceed the rated maximum value \( P_{\text{brmax}} \).

1. \( n \times P_{\text{br}} \times t_{\text{br}} \leq P_{\text{brmax}} \times 60 \text{ s} \)
2. \( P_{\text{br}} \leq P_{\text{brmax}} \)

\( n = \) Number of braking pulses during a 10-minute period
\( P_{\text{br}} = \) Maximum allowed braking power (kW)
\( t_{\text{br}} = \) Braking time (s)
\( P_{\text{brmax}} = \) Maximum braking power for a reference cycle (kW)

**Example 1**

The duration of a braking cycle is 30 minutes. The braking time is 15 minutes. **Result:** If the braking time exceeds 10 minutes, the braking is considered continuous. The allowed continuous braking power is 10% of maximum braking power \( (P_{\text{brmax}}) \).

**Example 2**

The duration of a braking cycle \( (T) \) is three minutes. The braking time \( (t_{\text{br}}) \) is 40 seconds.

1. \( P_{\text{br}} \leq \frac{P_{\text{brmax}} \times 60 \text{ s}}{4 \times 40 \text{ s}} = 0.375 \times P_{\text{brmax}} \)

\[ P_{\text{br}} \]
\[ P_{\text{brmax}} \]
\[ \frac{P_{\text{brmax}} \times 60 \text{ s}}{4 \times 40 \text{ s}} = 0.375 \times P_{\text{brmax}} \]

2. \( P_{\text{br}} \leq P_{\text{brmax}} \) **OK**

**Result:** The maximum allowed braking power for the cycle is 37% of the rated value given for the reference cycle.
Resistor braking

Selecting and routing the cables of a custom resistor

Use the same cable type for the resistor cabling as for the drive input cabling to ensure that the input fuses also protect the resistor cable. Alternatively, a two conductor shielded cable with the same cross-sectional area can be used.

Minimizing electromagnetic interference

Follow these rules in order to minimize electromagnetic interference caused by the rapid current changes in the resistor cables:

- Shield the braking power line completely, either by using shielded cable or a metallic enclosure. Unshielded single-core cable can only be used if it is routed inside a cabinet that efficiently suppresses the radiated emissions.
- Install the cables away from other cable routes.
- Avoid long parallel runs with other cables. The minimum parallel cabling separation distance should be 0.3 meters (1 ft).
- Cross any other cables at right angles.
- Keep the cable as short as possible in order to minimize the radiated emissions and stress on chopper IGBTs. The longer the cable the higher the radiated emissions, inductive load and voltage peaks over the IGBT semiconductors of the brake chopper.

Maximum cable length

The maximum length of the resistor cable(s) is 50 m (164 ft).

EMC compliance of the complete installation

Note: ABB has not verified that the EMC requirements are fulfilled with custom brake resistors and cabling. The EMC compliance of the complete installation must be considered by the customer.

Placing custom brake resistors

Install the resistors outside the drive in a place where they are able to cool effectively.

Arrange the cooling of the resistor in a way that

- no danger of overheating is caused to the resistor or nearby materials, and
- the temperature of the room the resistor is located in does not exceed the allowed maximum.

Supply the resistor with cooling air/water according to the resistor manufacturer’s instructions.

WARNING! The materials near the brake resistor must be non-flammable. The surface temperature of the resistor is high. The temperature of the air flowing from the resistor is hundreds of degrees Celsius. If the exhaust vents are connected to a ventilation system, ensure that the materials withstand high temperatures. Protect the resistor against contact.

Protecting the system against thermal overload

The brake chopper protects itself and the resistor cables against thermal overload when the cables are dimensioned according to the nominal current of the drive. By default, a brake chopper fault is wired to stop the supply unit of the drive.
Thermal protection of the resistors

The standard resistors available as option +D151 are equipped with a thermal switch. The switches of the resistors are wired in series and connected to the Enable input of the brake chopper. The relay output of the chopper is wired to the supply control unit so that a chopper fault condition stops the supply unit.

With custom resistors, a similar protection must be implemented. Use cable rated as follows:
- twisted pair, shielding recommended
- rated operating voltage between a conductor and ground \((U_0) \geq 750 \text{ V}\)
- insulation test voltage > 2.5 kV.

Keep the cable as short as possible.

- Protecting the resistor cable against short-circuits

The input fuses of the drive will also protect the resistor cable provided that the resistor cable is of the same type as the input cable.

Mechanical installation of custom brake resistors

Follow the resistor manufacturer’s instructions.

Electrical installation of custom brake resistors

- Connection diagram
Connection procedure

**WARNING!** Obey the instructions in chapter *Safety instructions*. If you ignore them, injury or death, or damage to the equipment can occur.

- Do the steps in section *Electrical safety precautions* (page 19) before you start the work.
- Connect the resistor cable at the resistor end only. If a shielded three-conductor cable is used, cut off the third conductor. Ground the twisted shield of the cable as well as any separate PE conductor (if present).
- At the chopper end of the cable, connect the R+ and R- conductors of the resistor cable together. Measure the insulation resistance between the combined conductors and the PE conductor by using a measuring voltage of 1 kV DC. The insulation resistance must be higher than 1 Mohm.

Start-up

Check the settings of the following inverter control program parameters (ACS880 primary control program):

- **30.30 Overvoltage control**: Overvoltage control disabled.

For settings of other control programs, see the appropriate firmware manual.

*Note:* New brake resistors may be coated with storage grease. As the brake chopper operates for the first time, the grease burns off and may produce some smoke. Make sure there is proper ventilation.
Further information

Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to www.abb.com/searchchannels.

Product training

For information on ABB product training, navigate to new.abb.com/service/training.

Providing feedback on ABB Drives manuals

Your comments on our manuals are welcome. Navigate to new.abb.com/drives/manuals-feedback-form.

Document library on the Internet

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