

ABB SERVO PRODUCTS

# MotiFlex e180 servo drive

## User's manual



# List of related manuals

## Drive hardware manuals and guides

## Code (English)

*MotiFlex e180 Quick Installation Guide*

[3AXD50000017336](#)

*MotiFlex e180 Wall chart*

[3AXD50000019945](#)

*MotiFlex e180 Common DC Systems Application Guide*

[3AXD50000019947](#)

## Certificates

*MotiFlex e180 EU Single Declaration of Conformity*

[3AXD10000371048](#)

*MotiFlex e180 UK Single Declaration of Conformity*

[3AXD10001409694](#)

*MotiFlex e180 STO Certificate*

[3AXD10000391362](#)

*MotiFlex e180 UL Certificate*

[3AXD10000439478](#)

## Accessories

*MotiFlex e180 Feedback Modules*

[3AXD50000029176](#)

*MotiFlex e180 Memory Unit*

[3AXD50000029175](#)

*OPT-EPLR-001 Ethernet POWERLINK Router*

[3AXD50000029650](#)

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.

# User's manual

**MotiFlex e180**

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## 1

# Safety

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## What this chapter contains

This chapter contains the safety instructions which you must obey when installing, operating and servicing the drive. If ignored, physical injury or death may follow, or damage may occur to the drive, motor or driven equipment. Read the safety instructions before you work on the unit.



## Use of warnings

Warnings caution you about conditions which can result in serious injury or death and/or damage to the equipment and advise on how to avoid the danger. The following warning symbols are used in this manual:



**Electricity warning** warns of hazards from electricity which can cause physical injury and/or damage to the equipment.



**General warning** warns about conditions, other than those caused by electricity, which can result in physical injury and/or damage to the equipment.



**Electrostatic sensitive devices warning** warns of electrostatic discharge which can damage the equipment.



**Hot surface warning** warns of component surfaces that may become hot enough to cause burns if touched.

---

## Safety in installation and maintenance

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

### ■ Electrical safety



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

- Only qualified electricians are allowed to install and maintain the drive!
- Be sure the system is properly earthed/grounded before applying power. Do not apply AC power before earths/grounds are connected.
- Never work on the drive, motor cable or motor when input power is applied. After disconnecting the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, motor or motor cable. Always ensure by measuring with a multimeter (impedance at least 1 Mohm) that:
  1. Voltage between drive input phases L1, L2 and L3 is close to 0 V.
  2. Voltage between terminals UDC+ and UDC- and the frame is close to 0 V.
  3. There is no voltage between terminals R+ and R- and the ground.
- Do not work on the control cables when power is applied to the drive or to the external control circuits. Externally supplied control circuits may cause dangerous voltages inside the drive even when the main power on the drive is switched off.
- Do not make any insulation or voltage withstand tests on the drive.
- Do not connect the drive to a voltage higher than what is marked on the type designation label. Higher voltage can activate the brake chopper and lead to brake resistor overload, or activate the overvoltage controller what can lead to motor rushing to maximum speed.
- If a drive whose varistors are not disconnected is installed on an IT power system (an ungrounded power system or a high resistance grounded [over 30 ohms] power system), the drive will be connected to earth potential through the varistors. This may cause danger or damage the drive.
- If a drive whose varistors (built-in) or mains filter (external option) are not disconnected is installed on a corner-grounded TN system, the drive will be damaged.
- Suitable for use on a circuit capable of delivering not more than the RMS symmetrical short circuit amperes listed here, at the rated maximum voltage (480 V AC):  
Horsepower: 1-60    RMS symmetrical amperes: 100,000



**Note:**

- The motor cable terminals on the drive are at a dangerously high voltage when the input power is on, regardless of whether the motor is running or not.
- The DC terminals (UDC+, UDC-) carry a dangerous DC voltage (over 500 V) when internally connected to the intermediate DC circuit.
- Depending on the external wiring, dangerous voltages (115 V, 220 V or 230 V) may be present on the terminals of relay outputs (NC, NO, COM).
- The Safe Torque Off function does not remove the voltage from the main and auxiliary circuits. The function is ineffective against deliberate sabotage or misuse. See page [227](#).

## ■ Grounding

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



**WARNING!** Ignoring the following instructions can cause physical injury or death, increased electromagnetic interference and equipment malfunction:

---

- Ground the drive, motor and adjoining equipment to ensure personnel safety in all circumstances, and to reduce electromagnetic emission and interference.
- Make sure that grounding conductors are adequately sized as required by safety regulations.
- In a multiple-drive installation, connect each drive separately to protective earth (PE).
- Where EMC emissions must be minimized, make a 360° high frequency grounding of cable entries in order to suppress electromagnetic disturbances. In addition, connect the cable shields to protective earth (PE) in order to meet safety regulations.

**Note:**

- Power cable shields are suitable for equipment grounding conductors only when adequately sized to meet safety regulations.
  - Standard EN 61800-5-1 (section 4.3.5.5.2.) requires that 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 and:
    - cross-section of the protective earthing conductor of at least 10 mm<sup>2</sup> Cu or 16 mm<sup>2</sup> Al, or
    - automatic disconnection of the supply in case of discontinuity of the protective earthing conductor, or
- 



- a second protective earthing conductor of the same cross-sectional area as the original protective earthing conductor.



## ■ Permanent magnet motor drives

These are additional warnings concerning permanent magnet motor drives.



**WARNING!** Ignoring the following instructions can cause physical injury or death, increased electromagnetic interference and equipment malfunction:

---

- Do not work on the drive when the permanent magnet motor is rotating. Also, when the supply power is switched off and the inverter is stopped, a rotating permanent magnet motor feeds power to the intermediate circuit of the drive and the supply connections become live.
- Before installation and maintenance work on the drive:
  - Stop the motor.
  - Ensure that there is no voltage on the drive power terminals according to step 1 or 2, or if possible, according to the both steps:
    1. Disconnect the motor from the drive with a safety switch or by other means. Check by measuring that there is no voltage present on the drive input or output terminals (L1, L2, L3, U1, V1, W1, UDC+, UDC-, R+, R-).
    2. Ensure that the motor cannot rotate during work. Make sure that no other system, like hydraulic crawling drives, is able to rotate the motor directly or through any mechanical connection like belt, rope, etc. Check by measuring that there is no voltage present on the drive input or output terminals (L1, L2, L3, U1, V1, W1, UDC+, UDC-, R+, R-). Ground the drive output terminals temporarily by connecting them together as well as to the PE.
- Do not run the motor over the rated speed. Motor overspeed leads to overvoltage which may damage or explode the capacitors in the intermediate circuit of the drive.



## General safety

These instructions are intended for all who install and service the drive.



**WARNING!** Ignoring the following instructions can cause physical injury or death, increased electromagnetic interference and equipment malfunction:

---

- Handle the unit carefully.
- Take care when lifting. Frame B models weigh approximately 4.8 kg (10.6 lb). Frame C models weigh approximately 10 kg (23 lb). Frame D models weigh approximately 17 kg (37.5 lb). Seek assistance if necessary. When carrying, do not suspend the unit from the removable front panels as they could detach and cause the unit to be dropped.
- Beware of hot surfaces. The surfaces of drive system components (such as the mains choke, DC choke, or braking resistor, if present) become hot when the system is in use, and remain hot for a while after disconnection of the electrical supply.
- Ensure that debris from drilling and grinding does not enter the drive when installing. Electrically conductive debris inside the unit may cause damage or malfunction.
- Ensure sufficient cooling.
- Do not attach the drive by riveting or welding.
- The MotiFlex e180 must be installed where the pollution degree according to EN61800-5-1 shall not exceed 2.



### ■ Printed circuit boards



**WARNING!** Ignoring the following instructions can cause damage to the printed circuit boards:

---

- Wear a grounding wrist band when handling the boards. Do not touch the boards unnecessarily. The printed circuit boards contain components sensitive to electrostatic discharge.
-

## Safe start-up and operation

### ■ General safety

These warnings are intended for all who plan the operation of the drive or operate the drive.



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

---

- Before you connect voltage to the drive, make sure that the drive covers are on. Keep the covers on during operation.
- Before adjusting the drive and putting it into service, make sure that the motor and all driven equipment are suitable for operation throughout the speed range provided by the drive. The drive can be adjusted to operate the motor at speeds above and below the speed provided by connecting the motor directly to the power line.
- Do not activate any automatic fault reset functions of the drive control program if dangerous situations can occur. When activated, these functions will reset the drive and resume operation after a fault.
- Do not control the motor with an AC contactor or disconnecting device (disconnecting means); instead, use external commands via the I/O board of the drive or a fieldbus adapter. The maximum allowed number of charging cycles of the DC capacitors (i.e. power-ups by applying power) is one per two minutes. The maximum total number of chargings is 100000 for frame sizes A and B, 50000 for frame sizes C and D.
- Make sure that any safety circuits (for example, emergency stop and Safe torque off) are validated in start-up. See chapter [Start-up](#) for reference of the validation instructions.
- The drive is not field repairable. Never attempt to repair a malfunctioning drive; contact your local ABB representative or Authorized Service Center for replacement.
- When operating a rotary motor with no load coupled to its shaft, remove the shaft key to prevent it flying out when the shaft rotates.
- Operating the MotiFlex e180 in torque mode with no load attached to the motor can cause the motor to accelerate rapidly to excessive speed.
- Improper operation or programming of the drive may cause violent motion of the motor and driven equipment. Be certain that unexpected motor movement will not cause injury to personnel or damage to equipment. Peak torque of several times the rated motor torque can occur during control failure.
- Violent jamming (stopping) of the motor during operation may damage the motor and drive.



- The drive can be programmed to start up and begin to turn the motor (auto-enable) immediately after an input voltage break or a fault reset.

**Note:**

- If an external source for start command is selected and it is ON, the drive could start immediately after an input voltage break or fault reset.

**■ Network security**

This product is designed to be connected to and to communicate information and data via a network interface. It is the customer's sole responsibility to provide and continuously ensure a secure connection between the product and the customer network or any other network (as the case may be). The 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.







# 2

## Introduction to the manual

---

### What this chapter contains

This chapter describes the manual. It contains a flowchart of steps for checking the delivery, installation and start-up of 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.

### Categorization according to the frame size

Some instructions, technical data and dimensional drawings which concern only certain frame sizes are marked with the symbol of the frame size A, B, C or D. The frame size is marked on the drive designation label. The following table describes the frame sizes:

Frame	Models
A	MFE180-04xx-03A0-4
	MFE180-04xx-05A0-4
	MFE180-04xx-07A0-4
B	MFE180-04xx-016A-4
C	MFE180-04xx-024A-4
	MFE180-04xx-031A-4
	MFE180-04xx-046A-4
D	MFE180-04xx-060A-4
	MFE180-04xx-090A-4

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## Categorization according to the + code

The instructions, technical data and dimensional drawings which concern only certain optional selections are marked with + codes. The options included in the drive can be identified from the + codes visible on the type designation label of the drive. The + code selections are listed in [Type designation key](#) on page 30.

## Contents of this manual

The manual consists of the following chapters:

- [Safety](#) (page 13) gives safety instructions you must follow when installing, commissioning, operating and servicing the drive.
  - [Introduction to the manual](#) (this chapter, page 21) describes applicability, target audience, purpose and contents of this manual. It also contains a quick installation and commissioning flowchart.
  - [Operation principle and hardware description](#) (page 27) describes the operation principle, connector layout, type designation label and type designation information in short.
  - [Mechanical installation](#) (page 33) describes how to check the installation site, unpack, check the delivery and install the drive mechanically.
  - [Planning the electrical installation](#) (page 43) describes the requirements for the AC supply, cabling and RCDs.
  - [Electrical installation: AC input, motor and brake](#) (page 53) describes the installation of high power connections including the AC supply, motor output, and brake resistor.
  - [Electrical installation: input / output](#) (page 65) describes the installation of low power connections, including analog and digital input/outputs (including Safe Torque Off), motor feedback and Ethernet.
  - [Installation checklist](#) (page 99) provides a list of checks to confirm that the physical installation has been completed correctly.
  - [Start-up](#) (page 101) describes the steps for applying power to the drive, installing the Mint Machine Center software, and tuning and optimizing the motor/drive combination.
  - [Fault tracing](#) (page 117) describes the drive's LED indicators and provides solution to common problems encountered during installation.
  - [Maintenance](#) (page 153) describes the maintenance required to maintain optimum performance from the drive.
  - [Technical data](#) (page 165) contains the technical specifications of the drive, e.g. the dimensions, ratings, technical specifications, and provisions for fulfilling the requirements for CE and other markings.
-

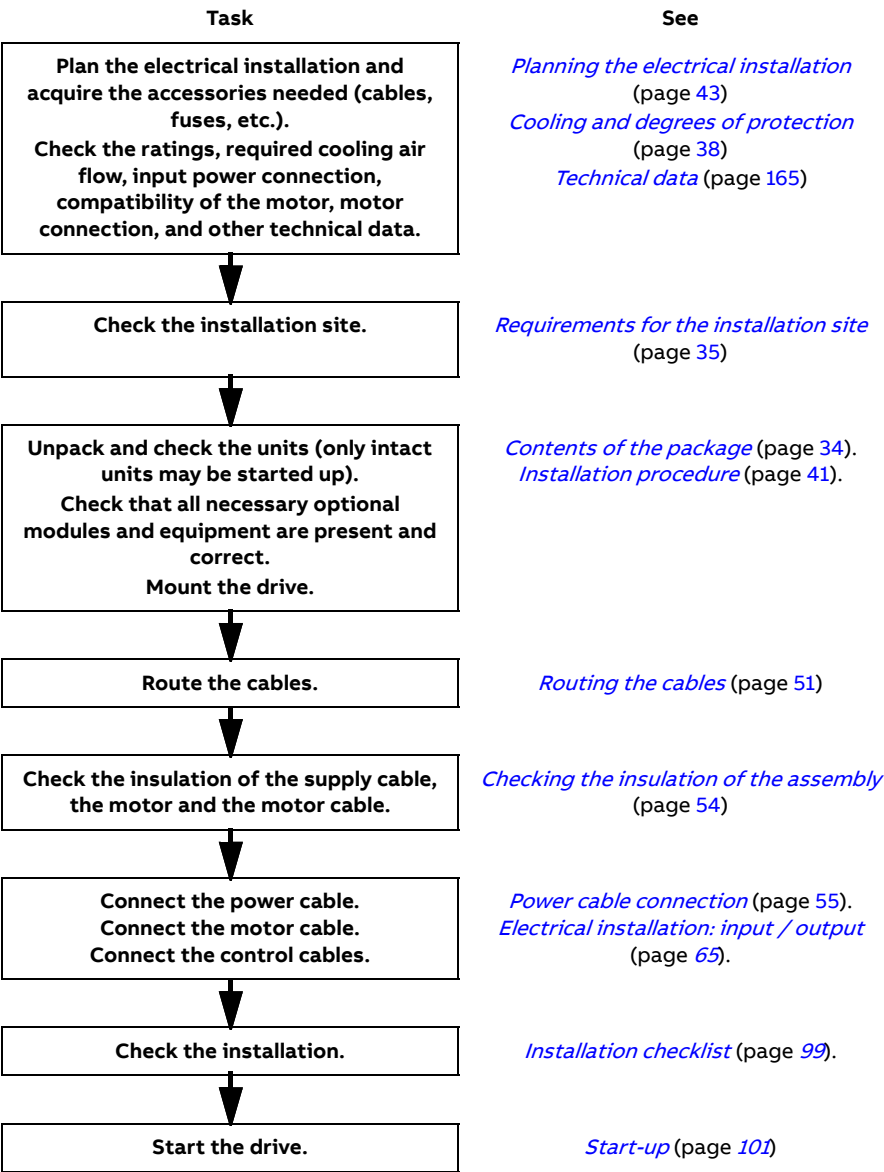
- [Mains chokes](#) (page 189) describes optional mains chokes that can be used with the drive.
- [DC chokes](#) (page 193) describes optional DC chokes that can be used with frame C and frame D drives.
- [Mains filters](#) (page 197) describes optional mains filters that can be used with the drive.
- [Resistor braking](#) (page 201) describes how to select, protect, and wire braking choppers and resistors.
- [Dimension drawings](#) (page 211) provides the dimensions of each drive.
- [Appendix: Safe Torque Off \(STO\)](#) (page 227) describes STO features, installation, and technical data.

## Related documents

See [List of related manuals](#) on page 2 (inside the front cover).

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## Quick installation and start-up flowchart



## Terms and abbreviations

The following units and abbreviations might appear in this manual.

### ■ General terms

Term/Abbreviation	Explanation
CHK-xx	Series of optional mains chokes for the MotiFlex e180.
DCL-xx	Series of optional DC chokes for the MotiFlex e180.
EMC	Electromagnetic Compatibility.
Frame (size)	Size of the drive. This manual deals with MotiFlex e180 frame sizes A, B, C or D. To determine the frame size of a drive, refer to the rating tables in chapter <a href="#">Technical data</a> .
IGBT	Insulated Gate Bipolar Transistor; a voltage-controlled semiconductor type widely used in inverters due to their easy controllability and high switching frequency.
I/O	Input/Output.
JBR-xx	Series of optional braking resistors for the MotiFlex e180.
Control unit	The control unit of the drive (part GCU-xx). The control unit is installed on top of the power unit. The external I/O control signals are connected to the control unit, or optional I/O extensions mounted on it.
JFI-xx	Series of optional mains filters for the MotiFlex e180.
MU-xx	The memory unit attached to the control unit of the drive.
RFI	Radio-frequency interference.

See also page [247](#) for safety related abbreviations.

## ■ Trademarks



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PROFINET<sup>®</sup> is defined by Profibus & Profinet International, an umbrella organization headquartered in Karlsruhe, Germany.



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Mint<sup>™</sup> and MotiFlex<sup>®</sup> are registered trademarks of Baldor, a member of the ABB group.

# 3

## Operation principle and hardware description

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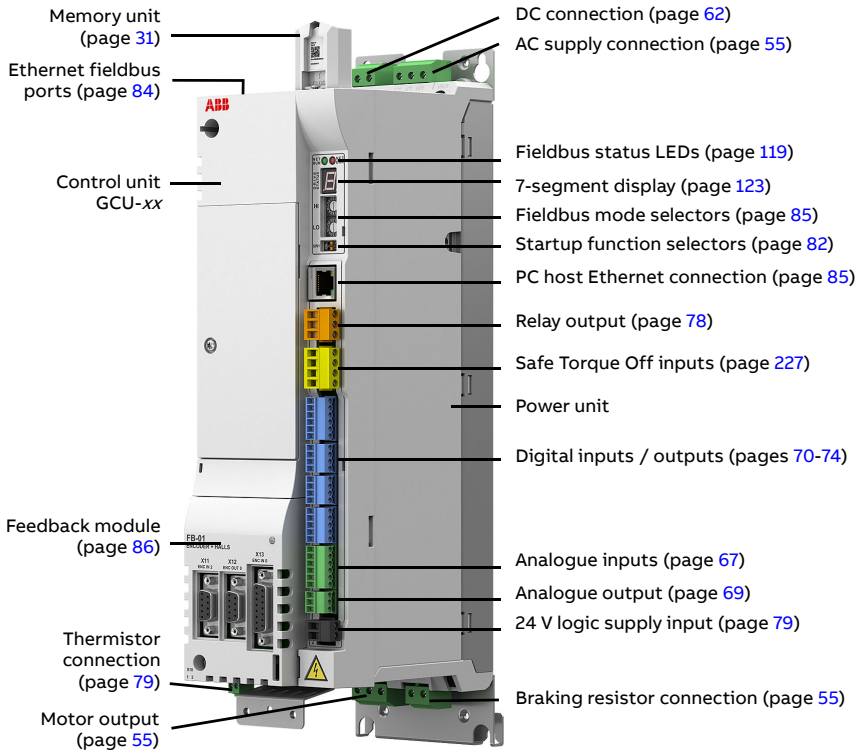
### What this chapter contains

The chapter briefly describes the operation principle, layout, type designation label and type designation information. It also shows a general diagram of power connections and control interfaces.

### Product overview

The MotiFlex e180 is an IP20 drive for controlling AC motors. It is to be installed into a cabinet by the customer. The MotiFlex e180 is available in several frame sizes depending on output power. All frame sizes use the same control unit (type GCU-xx).

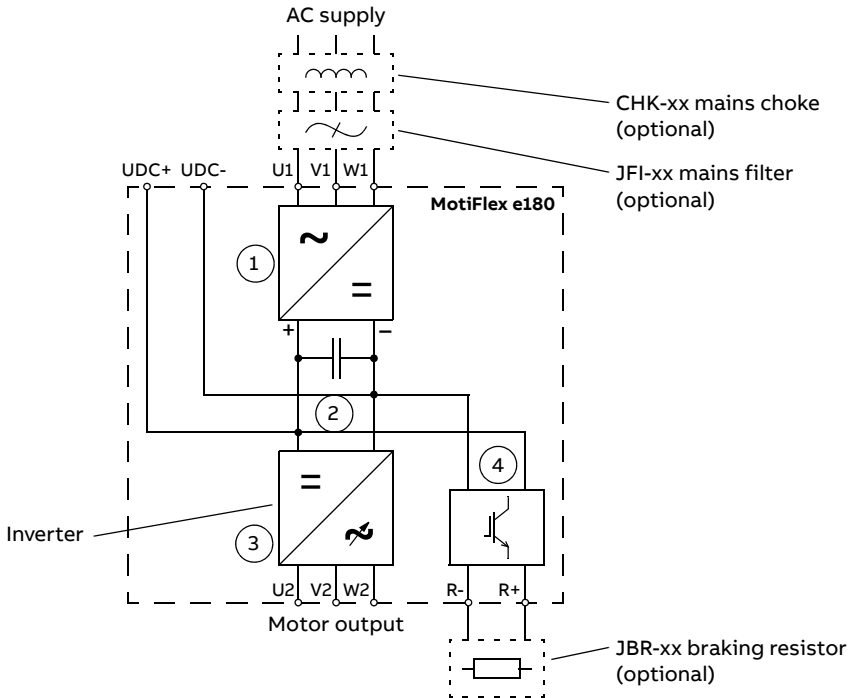
## ■ Layout





## ■ Main circuit

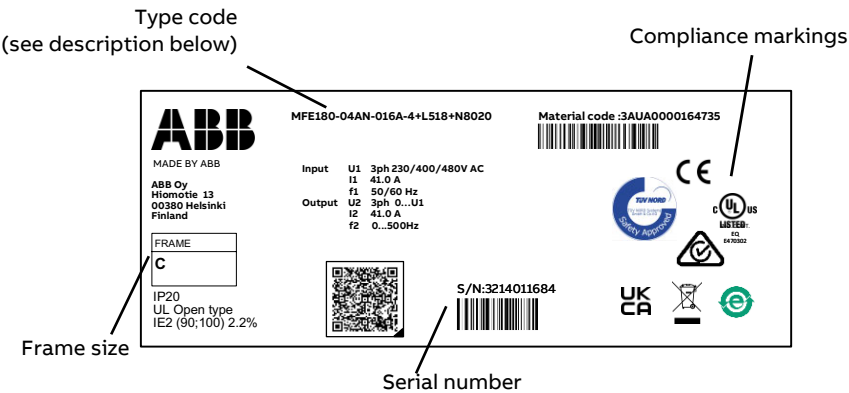
The diagram below shows the main circuit of the drive. For further information on the power unit, see the chapter [Electrical installation: AC input, motor and brake](#).



1. Rectifier. Converts alternating current and voltage to direct current and voltage.
2. DC link. DC circuit between rectifier and inverter.
3. Inverter. Converts direct current and voltage to alternating current and voltage.
4. Brake chopper. Conducts the surplus energy from the intermediate DC circuit of the drive to the brake resistor when necessary. The chopper operates when the DC link voltage exceeds a certain maximum limit. The voltage rise is typically caused by deceleration (braking) of a high inertia motor. User obtains and installs the brake resistor when needed.

## Type designation label

Before attempting installation and operation, check the information on the type designation label of the power unit to verify that the unit is of the correct type. The label is located on the left-hand side of the power unit.



The first digit of the serial number refers to the manufacturing plant. The 2nd and 3rd digit indicate the year of manufacture, while the 4th and 5th digits indicate the week. Digits 6 to 10 are a running integer starting every week at 00001.

### ■ Type designation key

The type code contains information on the specifications and configuration of the drive. The type code is explained in the following table. Not all selections are necessarily available for all types; refer to *MotiFlex e180 Ordering Information*, available on request.

MFE180-04AN-016A-4+N8020	
MFE180	MotiFlex e180
-04	Drive module
A	Cooling method: A = Air
N	Unused, reserved for future use.
-016A	Size: 05A0 = 5.0 A, 09A5 = 9.5 A, etc. See page 166.
-4	Input voltage: 4 = 200-480 V AC
+N8020	Memory unit: MFE180-MU-GCU+N8020

## ■ Memory unit - MU



The memory unit defines the identity and features of the drive, and holds the drive's firmware and saved parameters. The memory unit holds the Mint program on models with programming capability. The memory unit is an essential part of the drive and must always be fitted. It is not designed for frequent removal and insertion.

All power to the drive must be turned off before removing or inserting the memory unit. Always tighten the screw to protect the unit from vibration.

The unit can be inserted into an identical replacement drive. If the replacement drive does not have an identical specification, it must be retuned before using it to drive machinery. Retuning the drive using Mint WorkBench allows the correct tuning parameters to be saved in the memory unit.

The memory unit can be used only with MotiFlex e180 drives. It is not compatible with any other product that uses a similar unit, e.g. ZMU-02. The MotiFlex e180 memory unit can be identified by the part MFE180-MU-GCU-01 on the label.



# 4

## Mechanical installation

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### What this chapter contains

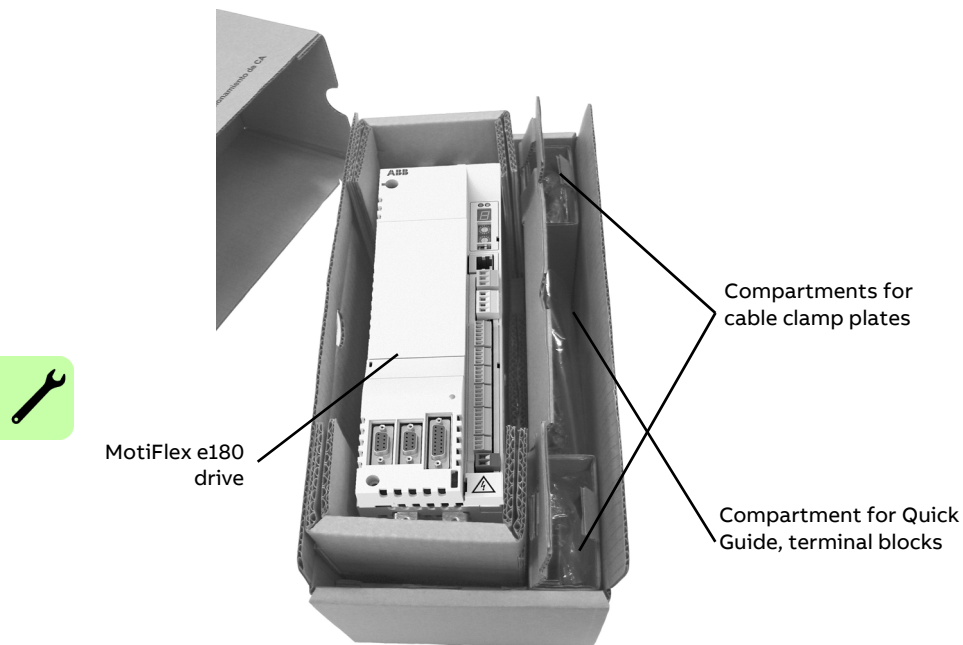
The chapter describes the mechanical installation of the drive.



## Contents of the package

The box contains:

- MotiFlex e180 drive, with factory-installed options
- Three cable clamp plates (two for power cabling, one for control cabling) with screws
- Screw-type terminal blocks to be attached to the headers on the control unit. Additional power connectors are supplied for frame A and B models.
- Memory unit
- Quick Guide.



## ■ Requirements for the installation site

The drive must be installed in an upright position with the cooling section against a wall. All drives can be installed tightly side by side. Make sure that the installation site complies with these requirements:

- The installation site has sufficient ventilation to prevent overheating of the drive.
- The operation conditions of the drive agree with the specifications in [Ambient conditions](#) (page 180).
- The wall is vertical, not flammable and strong enough to hold the weight of the drive. See [Dimensions and weights](#) (page 179).
- The material below the installation is not flammable.
- There is enough free space above and below the drive for cooling air flow, service and maintenance. There is enough free space in front of the drive for operation, service and maintenance.

## ■ Required tools

- Slot screwdrivers for the screw type connectors.
- A drill and screws or bolts for mounting the MotiFlex e180.
- Wire stripper.
- For UL installations, use UL listed closed loop connectors that are of appropriate size for the wire gauge being used.
- Connectors are to be installed using only the crimp tool specified by the manufacturer of the connector.



## Cabinet construction

The cabinet frame must be sturdy enough to carry the weight of the drive components, control circuitry and other equipment installed in it.

The cabinet must protect the drive against contact and meet the requirements for dust and humidity (see the chapter [Technical data](#)).

### ■ Disposition of the devices

For easy installation and maintenance, a spacious layout is recommended. Sufficient cooling air flow, obligatory clearances, cables and cable support structures all require space.

For layout examples, see section [Cooling and degrees of protection](#) below.

### ■ Grounding of mounting structures

Make sure all cross-members or shelves on which drive system components are mounted are properly grounded and the connecting surfaces left unpainted.

---

#### **Notes:**

Ensure that the components are properly grounded through their fastening points to the installation base.

It is recommended that the mains filter (if present) and the drive be mounted on the same mounting plate.

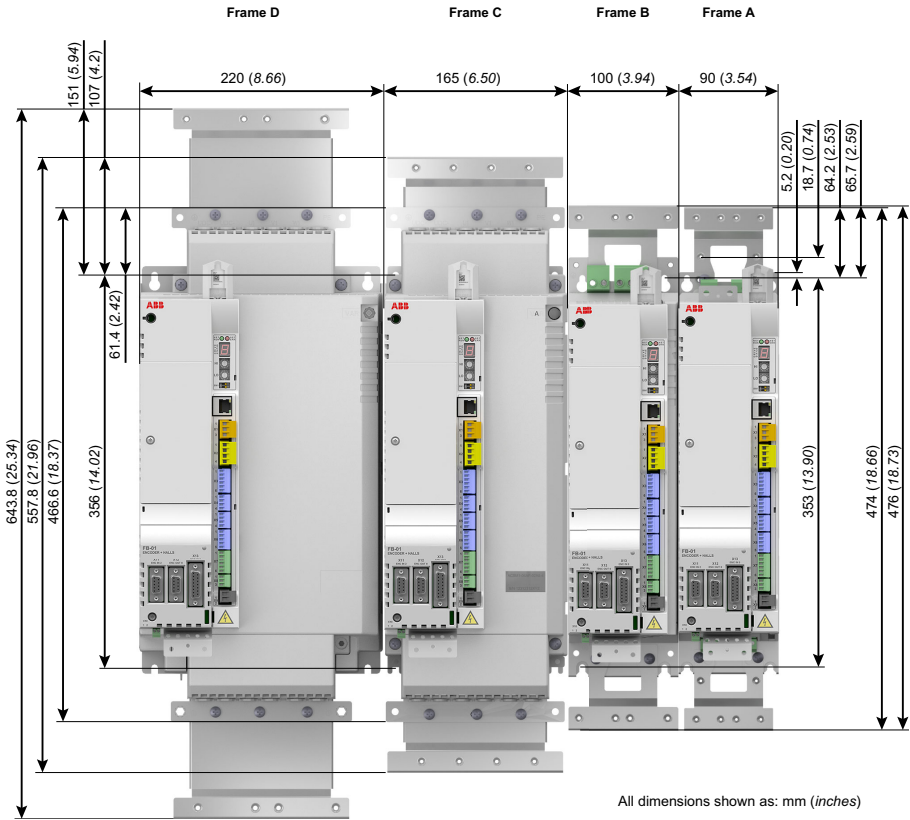
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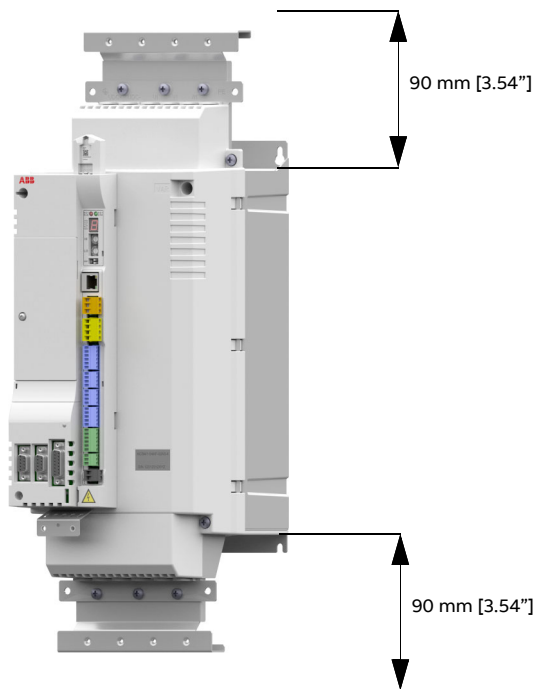
## Main dimensions and free space requirements

The drives can be installed side by side. The main dimensions of the drives as well as free space requirements are shown below. For more details, refer to the chapter [Dimension drawings](#).



## Cooling and degrees of protection

The cabinet must have enough free space for the components to ensure sufficient cooling. Observe the minimum clearances given for each component.



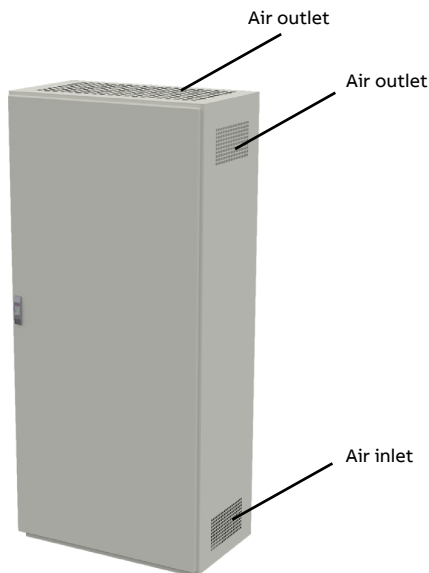
The air inlets and outlets must be equipped with gratings that

- guide the air flow
- protect against contact
- prevent water splashes from entering the cabinet.

The temperature of the cooling air entering the unit must not exceed the maximum allowed ambient temperature (see [Ambient conditions](#) in the chapter [Technical data](#)). Consider this when installing heat-generating components (such as other drives, mains chokes and braking resistors) nearby.

The drawing below shows two typical cabinet cooling solutions. The air inlet is at the bottom of the cabinet, while the outlet is at the top.

---



Arrange the cooling of the drives so that the requirements given in chapter *Technical data* are met:

- Cooling air flow. Note that the values in *Technical data* apply to continuous nominal load. If the load is less than nominal, less cooling air is required.
- Allowed ambient temperature.

Make sure the air inlets and outlets are sufficient in size. Note that in addition to the power loss of the drive, the heat dissipated by cables and other additional equipment must also be ventilated.

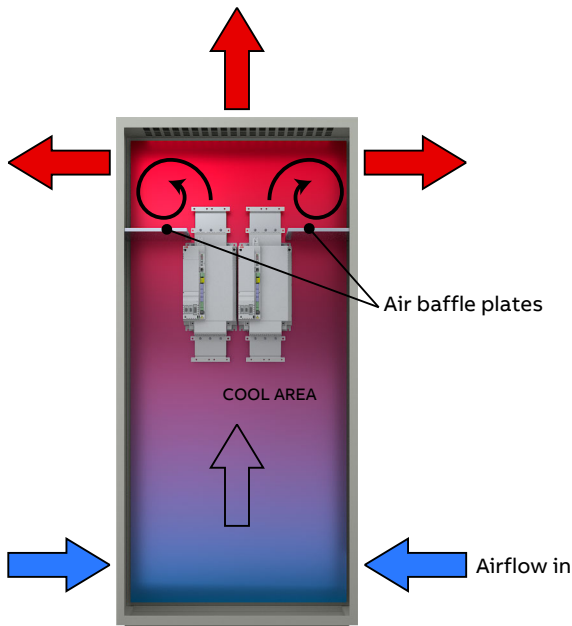
The internal cooling fans of the drives are usually sufficient to keep the component temperatures low enough in IP22 cabinets.

In IP54 cabinets, thick filter mats are used to prevent water splashes from entering the cabinet. This entails the installation of additional cooling equipment, such as a hot air exhaust fan.

The installation site must be sufficiently ventilated.



## ■ Preventing the recirculation of hot air



### Outside the cabinet

Prevent hot air circulation outside the cabinet by leading the outcoming hot air away from the area where the inlet air to the cabinet is taken. Possible solutions are listed below:

- gratings that guide air flow at the air inlet and outlet
- air inlet and outlet at different sides of the cabinet
- cool air inlet in the lower part of the front door and an extra exhaust fan on the roof of the cabinet.

### Inside the cabinet

Prevent hot air circulation inside the cabinet with leak-proof air baffle plates. No gaskets are usually required.

## Cabinet heaters

Use a cabinet heater if there is a risk of condensation in the cabinet. Although the primary function of the heater is to keep the air dry, it may also be required for heating at low temperatures. When placing the heater, follow the instructions provided by its manufacturer.

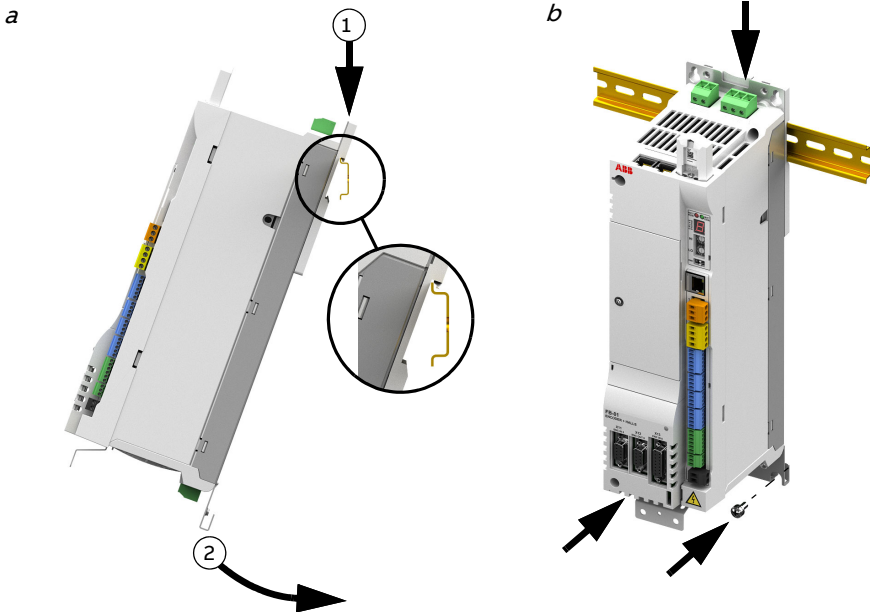
## Installation procedure

### ■ Direct wall mounting

1. Mark the locations for the four holes. The mounting points are shown in [Dimension drawings](#).
2. Fix the screws or bolts to the marked locations.
3. Position the drive onto the screws on the wall. **Note:** Only lift the drive by its chassis.
4. Tighten the screws.

### ■ DIN rail mounting (frames A and B only)

1. Click the drive to the rail as shown in Figure *a* below. To detach the drive, press the release lever on top of the drive as shown in Figure *b*.
2. Fasten the lower edge of the drive to the mounting base through the two fastening points.



### ■ Mains choke installation

See the chapter [Mains chokes](#) on page 189.

### ■ DC choke installation

See the chapter [DC chokes](#) on page 193.

### ■ Mains filter installation

See the chapter [Mains filters](#) on page 197.

### ■ Braking resistor installation

See the chapter [Resistor braking](#) on page 201.

### ■ Feedback module installation

If the feedback module has been supplied separately see [Motor feedback modules](#) on page 86.



## 5

# Planning the electrical installation

---

## What this chapter contains

This chapter contains the instructions that you must follow when selecting the motor, cables, protections, cable routing and way of operation for the drive. If the recommendations given by ABB are not followed, the drive may experience problems that the warranty does not cover.

**Note:** 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.

## Motor selection

Select the (3-phase AC induction) motor according to the rating table in the chapter [Technical data](#). The table lists the typical motor power for each drive type.

Only one permanent magnet synchronous motor can be connected to the inverter output. It is recommended to install a safety switch between the permanent magnet motor and the drive output in order to isolate the motor from the drive during maintenance work on the drive.

## Supply connection

Use a fixed connection to the AC power line.

---



**WARNING!** As the leakage current of the device typically exceeds 3.5 mA, a fixed installation is required according to EN 61800-5-1.

---

## Supply disconnecting device

Install a hand-operated input disconnecting device (disconnecting means) between the AC power source and the drive. The disconnecting device must be of a type that can be locked to the open position for installation and maintenance work.

### Europe:

If the drive is used in an application which must meet the European Union Machinery Directive according to standard EN 60204-1 Safety of Machinery, the disconnecting device must be one of the following types:

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

### ■ Other regions

The disconnecting means must conform to the applicable safety regulations.

## Thermal overload and short circuit protection

### ■ Thermal overload protection

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



**WARNING!** If the drive is connected to multiple motors, a separate thermal overload switch or a circuit breaker must be used for protecting each cable and motor. These devices may require a separate fuse to cut off the short-circuit current.

---

### ■ Protection against short-circuit in motor cable

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

---



## ■ Protection against short-circuit in the supply cable or the drive

Protect the supply cable with fuses or circuit breakers. Fuse recommendations are given in the chapter [Technical data](#). When placed at the distribution board, standard IEC gG fuses or UL type T 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.

### Operating time of the fuses and circuit breakers

Check that the operating time of the fuse is below 0.5 seconds. The operating time depends on the type, the supply network impedance, and the cross-sectional area, material and length of the supply cable. US fuses must be of the “non-time delay” type.

### Circuit breakers

The protective characteristics of circuit breakers depend on the supply voltage as well as the type and construction of the breakers. There are also limitations pertaining to the short-circuit capacity of the supply network. Your local ABB representative can help you in selecting the breaker type when the supply network characteristics are known.

## ■ Motor thermal protection

According to regulations, the motor must be protected against thermal overload and the current must be switched off when overloading is detected. The drive includes a motor thermal protection function that protects the motor and switches off the current when necessary. The MotiFlex e180 has a dedicated connection for PTC sensors. The drive can react to this input according to the setting of `MOTORTEMPERATUREMODE`. See the Mint help file for details.

## Ground fault protection

The drive is equipped with an internal ground fault protective function to protect the unit against ground faults in the motor and the motor cable. This is not a personal safety or a fire protection feature.

The optional mains filter 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.

## Emergency stop devices

For safety reasons, install the emergency stop devices at each operator control station and at other operating stations where emergency stop may be needed.

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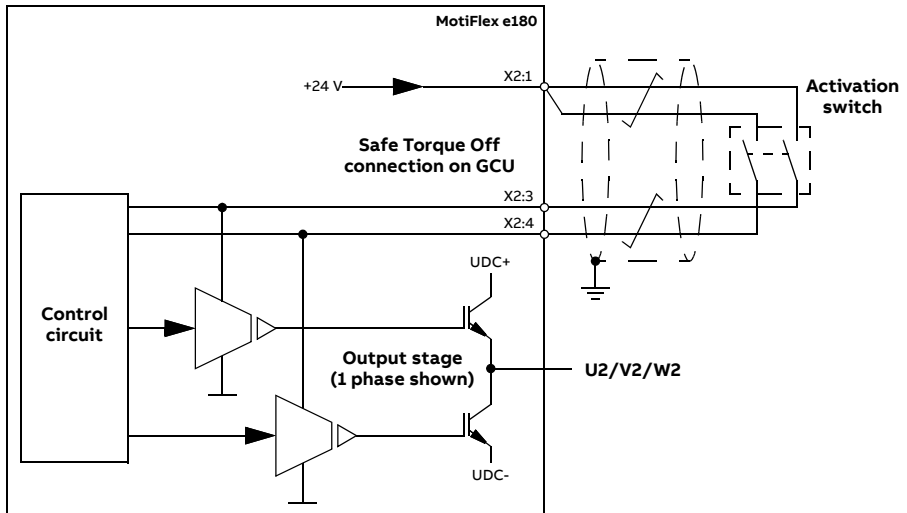
**Note:** Stopping motion and/or disabling the drive in software does not separate the drive from dangerous potential.

---

## Safe Torque Off

The drive supports the Safe Torque Off function according to standards EN 61800-5-2; IEC 61800-5-2; EN 60204-1; EN 61508.

The Safe Torque Off function disables the control voltage of the power semiconductors of the drive output stage, thus preventing the inverter from generating the voltage required to rotate the motor (see diagram below). By using this function, short-time operations (like cleaning) and/or maintenance work on non-electrical parts of the machinery can be performed without switching off the power supply to the drive.



### Notes:

- The STO function is activated when one or both of the safety circuit contacts open. If the period between both contacts opening or closing exceeds a predefined value, a fault in the safety circuit or wiring is assumed and an error is reported. See [Appendix: Safe Torque Off \(STO\)](#) on page 227.
- The maximum cable length between the drive and the activation switch is 30 m (98 ft)



**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 system from the main supply.

**Note:** It is not recommended to stop the drive by using the Safe Torque Off function. If a running drive is stopped by using the Safe Torque Off function, the drive will stop by coasting. If this is not acceptable (e.g. causes danger), the drive and machinery must be stopped using the appropriate stopping mode before using this function.

For further information on the function, see [Appendix: Safe Torque Off \(STO\)](#) on page 227.

# Selecting the power cables

## ■ General rules

Dimension the supply (input power) and motor cables **according to local regulations**.

- The cable must be able to carry the drive load current. See the chapter [Technical data](#) for the rated currents.
- The cable must be rated for at least 70 °C (US: 75 °C [167 °F]) maximum permissible temperature of conductor in continuous use.
- The conductivity of the PE conductor must be equal to that of a phase conductor (i.e. same cross-sectional area).
- 600 VAC cable is accepted for up to 500 VAC.
- Refer to the chapter [Technical data](#) for EMC requirements.

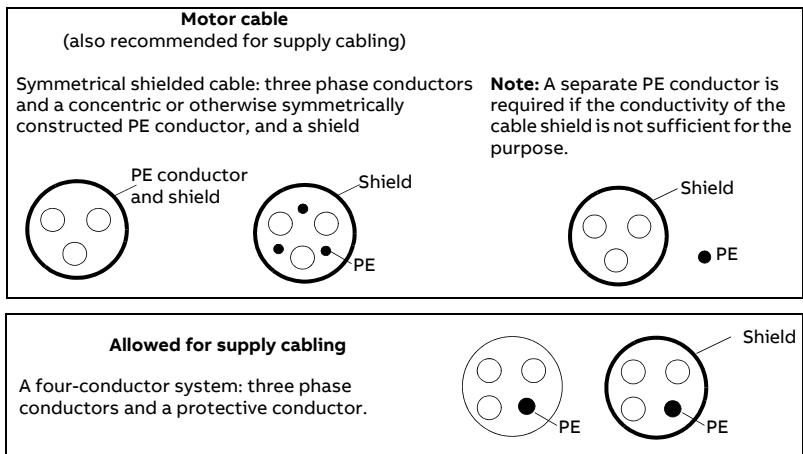
Symmetrical shielded motor cable must be used (see the figure below) to meet the EMC requirements of the CE mark.

A four-conductor system is allowed for input cabling, but shielded symmetrical cable is recommended. Compared to a four-conductor system, the use of symmetrical shielded cable reduces electromagnetic emission of the whole drive system as well as motor bearing currents and wear.

The motor cable and its PE pigtail (twisted shield) must be kept as short as possible in order to reduce electromagnetic emission.

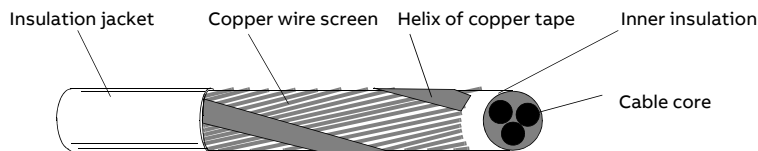
## ■ Alternative power cable types

Power cable types that can be used with the drive are represented below.



## ■ Motor cable shield

To function as a protective conductor, the shield must have the same cross-sectional area as a phase conductor when they are made of the same metal. To effectively suppress radiated and conducted radio-frequency emissions, the shield conductivity must be at least 1/10 of the phase conductor conductivity. The requirements are easily met with a copper or aluminium 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. The better and tighter the shield, the lower the emission level and the bearing currents.

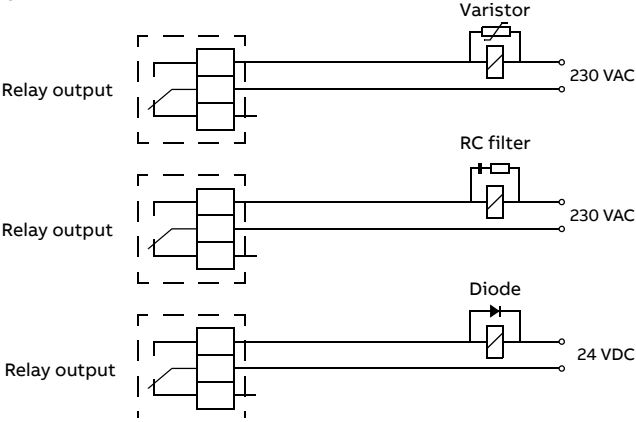


## Protecting the relay output contacts and attenuating disturbances in case of inductive loads

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

The relay output on the drive is protected with varistors (250 V) against overvoltage peaks. In addition, it is highly recommended to equip inductive loads with noise attenuating circuits (varistors, RC filters [AC] or diodes [DC]) in order to minimize the electromagnetic emissions 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, not at the relay output.



**Residual current device (RCD) compatibility**

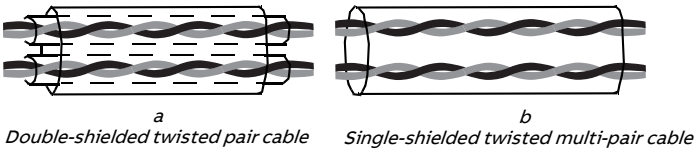
MotiFlex e180 drives are suitable to be used with residual current devices of Type B. Other measures for protection in case of direct or indirect contact, such as separation from the environment by double or reinforced insulation or isolation from the supply system by a transformer, can also be applied.

**Selecting the control cables**

It is recommended that all control cables be shielded.

Double-shielded twisted pair cable is recommended for analogue signals. For pulse encoder cabling, follow the instructions given by the encoder manufacturer. Use one individually-shielded pair for each signal. Do not use a common return for different analogue signals.

Double-shielded cable is the best alternative for low-voltage digital signals but single-shielded twisted multipair cable (Figure *b*) is also usable.



Run analogue and digital signals in separate cables.

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

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

## ■ Relay cable

The cable type with braided metallic screen (e.g. ÖLFLEX by Lapp Kabel, Germany) has been tested and approved by ABB.

## Connection of a motor temperature sensor to the drive

See page 79.

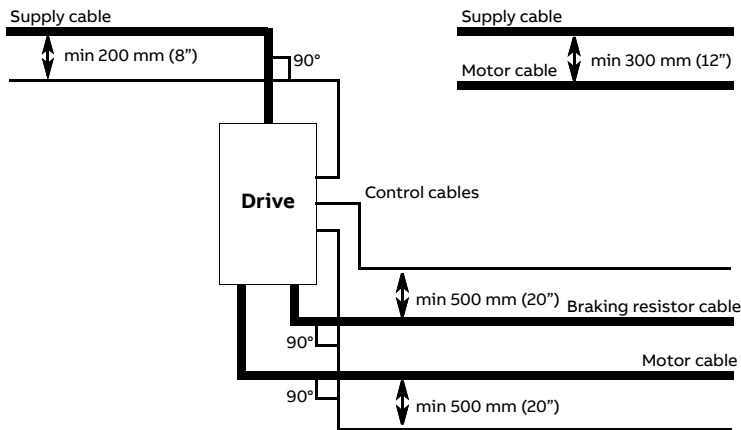
## Routing the cables

Route the motor cable away from other cable routes. Motor cables of several drives can be run in parallel installed next to each other. It is recommended that the motor cable, input power cable and control cables 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.

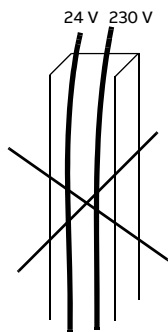
Where control cables must cross power cables make sure they are arranged at an angle as near to 90 degrees as possible. Do not run extra cables through the drive.

The cable trays must have good electrical bonding to each other and to the grounding electrodes. Aluminium tray systems can be used to improve local equalizing of potential.

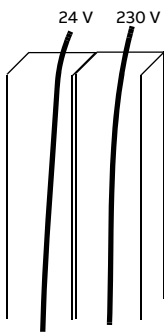
A diagram of the cable routing is below.



■ **Control cable ducts**



Not allowed unless the 24 V cable is insulated for 230 V or insulated with an insulation sleeving for 230 V.



Lead 24 V and 230 V control cables in separate ducts inside the cabinet.



# 6

## Electrical installation: AC input, motor and brake

---

### What this chapter contains

The chapter describes how to connect input power cables, motor and brake resistor.



**WARNING!** The work described in this chapter may only be carried out by a qualified electrician. Follow the instructions in chapter [Safety](#) on page [13](#). Ignoring the safety instructions can cause injury or death.

**Make sure that the drive is disconnected from the input power during installation. If the drive is already connected to the input power, wait for 5 minutes after disconnecting the input power.**

---



## Checking the insulation of the assembly

### ■ Drive

Do not make any voltage tolerance or insulation resistance tests (e.g. hi-pot or megger) 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.

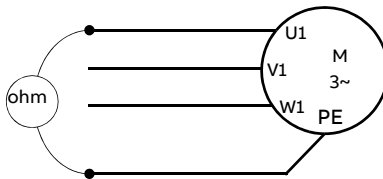
### ■ Supply cable

Check the insulation of the supply (input) cable according to local regulations before connecting to the drive.

### ■ Motor and motor cable

Check the insulation of the motor and motor cable as follows:

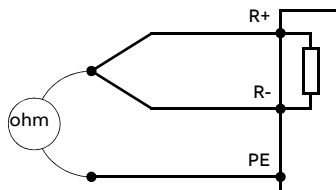
- Check that the motor cable is connected to the motor, and disconnected from the drive output terminals U2, V2 and W2.
- Measure the insulation resistance between each phase and the motor PE conductor by using a measuring voltage of 1 kV DC. The insulation resistance must be higher than 1 Mohm.



### ■ Braking resistor assembly

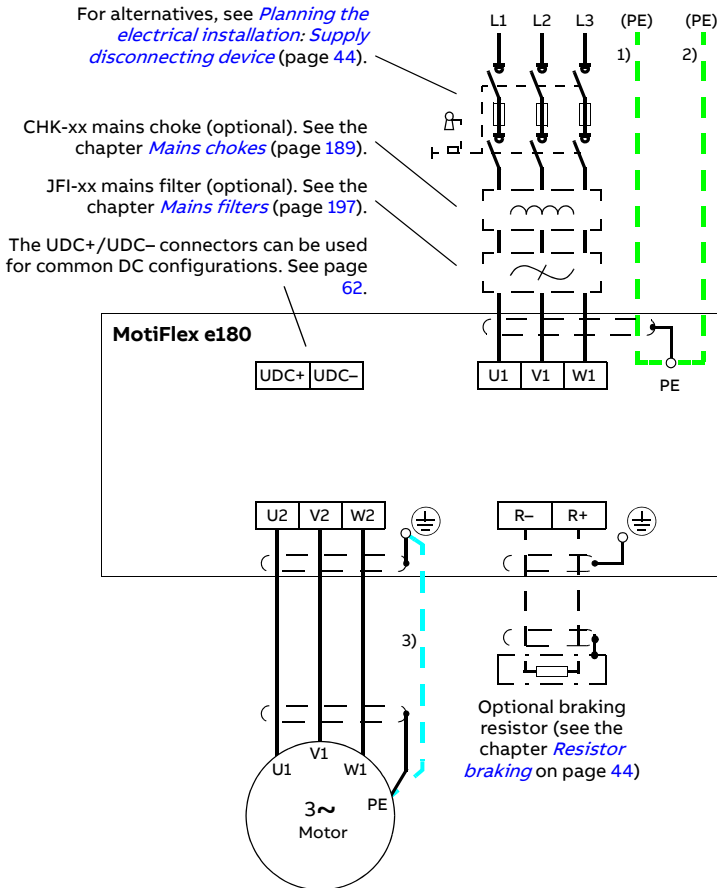
Check the insulation of the braking resistor assembly (if present) as follows:

1. Check that the resistor cable is connected to the resistor, and disconnected from the drive output terminals R+ and R-.
2. At the drive end, 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.



## Power cable connection

### ■ Power cable connection diagram



#### Notes:

- If shielded supply (input) cable is used, and the conductivity of the shield is less than 50% of the conductivity of a phase conductor, use a cable with a ground conductor (1) or a separate PE cable (2).
- For motor cabling, use a separate ground cable (3) if the conductivity of the cable shield is less than 50% of the conductivity of a phase conductor and the cable has no symmetrical ground conductors. See also section [Selecting the power cables](#) on page 48.

## ■ Procedure

Cabling drawings with tightening torques for each frame size are presented on pages 59 to 61.

1. Frame sizes C and D only: Remove the two plastic connector covers at the top and bottom of the drive. Each cover is fastened with two screws.
2. On IT (ungrounded) systems and corner grounded TN systems, disconnect the internal varistors by removing the screw labelled VAR (located close to the supply terminals on the power unit).



**WARNING!** If a drive whose varistors are not disconnected is installed on an IT system (an ungrounded power system or a high resistance grounded [over 30 ohms] power system), the system will be connected to earth potential through the varistors of the drive. This may cause danger or damage the drive.

If a drive whose varistors are not disconnected is installed on a corner grounded TN system, the drive will be damaged.

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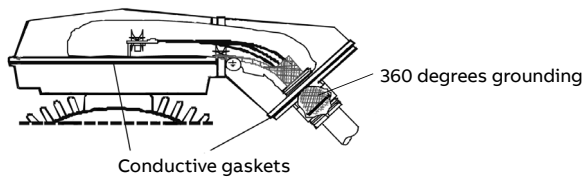
3. Fasten the two cable clamp plates included to the drive (see page 58), one at the top, one at the bottom. The clamp plates are identical. Using the cable clamp plates as shown below will provide better EMC compliance, as well as act as a strain relief for the power cables.
  4. Strip the power cables so that the shields are bare at the cable clamps.
  5. Twist the ends of the cable shield wires into pigtails.
  6. Strip the ends of the phase conductors.
  7. Connect the phase conductors of the supply cable to the U1, V1 and W1 terminals of the drive.  
Connect the phase conductors of the motor cable to the U2, V2 and W2 terminals.  
Connect the conductors of the resistor cable (if present) to the R+ and R- terminals.  
With frame size C or D, attach the screw terminal lugs included to the conductors first. Crimp lugs can be used instead of the screw lugs.
  8. Tighten the cable clamps onto the bare cable shields.
  9. Crimp a cable lug onto each shield pigtail. Fasten the lugs to ground terminals.  
**Note:** Try to work out a compromise between the length of the pigtail and the length of unshielded phase conductors as both should ideally be as short as possible.
  10. Cover visible bare shield and pigtail with insulating tape.
- 



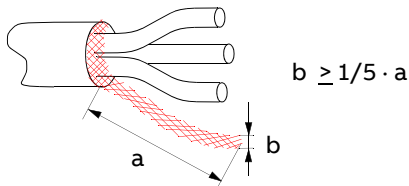
11. With frame size C or D, cut suitable slots on the edges of the connector covers to accommodate the supply and motor cables. Refit the covers. (Tighten the screws to 3 N·m [25 lbf·in]).
12. Secure the cables outside the unit mechanically.
13. Ground the other end of the supply cable shield or PE conductor(s) at the distribution board. In case a mains choke and/or a mains filter is installed, make sure the PE conductor is continuous from the distribution board to the drive.

### Grounding the motor cable shield at the motor end

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.



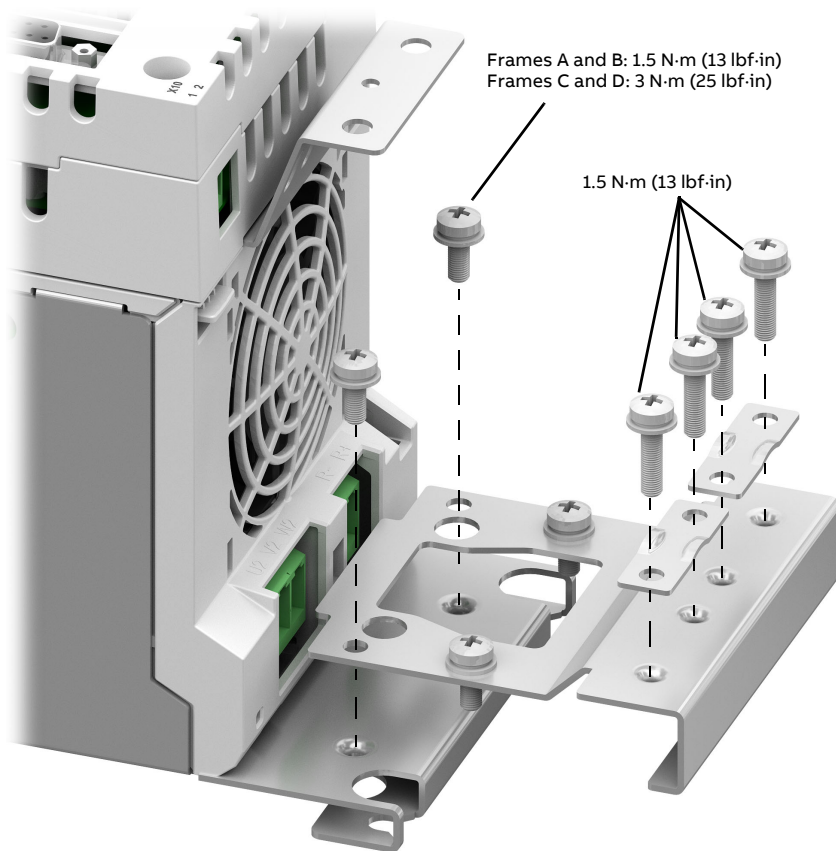
### Installation of power cable clamp plates

Two identical power cable clamp plates are included with the drive. The picture below depicts a frame size A drive; the installation is similar with other frame sizes.

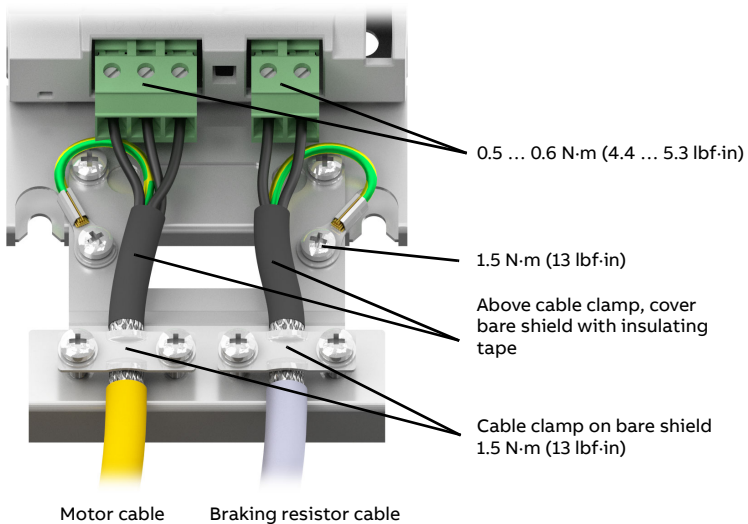
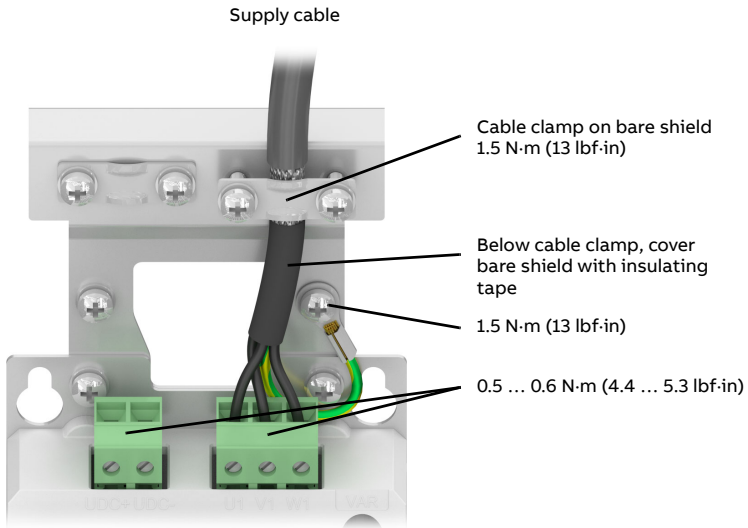
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**Note:** Pay attention to supporting the cables adequately within the installation enclosure especially if not using the cable clamps.

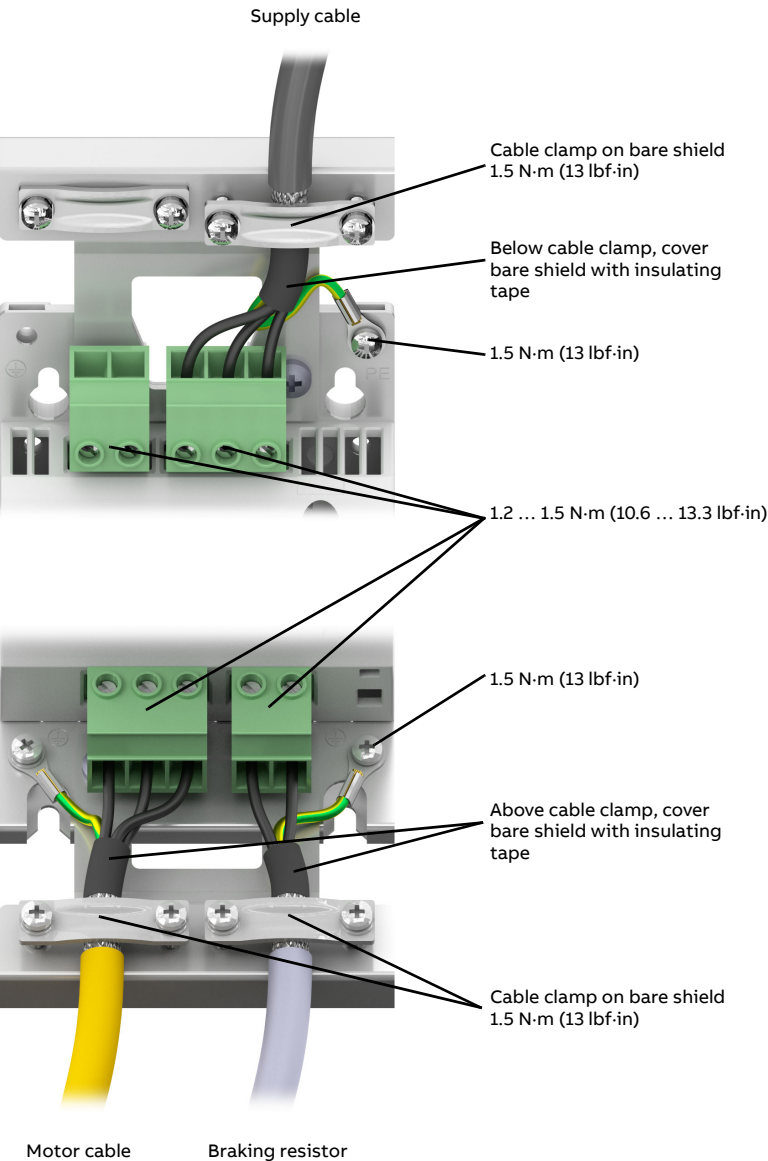
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## Power cable connection – frame size A

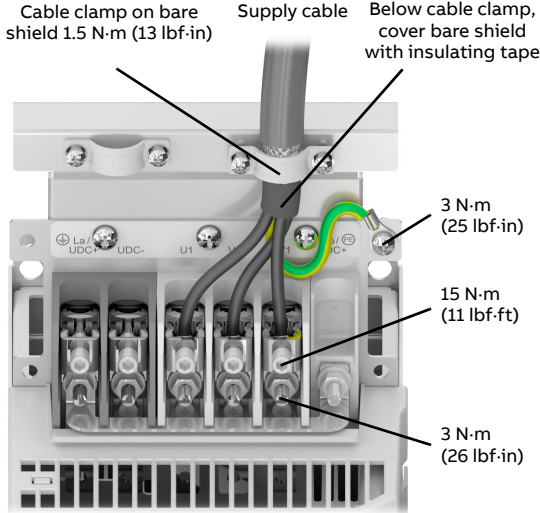


**Power cable connection – frame size B**

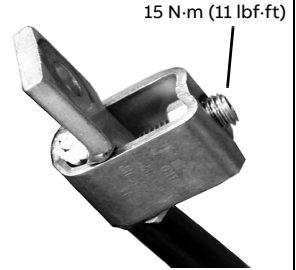




## Power cable connection – frame sizes C and D (connector covers removed)

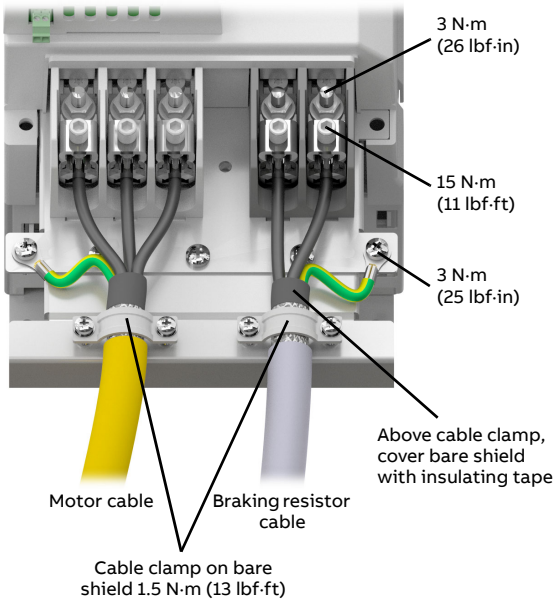
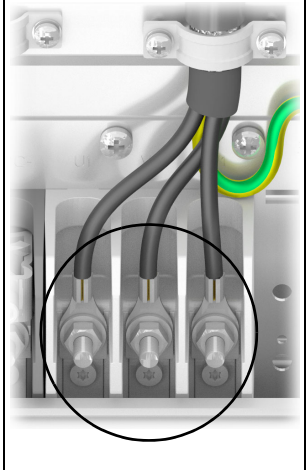


### Screw lug detail



### Direct lug connection

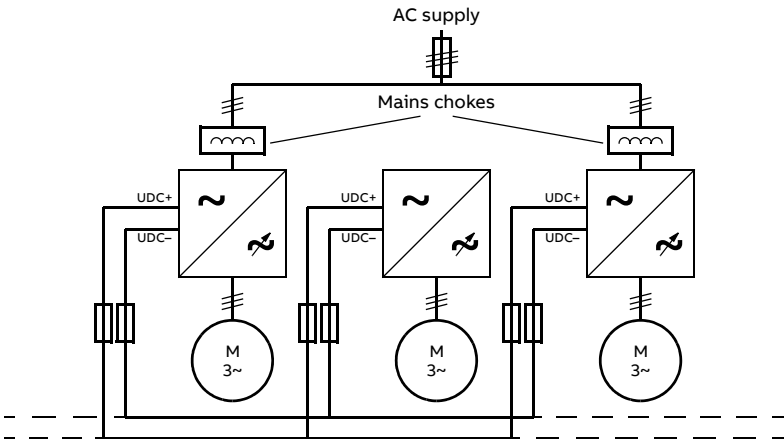
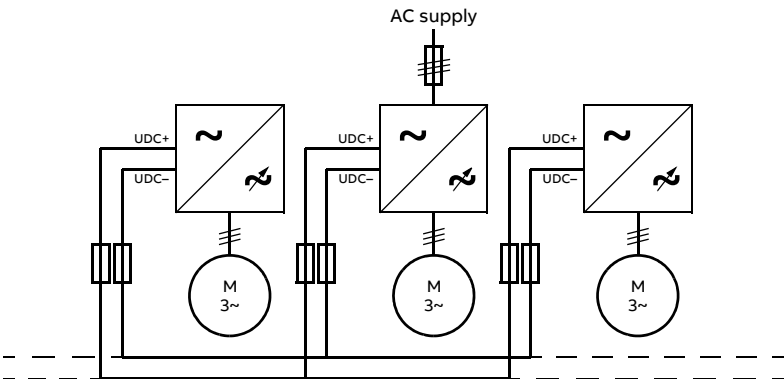
Instead of using the screw lugs included, the conductors of power cables can be connected to the drive terminals by removing the screw lugs and using crimp lugs.



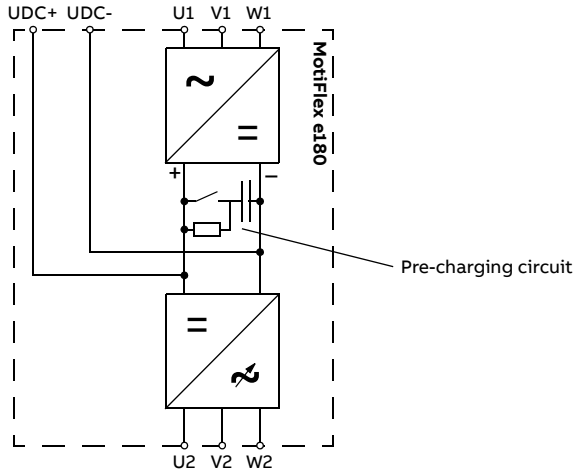
■ DC connection

The UDC+ and UDC– terminals are intended for common DC configurations of a number of MotiFlex e180 drives, allowing regenerative energy from one drive to be utilised by the other drives in motoring mode.

One or more drives are connected to the AC supply depending on the power requirement. In case two or more drives are connected to the AC supply, each AC connection must be equipped with a mains choke (or DC choke) to ensure even current distribution between the rectifiers. The diagram below shows two configuration examples.



Each drive has an independent DC capacitor pre-charging circuit.

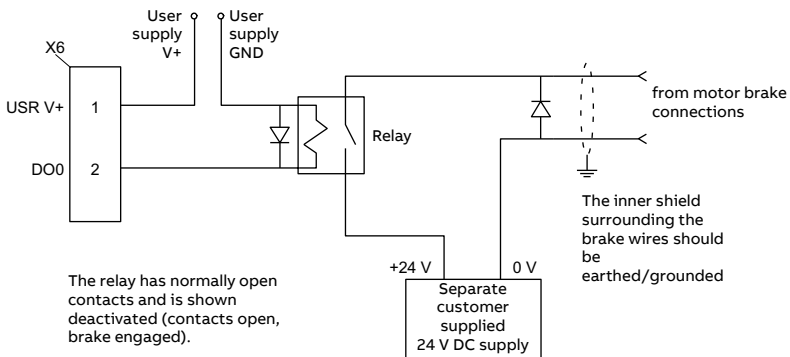


The ratings of the DC connection are given on page [172](#).

## Motor brake connection

A rotary motor might require a brake. The brake prevents the uncontrolled release of suspended or tensioned loads when power to the motor is removed or disconnected, e.g. by a motor circuit contactor. Contact your local supplier for details of appropriate brakes.

You can wire a motor's brake, via relays, to digital outputs on connector X6; see [Control connections to the control unit](#) on page [66](#). This provides a way for the MotiFlex e180 to control the motor's brake. A typical circuit is shown in the following diagram:



This circuit uses DO0 as a motor brake output. The output is configured using Mint keyword `MOTORBRAKEOUTPUT`; see the Mint help file for details. With this configuration, the following sequences can be used to control the brake.

To engage the brake:


- The motor is brought to rest under normal control;
- The relay is deactivated, causing the brake to engage;
- The drive is disabled, removing power from the motor.

To disengage the brake:

- The drive is enabled;
- The drive applies power to the motor to hold position under normal control;
- The relay is activated, causing the brake to be disengaged.

It is sometimes necessary to include a small delay after the relay has been activated, before starting motion. This delay allows time for the relay contacts to engage and the brake to release. See the Mint keyword `MOTORBRAKEDELAY`.

---

 **WARNING!** The 24 V DC power supply used to power the brake must be a separate supply as shown in the diagram. Do not use the supply that is powering the MotiFlex e180 digital outputs. The brake wires often carry noise that could cause erratic drive operation or damage. The brake contacts must never be wired directly to the digital outputs. The relay should be fitted with a protective flyback diode, as shown. The separate 24 V DC supply used for the motor brake can also be used to power the relay in the thermal switch circuit (page 79).

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# 7

## Electrical installation: input / output

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### What this chapter contains

The chapter describes how to connect low voltage control signals.

The following conventions will be used to refer to the inputs and outputs:

I/O	Input / Output
AI	Analogue Input
AO	Analogue Output
DI	Digital Input
DO	Digital Output
STO	Safe Torque Off



**WARNING!** The work described in this chapter may only be carried out by a qualified electrician. Follow the instructions in chapter [Safety](#) on page [13](#). Ignoring the safety instructions can cause injury or death.

**Make sure that the drive is disconnected from the input power during installation. If the drive is already connected to the input power, wait for 5 minutes after disconnecting the input power.**

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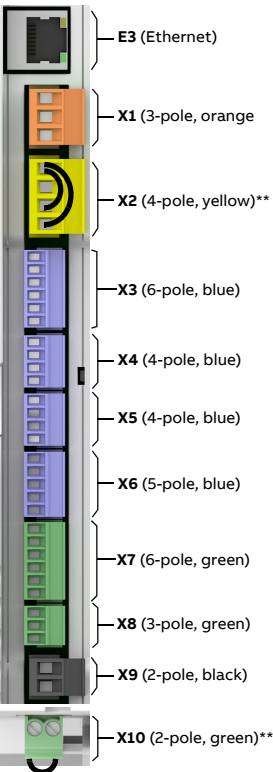
Connecting the control cables

Control connections to the control unit

**Notes:**  
\*Maximum 100 mA per output.  
The wiring shown is for demonstrative purposes only.  
Further information of the usage of the connectors and jumpers are given in the text; more details are available in the chapter *Technical data*.

**Wire sizes and tightening torques:**  
**X1, X2, X9:** 0.5 ... 2.5 mm<sup>2</sup> (20...12 AWG). Torque: 0.5 N·m (5 lbf·in)  
**X3, X4, X5, X6, X7, X8, X10:** 0.5 ... 1.5 mm<sup>2</sup> (20...14 AWG). Torque: 0.25 N·m (2.2 lbf·in)

Order of terminal headers and jumpers



Ethernet		E3	To host PC
Host		1	
Relay output		X1	
250 V AC / 30 V DC 2 A	NC	1	
	COM	2	
	NO	3	
Safe Torque Off. Both circuits must be closed for the drive to start. See page 227.		X2	
+24V OUT		1	
SGND		2	
STO1 IN		3	
STO2 IN		4	
Digital input 1-		X3	
Digital input 1+		1	
Shield		2	
Digital input 2-		3	
Digital input 2+		4	
Shield		5	
Digital input 0		X4	
Digital input 3		1	
Digital input 4		2	
Common reference 0		3	
Digital input 5		X5	
Digital input 6		1	
Digital input 7		2	
Common reference 1		3	
User +24 V DC		X6	
Digital output 0*		1	
Digital output 1*		2	
Digital output 2*		3	
Digital output 3*		4	
Analogue input 0+		X7	
Analogue input 0-		1	
Analogue ground		2	
Analogue input 1+		3	
Analogue input 1-		4	
Shield		5	
Analogue output 0		X8	
AGND		1	
Shield		2	
External power input, 24 V, 1 A		X9	
+24 V IN		1	
GND		2	
Motor thermistor		X10	
TH1		1	
TH2		2	

\* Maximum 100 mA per output.  
\*\* X2 and X10 connectors are supplied with wires that allow the drive to operate without using the STO or motor thermistor functions.

## Analogue I/O

The MotiFlex e180 provides:

- Two 12-bit resolution  $\pm 10$  V analogue inputs.
- One 12-bit resolution  $\pm 10$  V analogue output.

An analogue input receives the torque / velocity reference signal when operating as an analogue drive (see `CONTROLREFSOURCE` in the Mint help file), or it can be used as a general purpose ADC input.

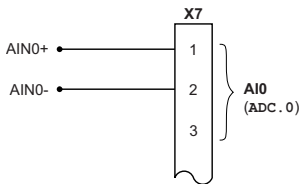
### ■ X7: Analogue inputs AI0, AI1

The analogue inputs pass through a differential buffer and second order low-pass filter with a cut-off frequency of approximately 1.2 kHz.

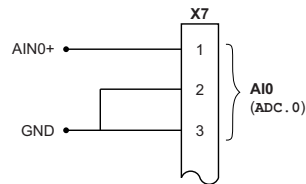
The analogue input can be connected as either a differential or a single ended input as shown below. The analogue input is not optically isolated from internal power rails, so care must be taken to avoid earth/ground loops and similar associated problems. To minimize the effects of noise, the analogue input signal should be connected to the system using an individually shielded twisted pair cable with an overall shield. The overall shield should be connected to the chassis at one end only. No other connection should be made to the shield.

When the MotiFlex e180 is connected to Mint WorkBench, the analogue input value (expressed as a percentage) can be viewed using the Spy window's Monitor tab. Alternatively, the command `Print ADC(0)` can be used in the command window to return the value of the analogue input. See the Mint help file for full details of `ADC`, `ADCMODE` and other related `ADC...` keywords.

Differential inputs: connect input to AIN+ and AIN-. Leave AGND unconnected:



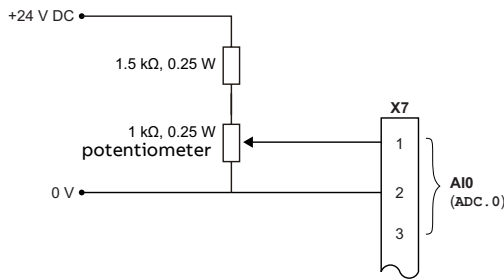
Differential connection



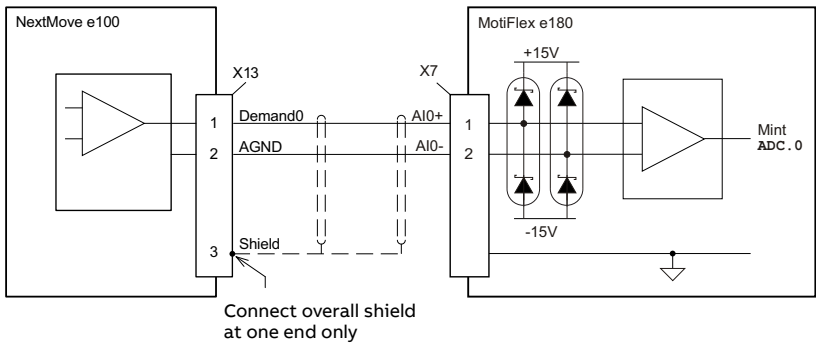
Single ended connection



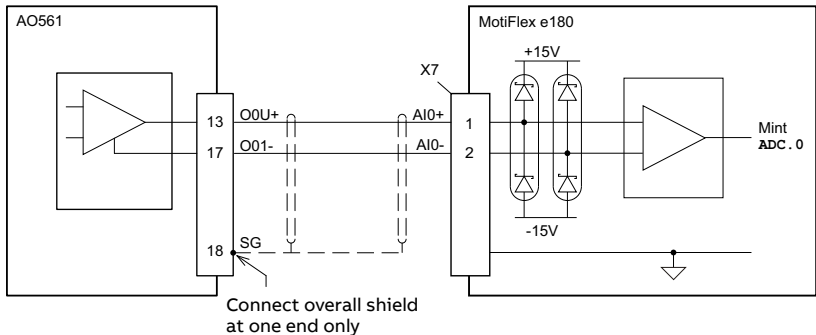
Typical input circuit to provide 0-10 V (approx.) input from a 24 V source:



Analogue input - typical connections from an ABB NextMove e100:



Analogue input - typical connections from an ABB AO561:

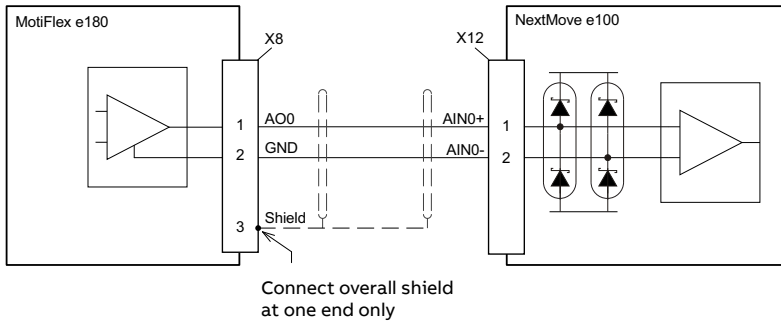




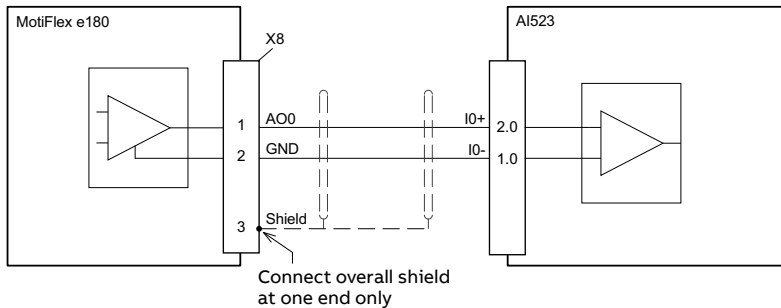
## ■ X8: Analogue output AOO

The analogue output can be used to drive loads of  $1\text{ k}\Omega$  or greater. Shielded twisted pair cable should be used. The shield connection should be made at one end only. In Mint, the analogue output can be controlled using the `DAC` keyword. See the Mint help file for full details of `DAC` and other related `DAC...` keywords.

Analogue output - typical connections to an ABB NextMove e100:



Analogue output - typical connections to an ABB AI523:



## Digital I/O

The MotiFlex e180 provides:

- 8 general purpose digital inputs.
- 2 dedicated Safe Torque Off (STO) inputs.
- 4 general purpose digital outputs.

### ■ Using a digital input as a drive enable input (optional)

A general purpose digital input can be configured as a 'drive enable input'. This input must be activated to allow the drive to operate. This provides an additional method for stopping the drive using a hardware switch or external PLC/controller (e.g. AC500 or NextMove e100) although it does not provide any of the formal safety features of the Safe Torque Off inputs (see page 227). The optional drive enable input is configured using the Digital I/O tool in Mint WorkBench.

### ■ Using a digital input as a home switch input (optional)

If homing is being handled locally by the MotiFlex e180, the axis home switch (if present) must be wired directly to the home input on the MotiFlex e180, otherwise it will not be able to complete its internal homing routines. The home switch input is configured using the Digital I/O tool in Mint WorkBench, or by using the Mint `HOMEINPUT` keyword. Other `HOME...` keywords define the homing sequence.

If homing is being handled by an EtherCAT® master over Ethernet, and the master is profiling the motion, there are three options. The choice depends on the accuracy required for the homing and the EtherCAT cycle-time:

- The axis home switch is wired to an input on the MotiFlex e180, and then mapped back to the master over EtherCAT;
- The home switch is wired directly to the EtherCAT master.
- The home switch is wired to one of the fast inputs (DI1 / DI2), and the master enables the drive's touchprobe function. See the Mint WorkBench help file for details.

### ■ X2: Digital inputs - Safe Torque Off (STO) inputs

The two safe torque off (STO) inputs are identical. Each input directly enables part of the motor output control circuit. Both inputs must be powered to allow the MotiFlex e180 to supply power to the motor. If an additional hardware drive enable input is used to control the MotiFlex e180, it must not be wired with the STO input circuit. The state of the STO inputs can be viewed using the Mint WorkBench Spy window's Axis tab. See the Mint help file for details.

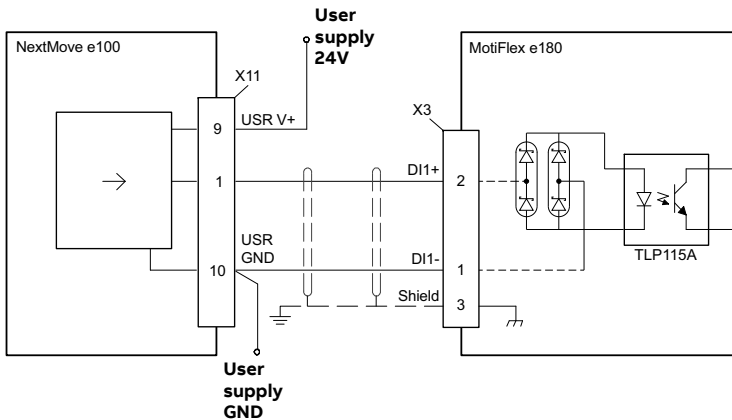
See Appendix: [Appendix: Safe Torque Off \(STO\)](#) on page 227.



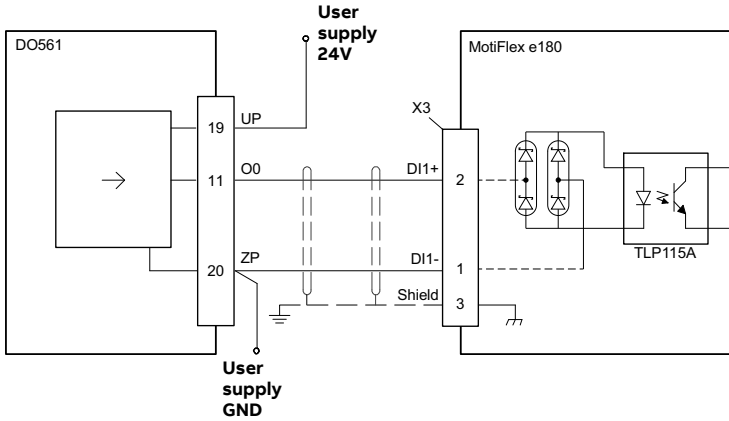
### ■ X3: Digital inputs - general purpose DI1 & DI2

These general purpose fast digital inputs are buffered by an opto-isolator, allowing the input signal to be connected with either polarity. When the MotiFlex e180 is connected to Mint WorkBench, the digital input can be configured using the Digital I/O tool. Alternatively, Mint keywords including `RESETINPUT`, `ERRORINPUT`, `STOPINPUT`, `FORWARDLIMITINPUT`, `REVERSELIMITINPUT` and `HOMEINPUT` can be used. The state of the digital inputs can be viewed using the Mint WorkBench Spy window's Axis tab. See the Mint help file for details.

Digital input - typical connections from an ABB NextMove e100:



Digital input - typical connections from an ABB DO561:



### ■ X3: Digital inputs - special function DI1 & DI2

DI1 and DI2 can be configured to perform special functions.

#### Step (pulse) and direction inputs

DI1 and DI2 can be configured using the statement `ENCODERMODE (1) =4` to become step and direction inputs:

- DI1 is used as the step input. The step frequency controls the speed of the motor.
- DI2 is used as the direction input. The state of the direction input controls the direction of motion. An active input results in forward motion. An inactive input results in motion in the opposite direction.

#### Encoder input

DI1 and DI2 can be configured using the statement `ENCODERMODE (1) =0` to form an additional encoder input. The two channels are read as a quadrature (CHA, CHB) encoder input.

In Mint, the encoder input formed by digital inputs DI1 and DI2 is encoder 1. The primary motor feedback encoder source on connector X13 is encoder 0, and the master incremental encoder on connector X11 is encoder 2; see pages [89-95](#).

## Fast latch input

DI1 or DI2 can be configured using the `LATCHTRIGGERCHANNEL` keyword to become a fast latch input. This allows the position of the axis to be captured in real-time and read using the Mint keyword `LATCHVALUE`. The input can be configured using the `LATCHTRIGGEREDGE` keyword to be triggered either on a rising or falling edge. Further control of position capture is provided by various other keywords beginning with `LATCH....` See the Mint help file for details.

The maximum latency to read the fast position depends on the feedback device. For an incremental encoder, the latency is approximately 150 - 300 ns. For other feedback devices latency can be up to 62.5  $\mu$ s, resulting from the 16 kHz sampling frequency used for these types of feedback device. The fast interrupt is latched on a pulse width of about 30  $\mu$ s, although a width of 100  $\mu$ s is recommended to ensure capture. The captured value is latched in software to prevent subsequent inputs causing the captured value to be overwritten.

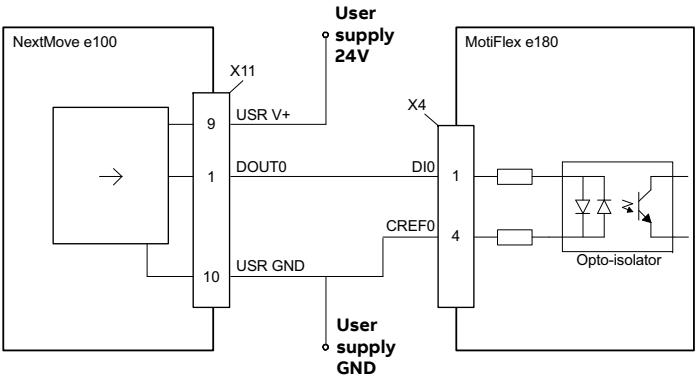
**Note:** The fast inputs are particularly sensitive to noise, so inputs must use shielded twisted pair cable. Do not connect mechanical switches, relay contacts or other sources liable to signal 'bounce' directly to the fast inputs. This could cause unwanted multiple triggering.



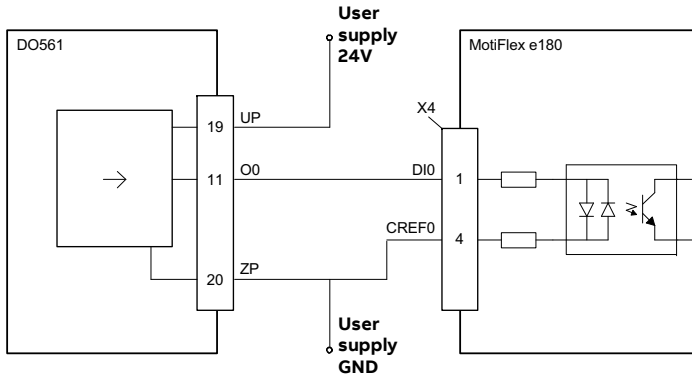
### ■ X4 & X5: Digital inputs - general purpose DI0, DI3 - DI7

These general purpose digital inputs are buffered by an opto-isolator, allowing the input signals to be connected with either polarity. Inputs DI0, DI3 and DI4 share common reference CREFO. Inputs DI5 - DI7 share common reference CREF1. When the MotiFlex e180 is connected to Mint WorkBench, the digital inputs can be configured using the Digital I/O tool. Alternatively, Mint keywords including `RESETINPUT`, `ERRORINPUT`, `STOPINPUT`, `FORWARDLIMITINPUT`, `REVERSELIMITINPUT` and `HOMEINPUT` can be used. The state of the digital inputs can be viewed using the Mint WorkBench Spy window's Axis tab. See the Mint help file for details.

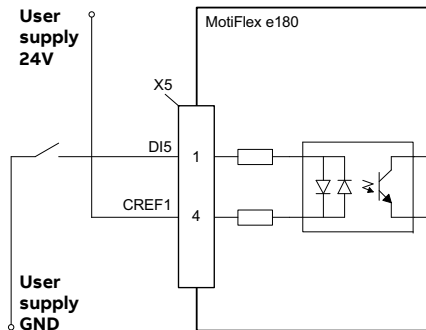
Digital input - typical connections from an ABB NextMove e100:



Digital input - typical connections from an ABB DO561:



Digital input - typical current sourcing connections to a digital input:



## ■ X6: Digital outputs - general purpose DO0 - DO3

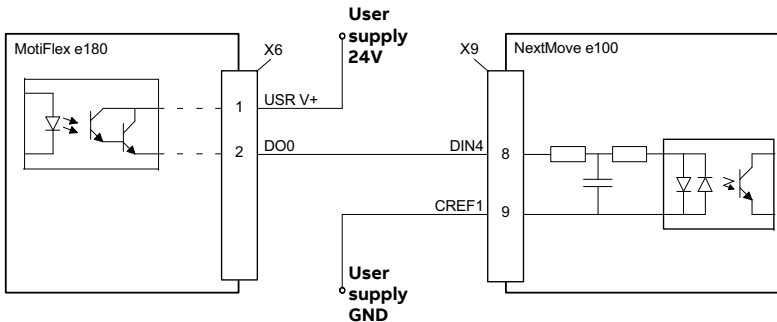
The general purpose digital outputs are optically isolated. They source current from the user supply as shown below. The maximum saturated voltage across the outputs when active is 1.0 V DC, so it can be used as a TTL compatible output.

The output includes a self-resetting fuse that operates at approximately 200 mA. The fuse can take up to 20 seconds to reset after the load has been removed. If the output is used to directly drive a relay, a suitably rated diode must be fitted across the relay coil, observing the correct polarity. This is to protect the output from the back-EMF generated by the relay coil when it is de-energized. The sense of the output can be configured in Mint WorkBench, and its state is displayed in the Spy window.

When the MotiFlex e180 is connected to Mint WorkBench, the active level of the output can be configured using the Digital I/O tool. Alternatively, the Mint keyword `OUTPUTACTIVELEVEL` can be used in the command window. Other Mint keywords such as `COMPAREOUTPUT`, `GLOBALERROROUTPUT`, `DRIVEENABLEOUTPUT` and `MOTORBRAKEOUTPUT` can be used to configure the output. The state of the digital outputs can be viewed using the Mint WorkBench Spy window Axis tab.

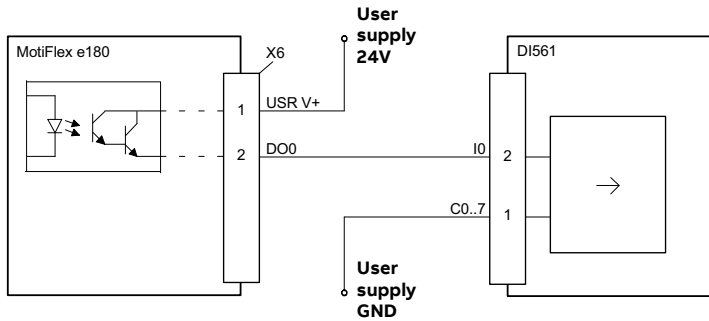
**Note:** By default DO0 is configured as a global error output. Use the Digital I/O tool or the Mint command `GLOBALERROROUTPUT = -1` to release the output for other purposes. See the Mint help file for details.

Digital output - typical connections to an ABB NextMove e100:





Digital output - typical connections to an ABB DI561:



### ■ X6: Digital outputs - special function DO0 - DO3

The general-purpose digital outputs can be assigned to special purpose functions. If an output has been assigned to one special purpose function, it cannot be assigned to other special purpose function at the same time.

#### Global error output

By default DO0 is configured as a global error output. Use the Digital I/O tool or the Mint command `GLOBALERROROUTPUT = -1` to release the output for other purposes.

When an asynchronous error occurs, Mint can deactivate a digital output (or relay) known as the global error output. The output is assigned with the `GLOBALERROROUTPUT` keyword. The output is deactivated as soon as the error occurs on any axis - it does not wait for any assigned default action to be completed.

#### Drive enable ready output

A general-purpose digital output can be configured as a 'drive enable ready indication output' by using the parameter `DriveEnableReadyOutput(P12.4)`, or by using the Mint `DRIVEENABLEREADYOUTPUT` keyword in Mint WorkBench.

The Mint `DRIVEENABLEREADY` keyword returns `true(1)` or `false(0)` to indicate if the drive axis is ready to be enabled. When the `DRIVEENABLEREADY` is true, the assigned digital output will be high level, otherwise the digital output will be low level.

#### Target position reached output

A general-purpose digital output can be configured as a 'target position reached indication output' by using the parameter `TargetPosReachedOutput(P12.5)`, or by using the Mint `TARGETPOSREACHEDOUTPUT` keyword in Mint WorkBench.



How to determine when the drive has reached the target position value:

- Remote control: DS 402 mode of operation is **profile position mode**, status word (object 6041h) Bit10 is true and control word (object 6040h) Bit8 is false.
- Direct control: Control mode is position control (`CONTROLMODE=3`) and the Keyword `IDLE` is true.

After the above conditions are met, the assigned digital output is high level, otherwise the digital outputs low level.

### Target velocity reached output

A general purpose digital output can be configured as a 'target velocity reached indication output' by using the parameter `TargetVelReachedOutput(P12.7)`, or by using the Mint `TARGETVELREACHEDOUTPUT` keyword in Mint WorkBench.

How to determine when the drive has reached the target velocity value and keep constant speed:

- Remote control: DS 402 mode of operation is **profile velocity mode**, status word (object 6041h) Bit10 is true and control word (object 6040h) Bit8 is false.
- Direct control: Control mode is velocity control (`CONTROLMODE=2`) and the keyword `MOVESTATUS` bit3 is true.

After the above conditions are met, the assigned digital output is high level, otherwise the digital outputs low level.

### Home completed output

A general-purpose digital output can be configured as a 'home completed indication output' by using the parameter `HomeCompleteOutput(P12.6)`, or by using the Mint `HOMECOMPLETEOUTPUT` keyword in Mint WorkBench.



How to determine when the drive has completed the homing process:

- Remote control: DS 402 mode of operation is **homing mode** and the status word (object 6041h) Bit10 is true.
- Direct control: The keyword `HOMESTATUS` is true.

After the above conditions are met, the assigned digital output is high level, otherwise the digital outputs low level.

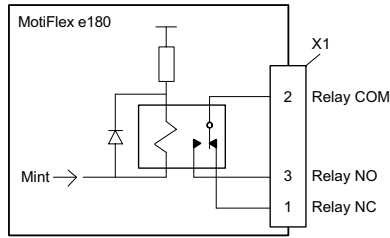
## Other I/O

### ■ X1: Relay (DO4)

For control purposes the relay is considered to be another digital output (DO4), and can be controlled directly using the Mint `OUT` or `OUTX` keywords. The relay can be configured as the global error output by setting `GLOBALERROROUTPUT=4`. See the Mint help file.

---

## Relay connections:



### ■ X9: External power supply for the control unit (optional)

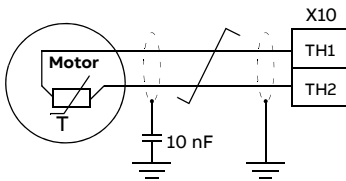
External +24 V, 1 A power supply for the control unit can be connected to terminal block X9. Using an external supply is recommended if:

- the application requires fast start after connecting the drive to the main input supply.
- fieldbus communication is required when the main input supply is disconnected.

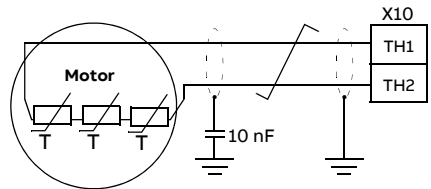
### ■ X10: Thermistor input

Motor overheating can be monitored using switch or a PTC sensor connected to the thermistor input. When the motor overheats and triggers the overtemperature input, the MotiFlex e180 is normally disabled.

One PTC sensor



Three PTC sensors



**WARNING!** As the thermistor inputs shown 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 terminals must be protected against contact and must not be connected to other equipments

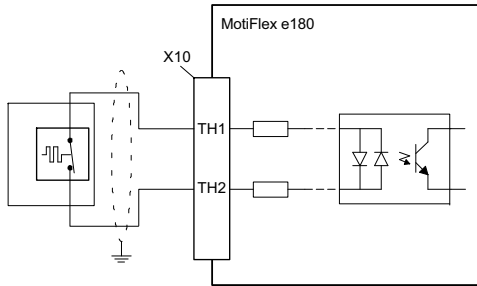
or

- the temperature sensor must be isolated from the I/O terminals.

### Connecting motors with normally closed switch contacts

Some motors contain a thermal switch with normally closed contacts. When the motor overheats the switch contacts open. For this type of motor, connect the switch contact outputs directly to TH1 and TH2, as shown below:

Using a switch controlled motor overtemperature output:



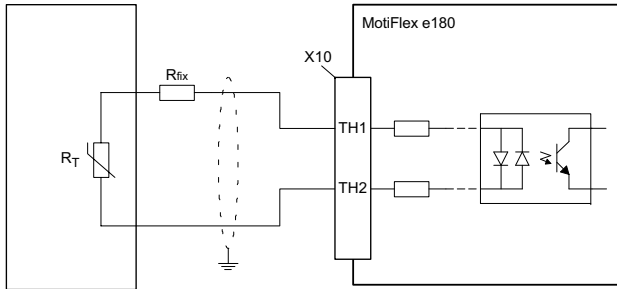
### Connecting motors with temperature dependent resistive output

Some motors contain a thermistor based resistive output. As the motor temperature increases, the resistance between the thermal output connections increases. For this type of motor, the thermal output connections may be connected directly to TH1 and TH2, but care must be taken to ensure that the resistance is sufficient to trigger the MotiFlex e180 input circuit.

To ensure triggering of the input circuit, the resistance between TH1 and TH2 must exceed 3.2 k $\Omega$ . If the motor thermistor does not achieve this resistance at the required trip temperature, it will be necessary to include an additional fixed resistor in the circuit, as shown below. The total resistance must fall to less than 2.8 k $\Omega$  (typical) to re-enable the drive.



Using a thermistor controlled motor overtemperature output:



**Example 1:**

Motor maximum temp. = 130°C

$R_T = 6 \text{ k}\Omega @ 130^\circ\text{C}$

$R_T > 3.2 \text{ k}\Omega$ , so  $R_{fix}$  not required

**Example 2:**

Motor maximum temp. = 130°C

$R_T = 2 \text{ k}\Omega @ 130^\circ\text{C}$

Add  $R_{fix} = 1.2 \text{ k}\Omega$ , so that  $R_T + R_{fix} > 3.2 \text{ k}\Omega$

Note: To remove the trip,  $R_T + R_{fix}$  must reduce to less than 2.8 kΩ.

Use a shielded twisted pair for the motor temperature connection, with the overall cable shield (screen) connected to the metal backplane or optional bracket (see page 83).

The state of the motor overtemperature input can be read using the `MOTORTEMPERATURESWITCH` keyword. The resulting behavior of the MotiFlex e180 can be controlled using the `MOTORTEMPERATUREMODE` keyword. See the Mint help file for details.



■ Linear switches - startup functions

The linear switches are read once at startup.

1: Selects normal IP address configuration, or a fixed IP address. The fixed IP address (192.168.0.1) allows the drive to be accessed if the software assigned IP address is not known.

Fixed IP address 192.168.0.1



Software assigned IP address



2: Selects normal operation or firmware recovery mode. Recovery mode allows new firmware and other configuration files to be downloaded. The fixed IP address 192.168.0.1 is enabled and the **I** symbol is displayed. Mint WorkBench allows you to update firmware and view the file system.

Recovery mode



Normal operation



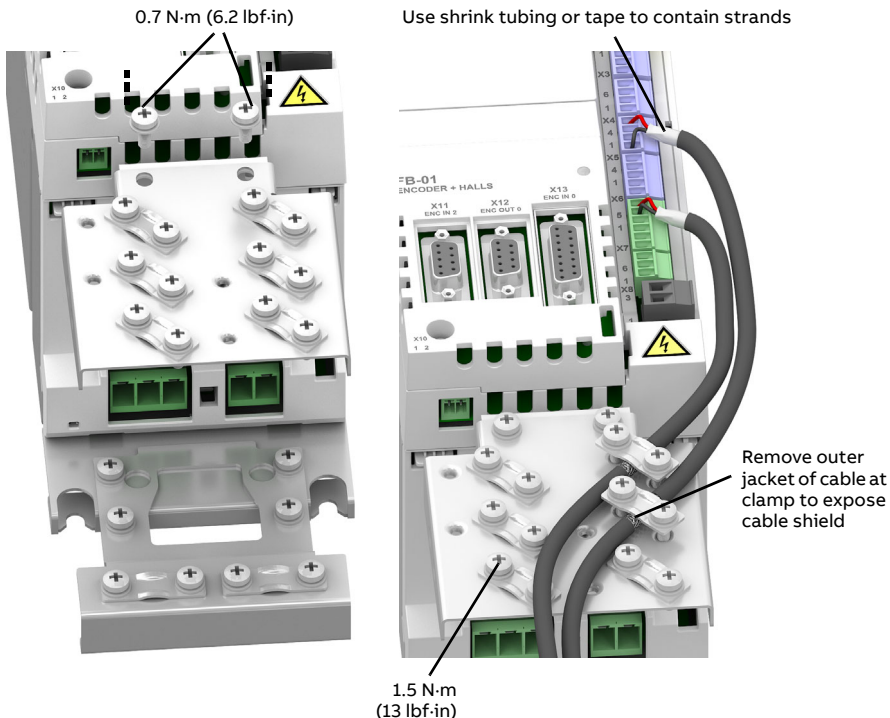
## ■ Control cable grounding

The shields of all control cables connected to the control unit must be grounded at the control cable clamp plate. Use M4 screws to fasten the plate as shown below left. The plate can be fitted either at the top or bottom of the drive.

The shields should be continuous as close to the terminals of the control unit as possible. Only remove the outer jacket of the cable at the cable clamp so that the clamp presses on the bare shield. At the terminal block, use shrink tubing or insulating tape to contain any stray strands. The shield (especially in case of multiple shields) can also be terminated with a lug and fastened with a screw at the clamp plate. Leave the other end of the shield unconnected or ground it indirectly via a few nanofarads high-frequency capacitor (e.g. 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.

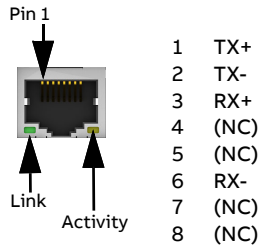
Keep any signal wire pairs twisted as close to the terminals as possible. Twisting the wire with its return wire reduces disturbances caused by inductive coupling.

### Mounting the clamp plate



# Ethernet ports

## ■ E1 / E2: Ethernet fieldbus



The E1 and E2 Ethernet ports on the top panel of the MotiFlex e180 are used for Ethernet fieldbus connections such as EtherCAT®, Ethernet POWERLINK® and PROFINET®\*. For full details about the fieldbus connections, see the Mint WorkBench help file.

In an EtherCAT network the E1 (IN) port must be connected to the master side of the network. The E2 (OUT) port, if used, must be connected to the IN port of the next slave device in the network. Set both front panel rotary HI / LO switches to 0 to select EtherCAT slave mode.

In an Ethernet POWERLINK and PROFINET\* network the connectors are identical.

See [MotiFlex e180 indicators](#) on page 119 for a description of the fieldbus status indicators.

EtherCAT connections:



\*The MotiFlex e180 that supports dual port PROFINET: factory firmware vision Build 5903.4 or later.



## ■ E1 / E2: Ethernet port configuration

The rotary switches are read once at startup. They select the mode of operation for the Ethernet fieldbus connectors E1 and E2 on the top panel of the drive. See page 84.

	Value	Mode
HI	00	EtherCAT slave mode
	01-EF	Ethernet POWERLINK CN mode: selected value is node ID
	F0-F1	Reserved
	F2	PROFINET slave mode*
LO	F3-FF	Reserved



## ■ E3: Ethernet host

The Ethernet host port is used to connect a PC for configuring the MotiFlex e180. See section [Start-up](#) on page 101 for details about configuring the PC's Ethernet adapter for communication with the MotiFlex e180.

The host port also can be used for Modbus TCP, Ethernet/IP and PROFINET fieldbus connections.

**Note:** E3 port supports PROFINET when rotary switches are set to 00-EF. E1 and E2 ports support PROFINET\* when rotary switches are set to F2.

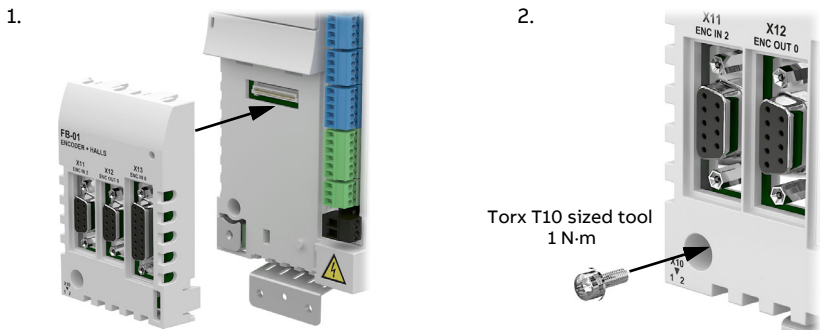
\*The MotiFlex e180 that supports dual port PROFINET: factory firmware vision Build 5903.4 or later.



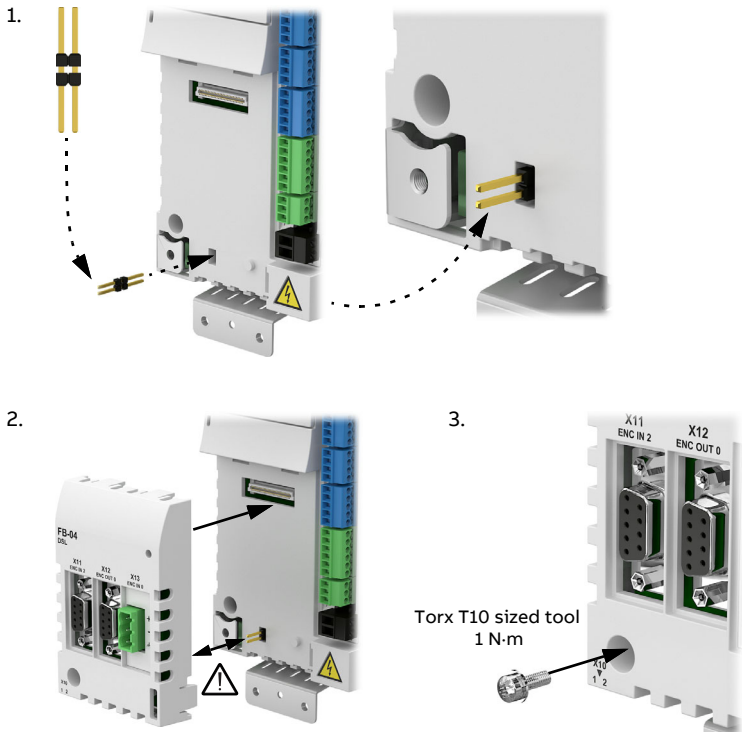
## Motor feedback modules

The MotiFlex e180 can be supplied with a range of feedback options to support different types of motor feedback. All options provide a master incremental encoder input and incremental encoder output.

### ■ Attaching the feedback module: FB-01, FB-02, FB-03



### ■ Attaching the feedback module: FB-04



**Note:**

- Remove all possible power from the drive before the operation.
- After installation, check the feedback module to ensure that it is fully seated and tightly connected to the drive, especially the top of the module where the connector is located.
- The fastening screw can help to reduce interference and noise. If it is not installed properly, the signal quality from the feedback module will be affected.

■ **Removing the feedback module**

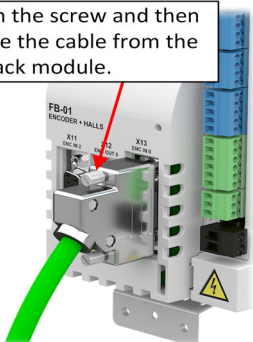
1. Loosen the connector of feedback module cable and remove the cable.
2. Remove the fastening screw with a Torx T10 sized tool.
3. Use a flat-head screwdriver to release the bottom clip.
4. Pull the feedback module out gently at 90 degrees from the drive main body.

**Note:**

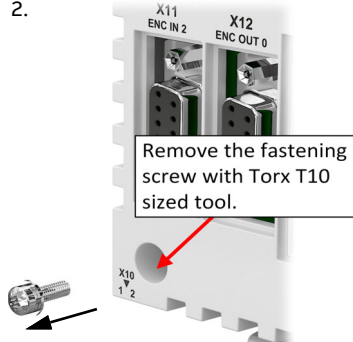
- Disconnect all possible power from the drive before the operation.
- When the feedback module is removed from the drive, there is a big risk of damaging the connector. Be gentle and careful. Do not tilt or wrench the module.



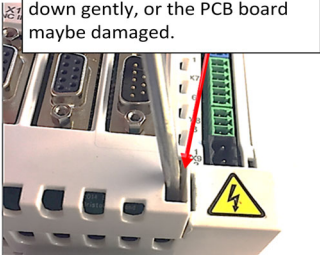
1. Loosen the screw and then remove the cable from the feedback module.



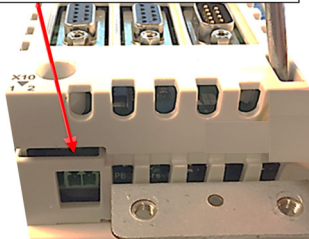
2. Remove the fastening screw with Torx T10 sized tool.



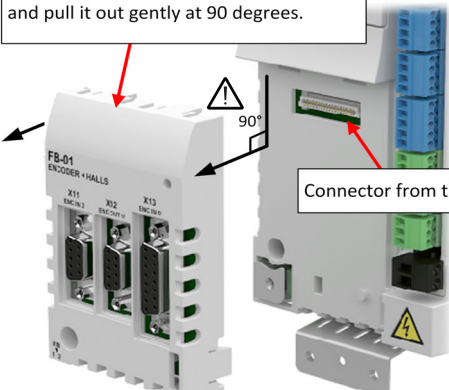
3. Use a flat-head screwdriver to release the bottom clip. Press down gently, or the PCB board maybe damaged.



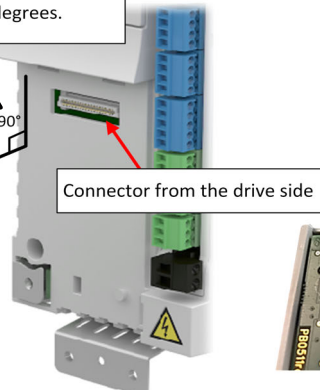
A small gap will be left after the bottom clip is released.




4. Grasp the upper side of feedback module and pull it out gently at 90 degrees.



Connector from the drive side



Check whether the connector is damaged.



## ■ All feedback options: Incremental encoder input (X11)

The incremental encoder input connections supports A/B channels and a Z index channel. The encoder inputs (CHA, CHB and CHZ) accept differential signals only. Twisted pairs must be used for each complementary signal pair e.g. CHA+ and CHA-. The encoder supply on pin 9 provides 5.5 V to the encoder (250 mA max).

X11 can also be configured to operate as a pair of step (pulse) and direction inputs, by using the statement `ENCODERMODE (2) = 4`. See the Mint help file for details.

- CHA+/CHA- are used as the step input. The step frequency controls the speed of the motor.
- CHB+/CHB- are used as the direction input. The state of the direction input controls the direction of motion. An active input results in forward motion. An inactive input results in motion in the opposite direction.

If you are using a motion controller such as NextMove e100 to supply the signals, it must provide differential step and direction outputs, e.g. NXE100-16xxDx.

Pin 1



1	CHA+ /	6	CHA- / Step-
2	Step+	7	CHB- / Dir-
3	CHB+ / Dir+	8	CHZ-
4	CHZ+	9	+5.5 V out
5	(NC)		
	GND		



■ All feedback options: Incremental encoder output (X12)

The incremental encoder output connections provide A/B channels and a Z index channel. Twisted pairs must be used for each complementary signal pair e.g. CHA+ and CHA-. The encoder output can be connected to the encoder input of a motion controller such as NextMove e100 to provide position feedback.

The A/B outputs are a pair of synthesized\* pulse trains with a 50% duty cycle, 90 degrees out of phase. The `ENCODEROUTCHANNEL` Mint keyword is used to define the source signal. This can be the encoder input at connector X11, X13, or digital inputs 1 and 2 when they are set to behave as an encoder input (see [X3: Digital inputs - special function DI1 & DI2](#) on page 72). The frequency of the A/B outputs is varied according to the source signal, and can be scaled using the `ENCODEROUTRESOLUTION` Mint keyword. There is a propagation delay of up to 125  $\mu$ s\*.

Pin 1



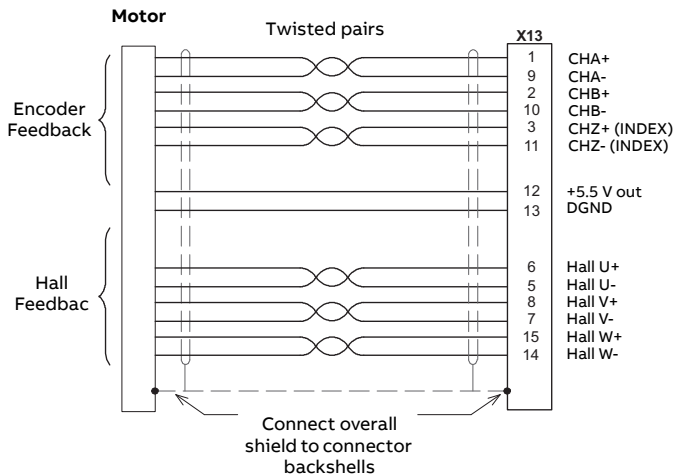
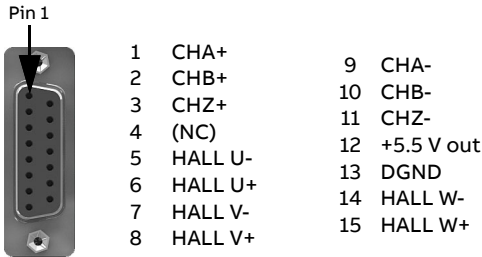
- |   |      |   |      |
|---|------|---|------|
| 1 | CHA+ | 6 | CHA- |
| 2 | CHB+ | 7 | CHB- |
| 3 | CHZ+ | 8 | CHZ- |
| 4 | (NC) | 9 | (NC) |
| 5 | GND  |   |      |

\* On feedback option FB-01, the output at X12 is identical to the input at X13 with no propagation delay, provided the output resolution is set to match the input resolution.



## ■ Feedback option FB-01 : Incremental encoder with Halls (X13)

The incremental encoder connections (ABZ channels and Hall signals) are made using the 15-pin D-type female connector X13. The encoder inputs (CHA, CHB and CHZ) accept differential signals only. Twisted pairs must be used for each complementary signal pair e.g. CHA+ and CHA-. The Hall inputs may be used as differential inputs (recommended for improved noise immunity) or single ended inputs. When used as single ended inputs, leave the Hall U-, Hall V- and Hall W- pins unconnected. The overall cable shield (screen) must be connected to the metallic shell of the D-type connector. The encoder supply on pin 12 provides 5.5 V to the encoder (250 mA max). Maximum cable length is 30 m.



■ Feedback option FB-02 : Serial interfaces + SinCos (X13)



The FB-02 feedback option supports the following feedback types, for use with linear and rotary motors:

- BiSS (Bi-directional Synchronous Serial Interface)
- SSI (Synchronous Serial Interface)
- EnDat, Hiperface, or Smart Abs absolute encoders
- SinCos encoders (1 V pk-pk, 2.5 V reference).

Twisted pairs must be used for each complementary signal pair e.g. CHA+ and CHA-or Data+ and Data-. Maximum cable length is 30 m.

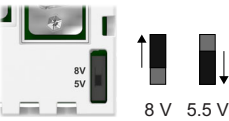
The overall cable shield (screen) must be connected to the metallic shell of the D-type connector. The encoder supply on pin 12 provides either 5.5 V or 8 V to the encoder (250 mA max), selected using the jumper.

Connection summary:



Pin	EnDat 2.1	BiSS, SSI or EnDat 2.2	Smart Abs	Hiperface	SinCos
1	Data+	Data+	Data+	Data+	(NC)
2	Clock+	Clock+	(NC)	(NC)	(NC)
3	(NC)	(NC)	(NC)	(NC)	(NC)
4	(NC)	(NC)	(NC)	(NC)	(NC)
5	Sin-	(NC)	(NC)	Sin-	Sin-
6	Sin+	(NC)	(NC)	Sin+	Sin+
7	Cos-	(NC)	(NC)	Cos-	Cos-
8	Cos+	(NC)	(NC)	Cos+	Cos+
9	Data-	Data-	Data-	Data-	(NC)
10	Clock-	Clock-	(NC)	(NC)	(NC)
11	(NC)	(NC)	(NC)	(NC)	(NC)
12	+5.5 V / 8 V*	5.5 V / 8 V*	5.5 V / 8 V*	5.5 V / 8 V*	5.5 V / 8 V*
13	DGND	DGND	DGND	DGND	DGND
14	(NC)	(NC)	(NC)	(NC)	(NC)
15	(NC)	(NC)	(NC)	(NC)	(NC)

\* The switch or jumper selects the voltage output on pin 12. Check the feedback device's power input specifications before using the 8 V position.

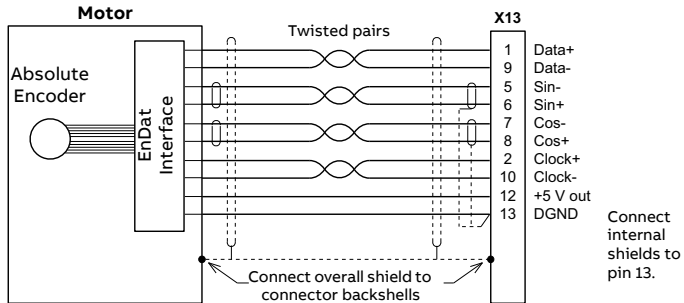




## EnDat interface

Incremental and absolute (multi and single turn) devices are supported. It is possible to read and write information to the encoder. The absolute encoder connections are made using the 15-pin D-type female connector X8. The Sin and Cos channels are not required when using a version 2.2 EnDat encoder.

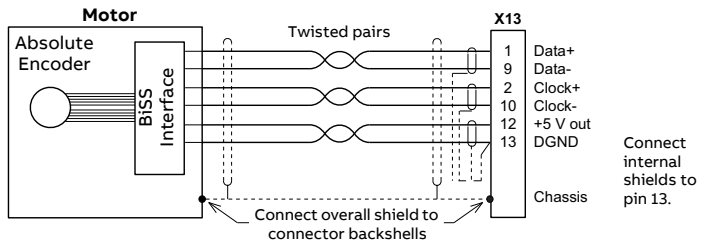
EnDat 2.1 interface cable connections:



## BiSS interface

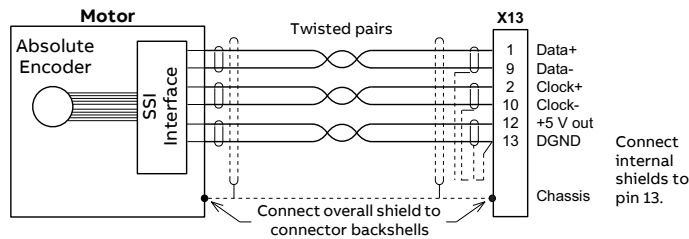
The BiSS (Bi-directional Serial Synchronous interface) is an open-source interface that can be used with many types of absolute encoder.

BiSS interface cable connections:



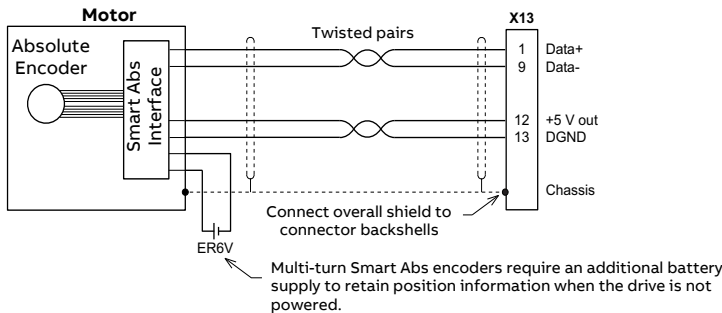
SSI encoders

SSI interface cable connections:



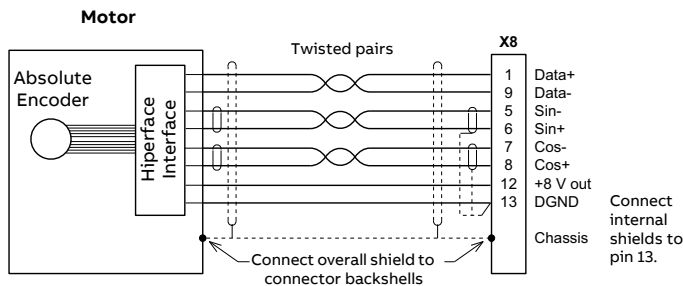
Smart Abs encoders

Smart Abs interface cable connections:



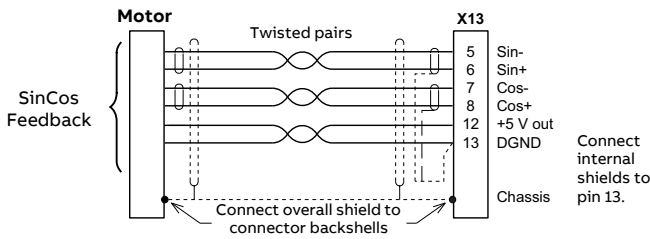
Hiperface interface

Hiperface interface cable connections:



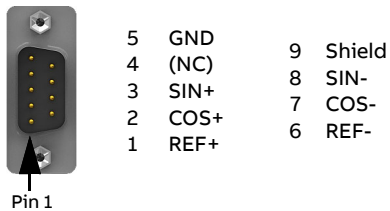
SinCos interface

SinCos interface cable connections:

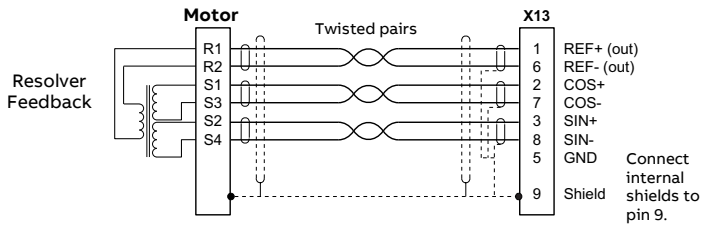


■ Feedback option FB-03 : Resolver (X13)

The FB-03 feedback option supports resolvers. Maximum cable length is 50 m.

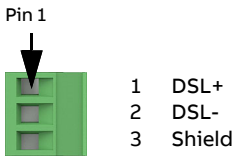


Resolver cable connections:

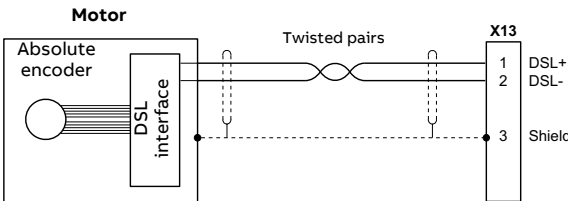


■ **Feedback option FB-04 : DSL (X13)**

The FB-04 feedback option supports Hiperface DSL. The MotiFlex e180 should operate with any Hiperface DSL device, although support is guaranteed only for motors in the Mint WorkBench motor database. Maximum cable length is 30 m.

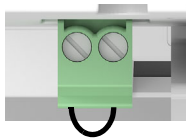


DSL interface cable connections:



Hiperface DSL provides the motor thermistor resistance as part of the feedback data. If this value exceeds the value set by the Mint keyword `MOTORTEMPERATURETRIP`, the drive trips with a motor overtemperature error (10019). The MotiFlex e180 attempts to read the state of the temperature indication every 100 ms. If other processing duties prevent the temperature being read for more than 200 ms, axis warning 20006 is raised.

Fit a wire loop to connector X10 to suppress the normal motor temperature detection.



If the drive's 24 V supply is removed wait at least 10 seconds before reconnecting the supply. This allows the FB-04 module to restart correctly.

## ■ Encoder 0 input

Encoder 0 on connector X13 is the e180 drive's universal encoder input channel, supports a wide range of feedback types as follows.

MotiFlex e180 needs to be equipped with the feedback option FB-01/FB-02 /FB-03/ FB-04 to support different types.

No.	Feedback type		Parameter value	Feedback option
1	Incremental encoder	Rotary incremental encoder without Halls	ENCODERTYPE (0) =0	FB-01
2		Linear incremental encoder without Halls	ENCODERTYPE (0) =1	FB-01
3		Rotary incremental encoder with Halls	ENCODERTYPE (0) =2	FB-01
4		Linear incremental encoder with Halls	ENCODERTYPE (0) =3	FB-01
5	Hall sensor	Rotary Hall sensors only without encoder	ENCODERTYPE (0) =4	FB-01
6		Linear Hall sensors only without encoder	ENCODERTYPE (0) =5	FB-01
7	SSI	Baumer SSI encoder of ABB motor	ENCODERTYPE (0) =6	FB-02
8		Linear SSI encoder	ENCODERTYPE (0) =19	FB-02
9		Generic SSI encoder	ENCODERTYPE (0) =24	FB-02
10	Rotary EnDat v2.1		ENCODERTYPE (0) =7	FB-02
11	EnDat v2.2	Rotary EnDat v2.2	ENCODERTYPE (0) =9	FB-02
11		Linear EnDat v2.2	ENCODERTYPE (0) =10	FB-02
13	SinCos	Rotary SinCos encoder	ENCODERTYPE (0) =11	FB-02
14		Linear SinCos encoder	ENCODERTYPE (0) =12	FB-02
15		Linear SinCos encoder with Halls	ENCODERTYPE (0) =21	FB-02
16	Rotary Hiperface encoder		ENCODERTYPE (0) =13	FB-02
17	Resolver		ENCODERTYPE (0) =15	FB-03
18	Smart Abs absolute encoder		ENCODERTYPE (0) =16	FB-02
19	BiSS-B	Rotary BiSS encoder	ENCODERTYPE (0) =17	FB-02
20		Linear BiSS encoder	ENCODERTYPE (0) =18	FB-02
21	Rotary Hiperface DSL encoder		ENCODERTYPE (0) =26	FB-04



■ Encoder 1 input

Encoder 1 is an extra incremental encoder input channel and can be used to set up dual-encoder control system or be connected to a master encoder. It comes from fast digital inputs 1 and 2 on connector X3.

The incremental encoder signal type:

- 24 V DC signal levels
- Logic levels: “0” < 2 V, “1” > 12 V
- A/B single ended, no Z index

No.	Feedback type	Parameter value
1	Rotary incremental encoder without Halls	ENCODERTYPE (1) =0
2	Linear incremental encoder without Halls	ENCODERTYPE (1) =1
3	Step & Direction inputs	ENCODERMODE (1) =4

■ Encoder 2 input

Encoder 2 on connector X11 is extra incremental encoder input channel and can be used to set up dual-encoder control system or be connected to a master encoder. The encoder input is 5V differential line driver (RS422).

The incremental encoder signal type:

- RS422 A/B/Z differential
- Max. input frequency A / B: 2 MHz
- Power supply: 5 V DC



No.	Feedback type	Parameter value	Feedback options
1	Rotary incremental encoder without Halls	ENCODERTYPE (2) =0	All
2	Linear incremental encoder without Halls	ENCODERTYPE (2) =1	All
3	Step & Direction inputs	ENCODERMODE (2) =4	All


See application note [AN00262](#) for more information about dual encoder control.

8

# Installation checklist

## Checklist

Check the mechanical and electrical installation of the drive before start-up. Go through the checklist together with another person.

 **WARNING!** Only qualified electricians are allowed to carry out the work described below. Read the safety instructions on the first pages of this manual before you work on the unit. Ignoring the safety instructions can cause injury or death. Open the main disconnecter of the drive and lock it to open position. Measure to ensure that the drive is not powered.

Check
<b>MECHANICAL INSTALLATION</b>
<input type="checkbox"/> The ambient operating conditions are allowable. (See <i>Mechanical installation, Technical data: Ratings, Ambient conditions.</i> )
<input type="checkbox"/> The unit is fastened properly to the cabinet. (See <i>Cabinet construction and Mechanical installation.</i> )
<input type="checkbox"/> The cooling air will flow freely.
<input type="checkbox"/> The motor and the driven equipment are ready for start. (See <i>Planning the electrical installation, Technical data: Motor connection.</i> )
<b>ELECTRICAL INSTALLATION</b> (See <i>Planning the electrical installation, Electrical installation: AC input, motor and brake.</i> )
<input type="checkbox"/> The VAR screw is removed if the drive is connected to an IT (ungrounded) supply network.

Check

- ☐ The capacitors are reformed if stored over one year (ask local ABB representative for more information).
  - ☐ The drive is grounded properly.
  - ☐ The supply (input power) voltage matches the drive nominal input voltage.
  - ☐ The supply (input power) is connected to U1/V1/W1 (UDC+/UDC- in case of a DC supply) and the terminals are tightened to specified torque.
  - ☐ Appropriate supply (input power) fuses and disconnecter are installed.
  - ☐ The motor is connected to U2/V2/W2, and the terminals are tightened to specified torque.
  - ☐ The braking resistor (if present) is connected to R+/R-, and the terminals are tightened to specified torque.
  - ☐ The motor cable (and braking resistor cable, if present) is routed away from other cables.
  - ☐ There are no power factor compensation capacitors in the motor cable.
  - ☐ The external control connections to the control unit are OK.
  - ☐ There are no tools, foreign objects or dust from drilling inside the drive.
  - ☐ The supply (input power) voltage cannot be applied to the output of the drive through a bypass connection.
  - ☐ Motor connection box and other covers are in place.
-



## 9

# Start-up

---

## What this chapter contains

This chapter describes software installation and the start-up procedure of the drive.

## Safety

---



**WARNING!** Read the [Safety](#) instructions on the first pages of this manual before performing any maintenance on the equipment. Ignoring the safety instructions can cause injury or death.

---

## Introduction

Before powering the MotiFlex e180 you must connect it to the PC using an Ethernet cable and install the Mint WorkBench software on the PC. This includes a number of applications and utilities to allow you to configure, tune and program the MotiFlex e180. Mint WorkBench and other utilities can be downloaded from [new.abb.com/drives](http://new.abb.com/drives).



## Connect the MotiFlex e180 to the PC

Connect a CAT5e Ethernet cable between the PC and the MotiFlex e180 E3 Ethernet port on the front panel. Do not connect the cable to the E1 or E2 ports on the top of the drive.



**NOTE!** You cannot connect an ordinary office PC to the MotiFlex e180 without first altering the PC's Ethernet adapter configuration. See [Configure the PC Ethernet adapter](#) on page 102.

---

## Install Mint WorkBench

The Windows user account requires administrative user rights to install Mint WorkBench. To install Mint WorkBench, download the application from [new.abb.com/drives](http://new.abb.com/drives) and run it.

## Configure the PC Ethernet adapter

It is necessary to alter the PC's Ethernet adapter configuration to operate correctly with the MotiFlex e180. By default, the MotiFlex e180 has a static IP address of 192.168.0.1. This can be changed using the Configuration tool in Mint WorkBench.



**NOTE!** You cannot connect an ordinary office PC to the MotiFlex e180 without first altering the PC's Ethernet adapter configuration. However, if you have installed a second Ethernet adapter dedicated for use with the MotiFlex e180, then this adapter's configuration can be altered without affecting the PC's office Ethernet connection. A USB to Ethernet adapter is a convenient way to add a second Ethernet adapter to a PC. If you are unsure about making changes to your PC's Ethernet adapter configuration, or are prevented by user permission levels, ask your I.T. administrator to assist you.

The following explanation assumes the PC is connected directly to the MotiFlex e180, and not across an intermediate Ethernet network. If you wish to attempt the connection through an intermediate Ethernet network, then the network administrator must be consulted to ensure that the necessary IP address is allowed and is not already allocated on the network.

1. On the Windows 7/10 Start menu, choose Control Panel, then Network and Sharing Center. (Windows 8.1: From the Start screen, click the down arrow or swipe up to go to the Apps screen. Choose Control Panel, Network and Internet, Network and Sharing Center).
2. On the left of the window, click Change Adapter Settings. Double click the icon for the required Ethernet adapter, then click Properties.
3. Select the 'Internet Protocol Version 4 (TCP/IPv4)' entry and click Properties.
4. On the General tab, make a note of the existing settings. Click Advanced... and make a note of any existing settings. Click Cancel and then click the Alternate Configuration tab and make a note of any existing settings.
5. On the General tab, choose the 'Use the following IP address' option.
6. In the IP address box, enter an IP address, e.g. 192.168.0.241. This is the IP address that will be assigned to the Ethernet adapter.
7. In the Subnet mask box, enter 255.255.255.0 and click OK.
8. Click Close to close the Local Area Connection Properties dialogue.
9. Click Close to close the Local Area Connection Status dialogue.

## Enable the Ethernet adapter for Mint WorkBench

Before Mint WorkBench can use the Ethernet adapter to discover the MotiFlex e180, the adapter must be enabled in the Mint HTTP server.

1. On the Windows 7/10 task bar in the notification area, right-click the Mint HTTP server icon and choose Properties. (Windows 8.1: On the Start screen, click the Desktop icon to access the desktop first.)
2. In the Discovery area, check the required local area connection, then click OK.

## Start the MotiFlex e180



If you have followed the instructions in the previous sections, you should have now connected the power sources, your choice of inputs and outputs, and the Ethernet cable linking the PC to the MotiFlex e180.

### ■ Preliminary checks

Before you apply power for the first time, check all items in [Installation checklist](#), starting on page 99.

### ■ Power on checks

See section [Drive status display](#) on page 123 for symbols that show if the drive has detected a fault.

1. Turn on the 24 V DC supply (if connected).
2. Turn on the AC supply.
3. The drive status display shows a test sequence which normally takes approximately 15-20 seconds. The sequence ends with the  symbol, or  if an STO input (page 227) is not powered. Startup can take more than 1 minute after downloading new firmware.
4. To allow the Commissioning Wizard to function, the Safe Torque Off inputs (page 227) need to be powered to allow the MotiFlex e180 to be enabled.



## Start Mint WorkBench

Mint WorkBench is a fully featured application for programming and controlling the MotiFlex e180. Mint WorkBench includes a comprehensive help file that contains information about every Mint keyword, how to use Mint WorkBench, and background information on motion control topics. Press F1 to display the help file. For help on using Mint WorkBench, click the red Mint WorkBench icon on the opening page.

1. On the Windows 7/10 Start menu, select All Programs, ABB, Mint WorkBench, Mint WorkBench. (Windows 8.1: On the Apps screen, click the Mint WorkBench icon.)
2. In the opening dialogue box, click Start Online Project...
3. Wait until the MotiFlex e180 is listed in the Controllers found box, e.g. *"MotiFlex e180 on 192.168.0.1"*.
4. Select the MotiFlex e180 in the list, and check Launch Commissioning Wizard.
5. Click Select.

**Note:** If the MotiFlex e180 is not listed, check the Ethernet cable is connected to the E3 port on the front panel of the drive, not E1 or E2 on the top panel. Check that the MotiFlex e180 is powered correctly and the startup sequence (see [Power on checks](#), above) has completed. Ensure you have enabled the Ethernet adapter for Mint WorkBench (see page [103](#)). Click Scan to re-scan the ports. It can take up to 5 seconds for Mint WorkBench to detect the MotiFlex e180.

6. Mint WorkBench connects to the MotiFlex e180 and displays the Commissioning Wizard.

**Note:** If Launch Commissioning Wizard was *not* checked, Edit & Debug mode is displayed.



## Commissioning Wizard

Each type of motor and drive combination has different performance characteristics. Before the MotiFlex e180 can be used to control the motor accurately, the MotiFlex e180 must be 'tuned'. Tuning is the process where the MotiFlex e180 powers the motor in a series of tests. By monitoring the drive's output and the feedback from the motor's encoder, the MotiFlex e180 can make small adjustments to the way it controls the motor. This information is stored in the MotiFlex e180 and can be uploaded to a file if necessary.

The Commissioning Wizard provides a simple way to tune the MotiFlex e180 and create the necessary configuration information for your drive/motor combination, so this is the first tool that should be used. If necessary, any of the parameters set by the Commissioning Wizard can be adjusted manually after commissioning is complete.

### ■ Using the Commissioning Wizard

Each screen of the Commissioning Wizard requires you to enter information about the motor, drive or application. Read each screen carefully and enter the required information. When you have completed a screen, click Next > to display the next screen. If you need to change something on a previous screen, click the < Back button. The Commissioning Wizard remembers information that you have entered so you do not need to re-enter everything if you go back to previous screens. If you need extra help, click Help or press F1.

#### Select your Motor Type:

Select the type of motor that you are using; rotary or linear, brushless or induction.

#### Select your Motor:

Carefully enter the details of your motor. If you are using a Baldor motor, the catalog number or spec. number can be found stamped on the motor's nameplate. If you are using a motor with EnDat or Hiperface feedback, are using a different manufacturer's motor, or need to enter the specification manually, select the 'I would like to define a custom motor' option.



#### Confirm Motor and Drive information:

If you entered the catalog or spec. number on the previous page, it is not necessary to change anything on this screen; all the required data is entered already. However, if you selected the 'I would like to define a custom motor' option, it is necessary to enter the required information before continuing.

#### Motor Feedback:

If you entered the catalog or spec. number on the previous page, it is not necessary to change anything on this screen; the feedback resolution is entered

already. However, if you selected the 'I would like to define a custom motor' option, it is necessary to enter the feedback resolution before continuing.

### **Drive Setup complete:**

This screen confirms that drive setup is complete.

### **Select Operating Mode and Source:**

In the Operating Mode section, choose the required operating mode. In the Reference Source section, it is important to select 'Direct (Host/Mint)' as the Reference Source. This allows the Autotune Wizard to operate correctly, and allows further initial testing to be performed using Mint WorkBench. Although the MotiFlex e180 might eventually be controlled over EtherCAT®, the 'RT Ethernet' reference source should be selected only after the MotiFlex e180 has been commissioned and is ready to add to the EtherCAT network. This is selected by choosing the Operating Mode tool in the Toolbox.

### **Application Limits:**

It is not necessary to change anything on this screen. However, if you wish to adjust the application peak current (App. Peak Current) and/or application maximum speed (App. Max. Speed), then click in the appropriate box and enter a value.

### **Select Scale Factor:**

It is not necessary to change anything on this screen. However, it is recommended to select a user unit for position, velocity and acceleration. This allows Mint WorkBench to display distance, speed and acceleration using meaningful units, instead of encoder counts. For example, selecting a Position User Unit of Revs (r) means that all position values entered or displayed in Mint WorkBench will represent revolutions. The Position Scale Factor value changes automatically to represent the required scale factor (the number of quadrature counts per revolution). If you need to use an alternative unit, for example degrees, type "Degrees" in the Position User Unit box and enter a suitable value in the Position Scale Factor box. Separate velocity and acceleration units can also be defined. See the Mint help file for more information about scale factors.

### **Profile Parameters:**

It is not necessary to change anything on this screen. However, if you wish to adjust the parameters for any control method, click in the appropriate box and enter a value.

### **Analogue input parameters:**

It is not necessary to change anything on this screen. However, if you wish to adjust the analogue inputs, click Common Settings to select the input range.



The Tune Offset button automatically adjusts the input to compensate for any DC offset.

### Operation setup complete:

This screen confirms that operation setup is complete.

### Autotune Wizard

The Autotune Wizard tunes the MotiFlex e180 for optimal performance with the attached motor. This removes the need for manual fine-tuning of the system, although in some critical applications this might be required.

Click Options... to configure optional autotuning parameters. These include Triggered Autotune which allows the autotuning process to be delayed until the drive is enabled.



**WARNING!** The motor moves during autotuning. For safety it is advisable to disconnect any load from the motor during initial autotuning. The motor can be tuned with the load connected after the Commissioning Wizard has finished.

---

### Autotune:

Click START to begin the auto-tuning process. Mint WorkBench takes measurements from the motor and then performs small test moves.

For further information about tuning with the load attached, see [Further tuning - with load attached](#) on page 109.

**Note:** Even if you do not perform any further tuning or configuration, the STO function must be tested; see [Appendix: Safe Torque Off \(STO\)](#) on page 227.

### ■ Further tuning - no load attached

The Autotune Wizard calculates many parameters that allow the MotiFlex e180 to provide good control of the motor. In some applications, these parameters need to be fine-tuned to provide the exact response that you require.

1. Click the Fine-tuning icon in the Toolbox on the left of the screen.

The Fine-tuning window is displayed at the right of the screen. This already shows some of the parameters that have been calculated by the Commissioning Wizard.

The main area of the Mint WorkBench window displays the capture window. When further tuning tests are performed, it displays a graph representing the response.

---



2. The Fine-tuning window has a number of tabs the bottom.

Click on the Velocity tab.

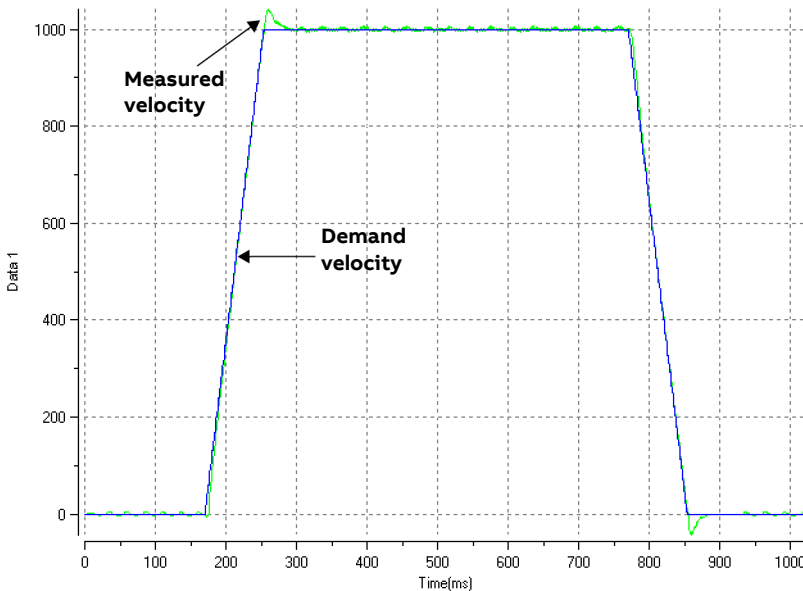
Some tabs might not be available depending on the configuration mode you selected in the Commissioning Wizard.

3. In the Test Parameters area at the bottom of the tab, click in the Move Type drop down box and select Forward.

Enter values in the Velocity and Distance boxes to create a short move. The values you enter depend on the velocity scaling factor that was selected in the Commissioning Wizard. This example assumes the velocity scaling factor was selected as Revs Per Minute (rpm), so entering a value of 1000 here creates a move with a velocity of 1000 rpm. Similarly, assuming the position scaling factor had been set to Revolutions (r), the value 10 creates a move lasting for 10 revolutions of the motor.

4. Click Go to start the test move. Mint WorkBench performs the test move and displays a graph of the result.
5. Click on the graph labels to turn off unwanted traces. Leave just Demand Velocity and Measured Velocity turned on.

Typical autotuned response (no load):



**Note:** The graph that you see will not look exactly the same as this one! Each motor has a different response.



The graph shows that the response reaches the demand quickly and only overshoots the demand by a small amount. This can be considered an ideal response for most systems.

For further information about tuning with the load attached, see [Further tuning - with load attached](#) on page 109.

### ■ Further tuning - with load attached

To allow Mint WorkBench to adjust the basic tuning to compensate for the intended load, it is necessary to attach the load to the motor and then perform the autotune procedure again.

1. Attach the load to the motor.
2. Click the Autotune icon in the Toolbox on the left of the screen.
3. Click the Autotune on load check box.
4. Click START to begin the auto-tuning process. Mint WorkBench takes measurements from the motor and then performs small test moves.
5. Click the Fine-tuning icon in the Toolbox on the left of the screen.
6. In the Velocity tab's Test Parameters area, ensure the same move parameters are entered and then click Go to start the test move.

Mint WorkBench performs the test move and displays a graph of the result.



## Optimising the velocity response

It can be desirable to optimise the default autotuned response to better suit your application. The following sections describe the two main tuning factors and how to correct them.

### ■ Correcting overshoot

The following graph shows a response where the measured velocity overshoots the demand by a significant amount.

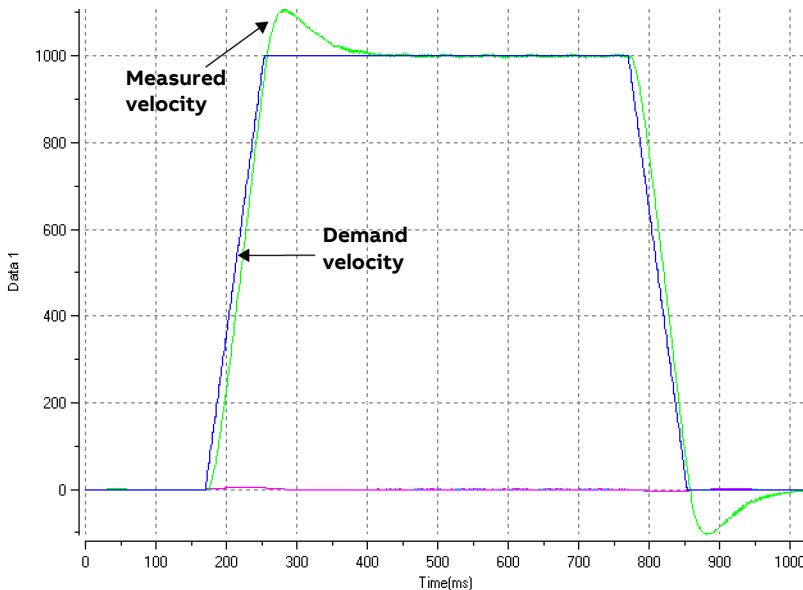
1. Go to the Fine-tuning window's Velocity tab.

To reduce the amount of overshoot, click Calculate... and increase the bandwidth using the slider control. Alternatively, type a larger value in the Bandwidth box.

Click OK to close the Bandwidth dialogue.

2. Click Go to start the test move. Mint WorkBench performs the test move and displays a graph of the result.

Velocity overshoots demand:



## ■ Correcting zero-speed noise in the velocity response

The following graph shows a response where there is very little overshoot but a significant amount of zero-speed noise. This can cause undesirable humming or ringing in the motor.

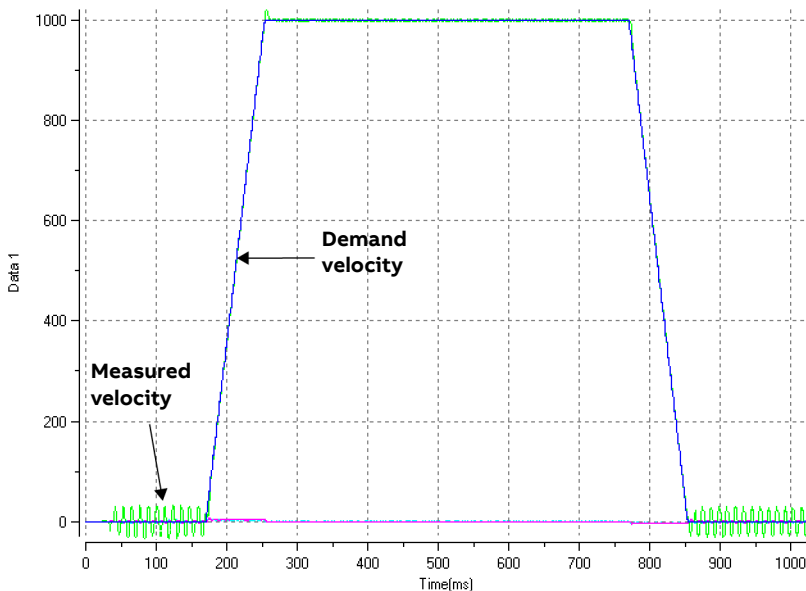
1. Go to the Fine-tuning window's Velocity tab.

To reduce the amount of noise, click Calculate... and decrease the bandwidth using the slider control. Alternatively, type a smaller value in the Bandwidth box.

Click OK to close the Bandwidth dialogue.

2. Click Go to start the test move. Mint WorkBench performs the test move and displays a graph of the result.

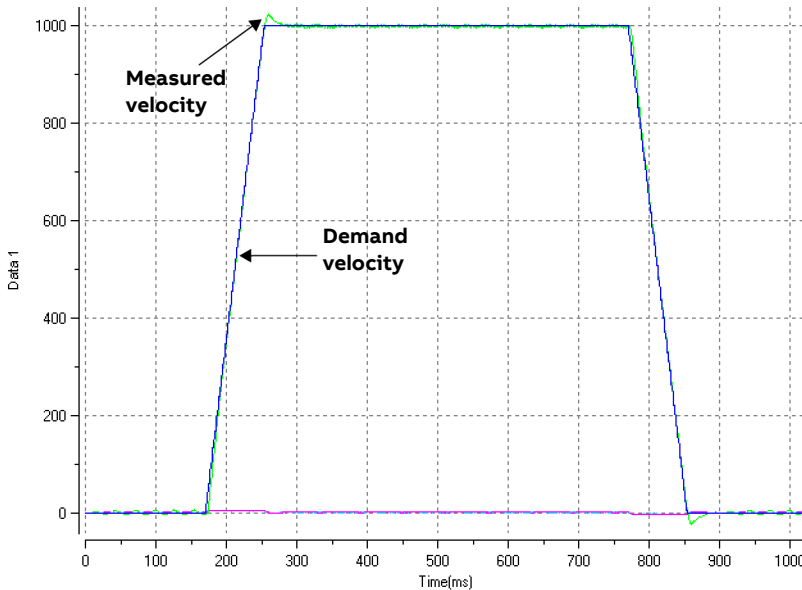
Zero-speed noise:



## ■ Ideal velocity response

Repeat the tests described in Correcting overshoot and Correcting zero-speed noise in the velocity response until the optimal response is achieved. The following graph shows an ideal velocity response. There is only a small amount of overshoot and very little zero-speed noise.

Ideal velocity response:



## ■ Performing test moves - continuous jog

This section tests the basic operation of the drive and motor by performing a continuous jog. To stop a move in progress, click the red stop button or the drive enable button on the toolbar. Alternatively, use the Mint WorkBench 'Red Stop Button' feature.

1. Check that the Drive enable button is pressed (down).
2. In the Toolbox, click the Edit & Debug icon.
3. Click in the Command window.

Type:

JOG (0) =10

This causes the motor to move continuously at 10 units per second. In Mint WorkBench, look at the Spy window located on the right of the screen. Check



that the axis tab is selected. The Spy window's Velocity display should show 10 (approximately). If there seems to be very little motor movement, it is probably due to the scale factor. In the Commissioning Wizard, on the Select Scale Factor page, if you did not adjust the scale factor then the current unit of movement is feedback counts per second. Depending on the motor's feedback device, 10 feedback counts per second could equate to a very small velocity. Issue another JOG command using a larger value, or use the Operating Mode Wizard to select a suitable scale factor (e.g. 4000 if the motor has a 1000 line encoder, or 10,000 for a 2500 line encoder).

4. To stop the test, type:

```
STOP (0)
```

5. If you have finished testing click the Drive Enable button to disable the drive.

### ■ Performing test moves - relative positional move

This section tests the basic operation of the drive and motor by performing a positional move. To stop a move in progress, click the red stop button or the drive enable button on the toolbar. Alternatively, use the Mint WorkBench 'Red Stop Button' feature.

1. Check that the Drive enable button is pressed (down).
2. In the Toolbox, click the Edit & Debug icon.
3. Click in the Command window.

Type:

```
MOVER (0) =10  
GO (0) =10
```

This causes the motor to move to a position 10 units from its current position.

The move stops when completed.

4. If you have finished testing click the Drive Enable button to disable the drive.



## Further configuration

Mint WorkBench provides a number of other tools for testing and configuring the MotiFlex e180. Every tool is explained fully in the help file. Press F1 to display the help file, then navigate to the Mint WorkBench book. Inside this is the Toolbox book.

### ■ Configuration tool

The Configuration tool shows the MotiFlex e180 integrated configuration interface.

1. Click the Configuration tool icon in the Toolbox on the left of the screen.
2. Select *Upload configuration from controller* or *Start new configuration*.
3. Enter a descriptive name for the controller and click NEXT at the bottom of the screen.
4. Continue through the screens making the required changes. Press F1 to display help.
5. Click APPLY to save the changed settings, then CLOSE to complete the configuration.

### ■ EtherCAT tool

The EtherCAT tool shows all information relating to the EtherCAT connection.


1. Click the EtherCAT tool icon in the Toolbox on the left of the screen.
2. Wait until data is uploaded from the MotiFlex e180.
3. The Summary tab shows basic information about the EtherCAT connection.
4. Click the Object Dictionary tab (above the table) to view the current state of the drive's object dictionary. Press F1 to see the Mint WorkBench help file for instructions about the screen's tool bar.


### ■ Parameters tool




The Parameters tool can be used to view or change most of the drive's parameters.

1. Click the Parameters icon in the Toolbox on the left of the screen. The main area of the Mint WorkBench window displays the Parameters editor screen.

Items listed with a grey  icon are read only so cannot be changed.

Items listed with a green  icon are currently set to their factory default value.

Items listed with a yellow  icon have been changed from their factory default value, either during the commissioning process or by the user.

2. In the parameters tree, scroll to the required item. Click on the small + sign beside the item's name. The list expands to show all items in the category. Click on the item you wish to edit.
3. The adjacent table lists the chosen item. Click in the Active Table cell and enter a value. This immediately sets the parameter, which remains in the MotiFlex e180 until another value is defined. The icon to the left of the item becomes yellow to indicate that the value has been changed.

Many of the MotiFlex e180's parameters are set automatically by the Commissioning Wizard, or when tests are performed in the Fine-tuning window.

### ■ Spy window

The Spy window can be used to monitor and capture parameters in real-time. If you tried the test moves in [Performing test moves - continuous jog](#) on page 112 or [Performing test moves - relative positional move](#) on page 113 then you have already seen the Spy window, as it is displayed in conjunction with Edit & Debug mode. See the Mint help file for full details of each tab.

1. Click the Edit & Debug icon in the Toolbox on the left of the screen. The Spy window is displayed on the right of the screen. Click on the tabs at the bottom of the window to select the required function.
  2. The Axis tab displays the five most commonly monitored parameters, together with the state of special purpose inputs and outputs.
  3. The I/O tab displays the state of all the digital inputs and outputs. Click on an output LED to toggle the output on/off.
  4. The Monitor tab allows up to six parameters to be selected for monitoring. Click in a drop down box to select a parameter.
- At the bottom of the Monitor tab, real-time data capture can be configured.

### ■ Other tools and windows

Remember, for help on each tool press F1 to display the help file, then navigate to the Mint WorkBench book. Inside this is the Toolbox book.



### Edit & Debug Tool

This tool provides a work area including the Command window and Output window. The Command window can be used to send immediate Mint commands to the MotiFlex e180. If you tried the test moves in [Performing test moves - continuous jog](#) on page 112 or [Performing test moves - relative positional move](#) on page 113, then you have already used Edit & Debug mode. Press Ctrl+N to open a Mint programming window.

### Scope Tool

Displays the capture screen. This screen is also shown when the Fine-tuning tool is selected.

### Digital I/O Tool

This tool allows you to configure the active states and special assignments for the digital inputs and outputs. For example, a general purpose digital input can be configured as an optional 'drive enable input', which must be active to enable the drive; see pages [70](#) to [74](#).

If a digital input is to be used as a home switch input, see [Using a digital input as a home switch input \(optional\)](#) on page [70](#) for important details.

### Safe Torque Off (STO) acceptance test

Drive commissioning is not complete until the STO function has been tested.

The acceptance test of the safety function must be carried out by an authorized person with expertise and knowledge of the safety function. The test must be documented and signed by the authorized person.

See [Appendix: Safe Torque Off \(STO\)](#) on page [227](#).





# 10

## Fault tracing

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### What this chapter contains


This section explains common problems and their solutions. The LED indicators are described in [MotiFlex e180 indicators](#) on page 119.

#### ■ Problem diagnosis

If you have followed all the instructions in this manual in sequence, you should have few problems installing the MotiFlex e180. If you do have a problem, read this section first.

- In Mint WorkBench, use the Error Log tool to view recent errors and then check the help file.
- If you cannot solve the problem or the problem persists, the SupportMe feature can be used.

#### ■ SupportMe feature

The SupportMe feature is available from the Help menu, or by clicking the  button on the motion toolbar. SupportMe can be used to gather information which can then be e-mailed, saved as a text file, or copied to another application. The PC must have e-mail facilities to use the e-mail feature. If you prefer to contact ABB technical support by telephone or fax, contact details are provided on the back cover of this manual.

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Have the following information ready:

- The serial number of your MotiFlex e180 (if known).
- Open the Help, SupportMe menu item in Mint WorkBench to view details about your system.
- The catalogue and specification numbers of the motor that you are using.
- A clear description of what you are trying to do, for example trying to establish communications with Mint WorkBench or trying to perform fine-tuning.
- A clear description of the symptoms that you can observe, for example the Status LED, error messages displayed in Mint WorkBench, or errors reported by the Mint error keywords `ERRORREADCODE` or `ERRORREADNEXT`.
- The type of motion generated in the motor shaft.
- A list of any parameters that you have setup, for example the motor data you entered/selected in the Commissioning Wizard, the gain settings generated during the tuning process and any gain settings you have entered yourself.

#### ■ **Power-cycling the MotiFlex e180**

The term 'power-cycle the MotiFlex e180' is used in the Troubleshooting sections. If the AC supply is removed, wait for 5 minutes before reapplying the supply.



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## MotiFlex e180 indicators

### ■ EtherCAT® mode

The Ethernet LEDs display the overall condition of the Ethernet interface once the startup sequence has completed. The LED codes conform to the EtherCAT Technology Group (ETG) standard at the time of production.






NET ERR (Red)	
	<b>Off:</b> No errors or not powered.
	<b>Blinking:</b> Invalid mailbox configuration in BOOT. Invalid mailbox configuration in PREOP. Invalid Sync manager configuration. Invalid output configuration. Invalid input configuration. Invalid watchdog configuration. Invalid DC Sync configuration. Invalid DC latch configuration.
	<b>1 flash:</b> Unspecific error. No memory. Invalid request state change. Unknown requested state. Bootstrap not supported. No valid firmware. No valid inputs available. No valid output. Synchronisation error. Invalid Sync manager types. Slave needs cold start. Slave needs INIT. Slave needs PREOP. Slave needs SAFEOP. Invalid input mapping. Invalid output mapping. Inconsistent settings. FreeRun not supported. SyncMode not supported.  FreeRun needs 3 buffer mode. Background watchdog occurred. No valid inputs and outputs. Fatal sync error. No sync error. PLL error. DC sync IO error. DC sync time-out error. Invalid DC Sync cycle time. DC Sync0 cycle time. DC Sync1 cycle time. Message box EoE error. Message box CoE error. Message box FoE error. Message box SoE error. Message box VoE error. EEPROM no access. EEPROM error. Slave restarted locally.
	<b>2 flashes:</b> Sync manager watchdog.



<b>NET RUN (Green)</b>	
	Off: INITIALISATION state (or not powered).
	Blinking: PRE-OPERATIONAL state. 1 flash: SAFE-OPERATIONAL state. 3 flashes: Device identification. This state can be set from the master to locate the device.
	Continuously illuminated, not flashing: Node in OPERATIONAL state. EtherCAT is operating normally.

### ■ Ethernet POWERLINK mode

The Ethernet LEDs display the overall condition of the Ethernet interface once the startup sequence has completed. The LED codes conform to the Ethernet POWERLINK Standardization Group (EPSG) standard at the time of production.



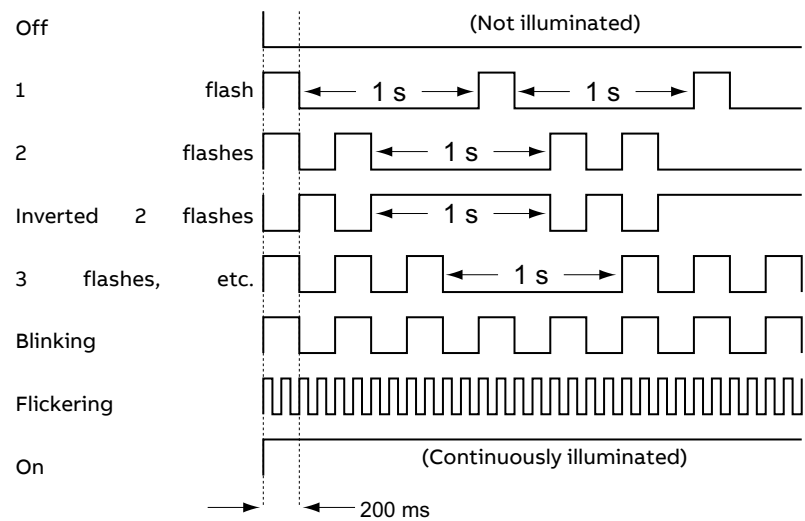
<b>Green (status)</b>	
	Off: Node in NOT ACTIVE state or a previous initialization state. The controlled node is waiting to be triggered by the manager node.
	1 flash: Node in PRE-OPERATIONAL1 state. Ethernet POWERLINK mode is starting.  2 flashes: Node in PRE-OPERATIONAL2 state. Ethernet POWERLINK mode is starting.  3 flashes: Node in READY TO OPERATE state. The node is signalling its readiness to operate.  Blinking (continuous flashing): Node in STOPPED state. The controlled node has been deactivated.  Flickering (very fast flashing): Node in BASIC ETHERNET state (Ethernet POWERLINK is not operating, but other Ethernet protocols may be used).
	Continuously illuminated, not flashing: Node in OPERATIONAL state. Ethernet POWERLINK is operating normally.

Red (error)	
	Off: Ethernet POWERLINK is working correctly.
	Continuously illuminated: An error has occurred.

LED flash periods

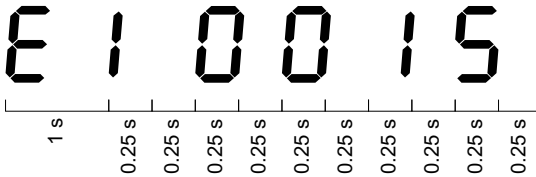
The following diagram shows the definitions of the terms ‘blinking’, ‘flashing’ and ‘flickering’ used in the previous sections, as defined by the EtherCAT Technology Group.

LED flash timing definitions:



## ■ Drive status display

The drive status display indicates errors and general MotiFlex e180 status information. When an error occurs the drive displays a sequence starting with the symbol E, followed by the five digit error code. For example, error code 10015 is displayed:



The decimal point to the right of the number also illuminates to indicate STO errors. For a complete list of error codes, open Mint WorkBench, press F1, and locate the Error Handling book. This contains topics listing the drive status display indicators and basic error codes. See also [Start the MotiFlex e180](#) on page 103.

The following information symbols can be displayed:

Symbol	Description
— .	Drive disabled, and one or both STO inputs are not powered. The drive must be enabled before operation can continue. Both STO inputs must be powered. If an optional drive enable input has been configured, it must also be powered.
—	Drive disabled. The drive must be enabled before operation can continue. If an optional drive enable input has been configured, it must also be powered.
— —	Suspend active. The Mint <code>SUSPEND</code> command has been issued and is active. Motion ramps down to zero demand whilst active.
— — —	Firmware loading (segments are illuminated sequentially). This sequence is followed by a numerical sequence representing firmware initialization stages.
HTA	Hold to Analogue (HTA) mode. The axis is in Hold To Analogue mode. See the Mint keyword <code>HTA</code> .
00	Drive enabled, but idle.
C	Cam move. A cam profile is in progress. See the Mint keyword <code>CAM</code> .

Symbol	Description
<b>d</b>	Dwell. A dwell (wait) 'move' is in progress. See the Mint keyword <code>MOVEDWELL</code> .
<b>f</b>	Flying shear. A flying shear is in progress. See the Mint keyword <code>FLY</code> .
<b>3</b>	Follow move. The drive is in follow mode. See the Mint keyword <code>FOLLOW</code> .
<b>h</b>	Homing. The drive is currently homing. See the Mint keyword <code>HOME</code> .
<b>l</b>	Incremental move. An incremental linear move is in progress. See the Mint keywords <code>INCA</code> and <code>INCR</code> .
<b>j</b>	Jog. The drive is jogging. See the Mint keywords <code>JOG</code> , <code>JOGCOMMAND</code> and related topics.
<b>o</b>	Offset move. An offset move is in progress. See the Mint keyword <code>OFFSET</code> .
<b>p</b>	Position move. A linear move is in progress. See the Mint keywords <code>MOVEA</code> and <code>MOVER</code> .
<b>q</b>	Torque move. The drive is in torque mode. See the Mint keywords <code>TORQUEREF</code> , <code>TORQUEREFSOURCE</code> and related commands.
<b>i</b>	Firmware recovery mode in operation; see <a href="#">Linear switches - startup functions</a> on page 82.
<b>S</b>	Stop input active. A Mint <code>STOP</code> command has been issued or an optional stop input is active.
<b>v</b>	Velocity reference move. The drive is under velocity control. See the Mint keywords <code>VELREF</code> and related keywords.
<b>2</b>	Spline. A spline move is in progress. See the Mint keyword <code>SPLINE</code> and related keyword.

User defined symbols can be displayed using Mint keywords `LED` and `LEDDISPLAY`.



## MotiFlex e180 fault diagnosis

### ■ Power

#### Drive does not start when applying AC power:

- Check that the motor output phases are not short circuited. The drive trips on a motor phase short circuit and will not restart unless AC power is removed. Remove all power from the drive, correct the short circuit and restart the drive.

### ■ Communication

#### Drive status display is off:

- Check that the 24 V DC control circuit supply is correctly connected at X9, and is switched on.

#### Drive status display shows 'r':

- The MotiFlex e180 is in firmware recovery mode. This means that it does not boot fully, and allows Mint WorkBench to download firmware from the Choose Firmware dialogue.

#### Mint WorkBench fails to detect the MotiFlex e180:

- Ensure that the MotiFlex e180 is powered and the drive status display is illuminated (page [123](#)).
  - Check that the Ethernet cable is connected between the PC and MotiFlex e180. Check that the cable is connected to port E3 (on the front panel) and not port E1 or E2.
  - Check that the PC's Ethernet port has been correctly configured for TCP/IP operation, and enabled for use with Mint WorkBench (see [Configure the PC Ethernet adapter](#) on page [102](#)).
  - Check that any PC firewall or security software does not prevent communication on TCP ports 5000 and 5001, and UDP port 5050. These ports are essential for communication with the MotiFlex e180.
  - Try an alternative cable or different port on the PC.
-

## ■ Mint WorkBench

### The Spy window does not update:

- The system refresh has been disabled. Go to the Tools, Options menu item, select the System tab and then choose a System Refresh Rate (500 ms is recommended).

### Cannot communicate with the controller after downloading firmware:

- After firmware download, always power-cycle the MotiFlex e180.

## ■ Ethernet

### Cannot connect to the drive:

- Check that the PC's Ethernet adapter has been correctly configured, as described in [Configure the PC Ethernet adapter](#) on page 102.

### How do I configure my EtherCAT manager to operate with the MotiFlex e180?

- An EtherCAT ESI file (.xml) that describes the drive to the EtherCAT manager can be uploaded from the controller using the Mint WorkBench EtherCAT tool.

### I cannot control the MotiFlex e180 from my EtherCAT manager

The drive reference source must be set to allow the EtherCAT manager to take control of the MotiFlex e180. There are several ways to do this:

- Set the `CONTROLREFSOURCESTARTUP` parameter to '1' using the Mint WorkBench Parameter viewer or Command window, and restart the drive. This gives control to the manager each time the MotiFlex e180 starts.
  - Set the Control Ref. Source to 'RT Ethernet (CiA402)' in the Mint WorkBench Operating Mode Wizard or Commissioning Wizard.
  - Click the Direct button on the Mint WorkBench Motion tool bar, and select 'RT Ethernet (CiA402)' in the Axis 0 drop-down.
  - Confirm that the reference source on all controlled nodes has been set to EtherCAT in the Mint WorkBench Operating Mode Wizard, and that the master has been configured correctly.
-

## ■ Tuning

### **Cannot enable the MotiFlex e180 because there is an error 10010:**

- Check the drive enable input, if assigned, is connected and powered correctly.

### **Cannot enable the MotiFlex e180 because there is an error 10033 and/or 10035:**

- Check the Safe Torque Off inputs on connector X2 are both connected and powered correctly.

### **When the MotiFlex e180 is enabled the motor is unstable:**

- Check that the load is firmly coupled to the motor.
  - Use the Mint WorkBench Drive Setup Wizard to confirm that the correct motor data has been entered.
  - Use the Mint WorkBench Autotune Wizard to retune the motor.
  - If the motor is still unstable, select the Mint WorkBench Autotune Wizard once more. Click Options.... On the Bandwidth tab, move the Current and/or Position and Speed Control sliders to a slower position to select a lower bandwidth. Click OK to exit and then start the Autotune Wizard again.
-

## ■ Encoder battery flat detection

For Smart-ABS multi-turn encoder, the drive can detect and react when battery becomes flat when the motor is running, or drive sys stays under power off and whether the position data should be restored if the battery becomes flat during power off. The `EncoderBatteryError` is used to select the type of reaction.

When the `EncoderBatteryError` parameter is:

- set to 1 (default), the battery flat detection is enabled, and if battery becomes flat, error [10038](#)/warning [20004](#) will be reported.
  - If battery becomes flat when drive is running then warning 20004 will be generated until battery issue is solved.
  - If battery becomes flat when drive is under power off then error 10038 will appear after power on and manually acknowledge is needed to clear this error and after that warning 20004 will be generated until battery issue is solved.
- set to 0, the battery flat detection is disabled, and error 10038/warning 20004 will not be reported.

### **Note:**

1. Error [10038](#) occurs only at startup and the axis can not be enabled until the error is cleared.
  2. Warning [20004](#) will not stop the axis running just to remind the customer to replace the battery.
-

## ■ Dual encoder

In dual encoder applications, a feedback deviation error (*10045*) will occur if the axis' position encoder and velocity encoder deviate from each others values by a value which exceeds its maximum deviation error limit. To ensure accuracy, an incremental calculation period is defined by using the keyword `POSVELENCODERDEVIATIONCLEARPERIOD`. At the beginning of each calculation period, the deviation value is initialized to 0 and recalculated.

If `POSVELENCODERDEVIATIONCLEARPERIOD` is set to 0, the deviation tracing function will be closed, and error *10045* will not be reported.

The maximum deviation error limit is set with the keyword `POSVELENCODERDEVIATIONFATAL`. The keyword `POSVELENCODERDEVIATION` returns the instantaneous deviation value. So the deviation error occurs when the value of `POSVELENCODERDEVIATION` is greater than the value of `POSVELENCODERDEVIATIONFATAL`.

The keyword `POSVELENCODERDEVIATIONERRORMODE` is used to specify the default action to be taken in the event of a deviation error. The available modes are 'crash stop and disable' and 'error decel as velocity mode'.

If the user sets `POSVELENCODERDEVIATIONERRORMODE (0) = 1` then **crash stop and disable mode**, is selected. This means that when a deviation error occurs, the drive will:

- Perform crash stop.
- Call the error event and the error *10045* is generated.
- Be disabled.

If the user sets `POSVELENCODERDEVIATIONERRORMODE (0) = 10` then **error decel as velocity mode**, is selected. This means that when a deviation error occurs, the drive will:

- Switch to velocity mode automatically.
  - Call the error event and the error 10045 is generated.
  - Stop the motor to zero at the `ERRORDECEL` rate.
  - Stay enabled (if no other error occurs) in velocity mode until next command.
-

## Warning messages generated by the drive

### ■ Axis warnings

Code	Warning	Cause	What to do
20003	All axis warnings cleared (_ecAXIS_WARNINGS_CLEARED)	This information message can appear in the error log to indicate that all axis warnings have been cleared.	No Action required.
20004	Encoder battery low (_ecENCODER_BATTERY_LOW)	For an encoder with battery backup (e.g. Smart Abs multiturn) a battery low condition has been reported when drive is running.	Consider changing the Encoder battery. Note: This information message will not stop the axis running just to remind the customer to replace the battery.
20005	Phase loss detected (_ecPHASE_LOSS_WARNING)	One of the AC supply phases has been lost.	Check the AC supply wiring to the drive.
20006	Motor temperature not read (_ecMOTOR_TEMP_NOT_READ_WARNING)	The Hiperface DSL feedback device has indicated a motor overtemperature condition.	Check motor temperature.

## ■ Controller warnings

Code	Warning	Cause	What to do
40006	Attempt to configure too many axes (_ecTOO_MANY_AXES)	The device configuration file has attempted to assign more axes than are available on the controller.	Re-run the System Configuration Wizard.
40007	CamBox segments have been skipped (_ecCAM_BOX_OVERRUN)	The cam box has skipped a segment. This can happen if the source is moving fast enough to cause a segment to be skipped.	See CAMBOX in Mint WorkBench Help, look at "position array". Either slow down the source or increase the size of the segments.
40012	A host event has failed with retries (_ecEVENT_RETRY_WARNING)	A host (i.e. ActiveX) event handler has failed to acknowledge an event that has been raised by the controller. There is a 'time-out' period of 1 second in which the host must acknowledge an event.	If the host does not acknowledge the event after 3 time-out periods, the controller generates warning 40012. See ERRDATA for details of the error.
40013	Attempted to assign too many servo axes (_ecTOO_MANY_SERVO_AXES)	During the processing of the .CMCF / .DCF (device configuration file), too many servo axes were configured.	To fix this issue, use the System Config Wizard to reduce the number of configured servo axes.
40014	Attempted to assign too many stepper axes (_ecTOO_MANY_STEPPER_AXES)	During the processing of the .CMCF / .DCF (device configuration file), too many stepper axes were configured.	To fix this issue, use the System Config Wizard to reduce the number of configured stepper axes.
40015	Attempted to assign too many virtual axes (_ecTOO_MANY_VIRTUAL_AXES)	During the processing of the .CMCF / .DCF (device configuration file), too many virtual axes were configured.	To fix this issue, use the System Config Wizard to reduce the number of configured virtual axes.
40016	Attempted to assign too many remote axes (_ecTOO_MANY_REMOTE_AXES)	During the processing of the .CMCF / .DCF (device configuration file), too many remote axes were configured.	To fix this issue, use the System Config Wizard to reduce the number of configured remote axes.
40021	All controller warnings cleared (_ecCONTROLLER_WARNINGS_CLEARED)	This information message can appear in the error log to indicate that all controller warnings have been cleared.	No Action Required.
40022	Last reset was not controlled (_ecRESET_NOT_CONTROLLED)	Last reset was not controlled.	To fix this issue, use the System Config Wizard to reduce the number of configured servo axes.

Code	Warning	Cause	What to do
40023	Default MAC detected (_ecDEFAULT_MAC_DETECTED)	Default MAC has been detected, valid MAC address is not set.	Set valid MAC address.
40024	Could not open license file or Error reading license file (_ecMISSING_LICENCE_FILE)	Could not open license file or Error reading license file.	If this error is received, please contact ABB technical support.
40025	Licence file doesn't match hardware ID(_ecFOREIGN_LICENCE_FILE_PRESENT)	Wrong licencing version or platform, or Flash unique ID does not match the one in the license file.	If this error is received, please contact ABB technical support.
40026	Invalid Licence file (_ecINVALID_LICENCE_FILE_PRESENT)	Licence data hash does not match the one in the Licence File.	If this error is received, please contact ABB technical support.
40027	Warning applying parameter value (_ecPARAM_WARNING)	This warning will be generated if an attempt is made to write to a parameter that is no longer supported.	If necessary recommission the drive to create a new parameter table.
40028	Warning fan fault (_ecFAN_FAULT_WARNING)	The fan is possibly faulty, unplugged or jammed.	Firstly ensure the latest firmware is in use (as the fan is controlled by firmware). Check the bottom of the drive to determine that the fan inlets are not blocked and the fan is rotating. If the drive fan does not turn see the drive installation manual for instructions on how to replace the fan.

See [AN00267 ABB Motion Drives Error trouble shooting manual](#) for more details on error handling.



## Error messages generated by the drive

### ■ Autotuning errors

Code	Error	Cause	What to do
4000	No autotuning error (_ecAUTOTUNE_SUCCES)	There is no autotuning error.	No Action.
4001	Drive rating data invalid	One of the following conditions has not been met 1. Drive bus nominal voltage < 1 2. Drive rated current <= 0	Check memory module is connected correctly, check power supply level is correct.
4002	Drive speed max invalid	DriveSpeedMax <= 0 Only check AutoTune test ID autoDESIGN_MOTION_CONTROL.	Re-run commissioning and check that DriveSpeedMax is set correctly.
4003	Config doesn't support that test (_ecCONFIG_NOT_RIGHT_TYPE)	The autotuning operation does not support this controller configuration.	This error will not occur unless the configuration has been manually changed using the CONFIG keyword.
4004	Axis error has occurred (_ecAXIS_ERROR)	An asynchronous axis error or drive error has occurred during the autotuning operation.	See the Mint WorkBench Motion toolbar for more information on the error.
4005	Calculated torque constant invalid	Drive had calculated a Torque Constant which is too small.	Check motor data is correct.
4006	Inductance value is zero	For the selected motor the winding inductance is zero.	To avoid this error, make sure that a motor has been selected from the database in the Drive Setup Wizard. Alternatively, if a custom motor has been selected and you are unsure of motor data, check that the "Measure motor resistance and inductance" test has been selected and run using the Autotune tool.
4007	Resistance value is zero (_ecZERO_RESISTANCE_VALUE)	For the selected motor the winding resistance is zero.	To avoid this error, make sure that a motor has been selected from the database in the Drive Setup Wizard. Alternatively, if a custom motor has been selected and you are unsure of motor data, check that the "Measure motor resistance and inductance" test has been selected and run using the Autotune tool.
4008	User has aborted test (_ecUSER_TEST_ABORT)	The autotuning operation has been manually aborted.	This will occur if the Autotune tool's STOP button is clicked while tests are being performed.
4009	Cannot capture data during test (_ecCAPTURE_FAILED)	Many of the autotuning operations use the data capture facility. This error message can occur if the capture facility is in use prior to performing the autotuning operation.	Not normally a problem, but to prevent this before autotuning, type CP=0 in the Command window to halt any capture operations.

Code	Error	Cause	What to do
4010	Resistance too low, possible short circuit ( <code>_ecPOSSIBLE_SHORT_CIRCUIT</code> )	This error can occur during the Measure motor resistance and inductance test and indicates that the effective motor winding resistance is very low.	Check that there are no short circuits between the U, V and W terminals of the motor and that the motor power cable is wired correctly.
4011	Autotuning doesn't support feedback device ( <code>_ecUNSUPPORTED_FEEDBACK_TYPE</code> )	The Test the feedback or Feedback calibration test (EnDat absolute encoders only) does not operate on this feedback type.	This error will not normally occur because Mint WorkBench will not allow autotuning on unsupported feedback types. I.e. the combination of Motor and Feedback device is not supported by Mint WorkBench.
4012	Encoder resolver rotation sense is wrong ( <code>_ecFEEDBACK_SENSE_WRONG</code> )	During the Measure the voltage constant and Measure the motor inertia tests, a torque is applied to the motor. This error will occur if the resulting motion is in the opposite direction to the torque (a positive torque should cause positive velocity).	<p>The most common cause of this error is an incorrectly wired or set up feedback device (encoder or resolver), or an incorrectly wired motor. Select the Test the feedback option. This will indicate if there is a problem with the wiring or setup of the drive and will automatically compensate for certain wiring errors. Note that the Test the feedback test should ideally be run with the motor disconnected from the load.</p> <p>This error can also occur when autotuning a motor connected to some types of load. In particular, loads with a lot of compliance (e.g. belt drives) or torque offsets (e.g. gravitational loading) can cause problems for autotuning.</p> <p>Another cause of the error may be because the position feedback is noisy, perhaps due to long cables on resolver feedback systems, for example. In either of these cases, it may be necessary to manually tune the system using the Fine-tuning tool.</p>

Code	Error	Cause	What to do
4013	Hall sequence doesn't behave as expected (_ecHALL_FAULT_OR_NO_ROTATION)	The Hall sequence doesn't behave as expected. This error can occur during the Test the feedback test when using an incremental encoder + Halls feedback system.	<p>The error can occur for a number of reasons, so try the following tests:</p> <ul style="list-style-type: none"> <li>Return to the Confirm Motor Information page of the Drive Setup Wizard to check these values. If the resolver is not a standard ABB product, check that the specification is compatible in the drives hardware manual</li> <li>A common cause of this error is an incorrectly wired or set up encoder/resolver. Try manually moving the rotor and watching the position field in the Axis tab. If the position does not change, or it changes erratically, this indicates a problem with the encoder wiring.</li> <li>Run the Test the feedback test again. Ideally, the Test the feedback test should be run with the motor disconnected from the load, although it will operate successfully where the load is purely inertial or load friction is small.</li> </ul> <p>Note: watch the movement of the rotor. For rotary motors, the shaft should rotate through just over one revolution in one direction followed by one revolution in the opposite direction. For linear motors, the rotor should move through just over one pole pitch in one direction followed by one pole pitch in the opposite direction. If the rotor moves significantly more or less than these distances, this indicates that the number of motor poles is not set correctly (rotary motors), or the pole pitch is not set correctly (linear motors). If the motion during the test is not smooth, this indicates that friction is high and the test will not be able to obtain conclusive results.</p>
4015	Position control update rate invalid	Position loop control rate (ControlRate(0,1)) < 1.	Change control rate to expected value (normally 4000).

Code	Error	Cause	What to do
4016	Mathematic error in gain calculations ( <code>_ecGAIN_CALCS_FAILED</code> )	This error can occasionally occur during the Calculate current loop gains or Calculate the speed and position gains tests, indicating a numerical problem in the gain equations. It can also indicate a problem with the values of motor resistance and inductance ( <code>MOTORRS</code> and <code>MOTORLS</code> ) when it occurs during current loop gain calculations, or with the values of inertia and damping ( <code>LOADINERTIA</code> and <code>LOADDAMPING</code> ) when it occurs during speed/position loop gain calculations.	The error can usually be cleared by changing the design bandwidth for the appropriate operation (click Options... in the Autotune tool). If that fails, try running the entire autotuning sequence again.
4017	Drive setup is invalid	This error can potentially occur in any of the autotuning operations, although it is rare. It indicates a problem with the fundamental setup of the drive such as the settings for motor rated current or peak current.	Try running the Commissioning Wizard again, making sure that the I am starting a new application. Reset memory to factory defaults option on the Welcome page is selected.
4018	Can't fit model to voltage/current data ( <code>_ecCANNOT_FIT_RESISTANCE_MODEL</code> )	During the Measure motor resistance and inductance test, a gradually increasing voltage is applied to the motor and the generated current is logged. The process is stopped when the drive current reaches 80% of the specified motor rated current value. The resulting voltage/current characteristic is used to calculate the resistance of the windings and certain parameters of the drive's power stage. Error 4018 will occur if there is not enough data in the voltage/current characteristic to perform the calculation.	Check the wiring between the drive and motor and the motor windings for open circuits.
4019	Can't fit model to voltage/current transient ( <code>_ecCANNOT_FIT_INDUCTANCE_MODEL</code> )	During the Measure motor resistance and inductance test, stator inductance is measured by applying a voltage step to the motor and logging the generated current waveform. Inductance is then calculated from the resulting voltage/current characteristic. Error 4019 indicates that this calculation cannot be performed because of insufficient data or an unusual characteristic.	Try skipping the Measure motor resistance and inductance test. To do this, manually enter the motor resistance and inductance in the Confirm Motor Information page of the Drive Setup Wizard (most motor manufacturers will supply this information) and confirm that the test is not selected in the Autotune tool. Once autotuning is complete, check that the response of the current controllers is satisfactory using the Fine-tuning tool's Current tab.

Code	Error	Cause	What to do
4020	Can't fit load model speed data (_ecCANNOT_FIT_LOAD_MODEL)	During the Measure the motor inertia test, a torque waveform is applied by the motor and the motor speed logged. A simple inertia/damping model is then fitted numerically to the resulting torque/speed characteristic. Error 4020 indicates that the fitting process failed. A common cause for this is lack of sufficient information to fit the load model.	Click Options... in the Autotune tool and then select the Limits tab. Increase the value in the Max Travel box to allow the motor to rotate further during the test and consequently log more data. The model fitting process can also fail for certain types of load. For example, loads with high coulomb or static friction will not conform well to an inertial load model. Likewise gravitational loading (i.e. vertical axes) will cause problems for autotuning. If the Measure the motor inertia test continues to fail then the subsequent Calculate the speed and position gains test will also fail, as it requires values for load inertia and damping. It may be necessary to manually tune the system using the Fine-tuning tool's Speed and Position tabs.
4021	Motor test timed out (_ecAUTOTUNE_TEST_TIMEOUT)	During the Measure the voltage constant and Measure the motor inertia tests, current is applied to the motor to accelerate the motor and load. Error 4021 indicates that the rotor did not reach a sufficient speed, or travel a sufficient distance, within the duration of the test. Error 4021 can occur if the torque (or force) generated by the motor is insufficient to overcome friction in the load.	Click Options... in the Autotune tool and then select the Limits tab. Increase the value in the Max Torque box to allow the motor to generate sufficient torque to overcome friction. If the Measure the motor inertia test continues to fail then the subsequent Calculate the speed and position gains test will also fail, as it requires values for load inertia and damping. It may be necessary to manually tune the system using the Fine-tuning tool's Speed / Velocity and Position tabs.
4022	Motor travelled too far during test (_ecAUTOTUNE_TEST_OVERTRAVEL)	During the Measure the voltage constant and Measure the motor inertia tests, current is applied to the motor to accelerate the motor and load. Once the motor has reached a sufficient speed, the direction of applied current is reversed to bring the rotor to a halt within specified travel limits. Error 4022 indicates that the test was unable to impose these limits.	Click Options... in the Autotune tool and then select the Limits tab. Increase the value in the Max Travel box to allow the motor to rotate further during the test. Also, try reducing the value in the Max Speed box. If the Measure the motor inertia test continues to fail then the subsequent Calculate the speed and position gains test will also fail, as it requires values for load inertia and damping. It may be necessary to manually tune the system using the Fine-tuning tool's Speed / Velocity and Position tabs.

Code	Error	Cause	What to do
4023	Not enough test data to analyse (_ecINSUFFICIENT_TEST_DATA)	This error can occur during any of the autotuning tests, namely the Measure motor resistance and inductance test, the Measure the voltage constant and Measure the motor inertia tests, and the Feedback calibration test (for absolute encoders only). Generally, error 4023 means that insufficient data was logged during the test to obtain accurate parameter measurement.	See errors 4018, 4019 and 4020 for the reasons why these tests fail.
4024	Flux model parameters are invalid (_ecINVALID_FLUX_MODEL)	The Measure the motor inertia test will fail with this error if the voltage constant has not been defined.	To determine the voltage constant, either select a standard motor from the database in the Drive Setup Wizard, enter a voltage constant value in the Confirm Motor Information page of the Drive Setup Wizard (see manufacturer's motor data), or run the Measure the voltage constant test.
4025	Load model is invalid (_ecINVALID_LOAD_MODEL)	If this error occurs during the Measure the motor inertia test, it suggests that the characteristics of the load are such that inertia cannot be accurately calculated.	See error 4020 for more information.
		Error 4025 can also occur during the Calculate the speed and position gains test if the values of load inertia and damping have not been defined.	In this case, run the Measure the motor inertia test to measure load inertia and damping.
4026	Encoder parameter invalid	Either; EncoderResolution < 1 or EncoderCycleSize = 0.	Correct Encoder parameters and re run autotune tests
4027	Motor inductance is not set	When motor type is AM, Lm or Llr <= 0.	To avoid this error, make sure that a motor has been selected from the database in the Drive Setup Wizard. Alternatively, if a custom motor has been selected and you are unsure of motor data, check that the "Measure motor resistance and inductance" test has been selected and run using the Autotune tool.

Code	Error	Cause	What to do
4028	Can't set stator resistance (_ecCANNOT_SET_STAT_OR_RESISTANCE)	Can't set stator resistance.	Error codes 4028 to 4054 will occur if the associated drive parameter, calculated by one of the autotuning tests, or set by the user is outside the allowable range of values. These errors should not normally occur. If the problems persist, make sure that a motor has been selected from the database in the Drive Setup Wizard. Alternatively, if a custom motor has been selected and you are unsure of motor data, check that the "Measure motor resistance and inductance" test has been selected and run using the Autotune tool. If the problem persists you will need to manually tune the control loops in the drive.
4029	Can't set stator leakage inductance (_ecCANNOT_SET_STAT_OR_INDUCTANCE)	Can't set stator leakage inductance.	
4030	Motor pole pitch invalid	Calculated motor pole pitch $\leq 0$ .	
4031	Motor pole number invalid	Calculated motor poles $< 2$ .	
4032	Load inertia is not set	Calculated load inertia $\leq 0$ .	
4033	Can't set maximum motor flux (_ecCANNOT_SET_MOTOR_MAX_FLUX)	Can't set motor flux model time constant.	
4035	Can't set load inertia (_ecCANNOT_SET_LOAD_INERTIA)	Can't set load inertia.	
4036	Can't set load damping (_ecCANNOT_SET_LOAD_DAMPING)	Can't set load damping.	
4037	Can't set controller proportional gain (_ecCANNOT_SET_GAIN_KIPROP)	Can't set controller proportional gain.	
4038	Can't set current controller integral gain (_ecCANNOT_SET_GAIN_KIINT)	Can't set current controller integral gain.	
4039	Can't set speed controller proportional gain (_ecCANNOT_SET_GAIN_KVPRO)	Can't set speed controller integral gain.	
4040	Can't set speed controller integral gain (_ecCANNOT_SET_GAIN_KVINT)	Can't set speed controller integral gain.	
4041	Can't set position proportional gain (_ecCANNOT_SET_GAIN_KPROP)	Can't set position proportional gain.	
4042	Can't set position derivative gain (_ecCANNOT_SET_GAIN_KDERIV)	Can't set position derivative gain.	

Code	Warning	Cause	What to do
4043	Can't set position integral gain ( <code>_ecCANNOT_SET_GAIN_KINT</code> )	Can't set position integral gain.	Error codes 4028 to 4054 will occur if the associated drive parameter, calculated by one of the autotuning tests, or set by the user is outside the allowable range of values. These errors should not normally occur. If the problems persist, make sure that a motor has been selected from the database in the Drive Setup Wizard. Alternatively, if a custom motor has been selected and you are unsure of motor data, check that the "Measure motor resistance and inductance" test has been selected and run using the Autotune tool. If the problem persists you will need to manually tune the control loops in the drive.
4044	Can't set velocity feedforward gain ( <code>_ecCANNOT_SET_GAIN_KVELFF</code> )	Can't set velocity feedforward gain.	
4045	Can't set velocity feedback gain ( <code>_ecCANNOT_SET_GAIN_KVEL</code> )	Can't set velocity feedback gain.	
4046	Can't set acceleration feedforward gain ( <code>_ecCANNOT_SET_GAIN_KACCEL</code> )	Can't set acceleration feedforward gain.	
4047	Inertia test failed ( <code>_ecINERTIA_TEST_FAILED</code> )	Inertia measurement failed	
4048	Voltage constant test failed ( <code>_ecVOLTAGE_CONSTANT_TEST_FAILED</code> )	Voltage constant measurement failed	
4049	Can't set offset angle ( <code>_ecCANNOT_SET_ANGLE_OFFSET</code> )	Can't set motor feedback offset angle (Possible encoder fault or wrong config)	
4050	Can't set observer gain K1 ( <code>_ecCANNOT_SET_OBSERVER_GAIN_K1</code> )	Can't set observer gain K1.	
4051	Can't set observer gain K2 ( <code>_ecCANNOT_SET_OBSERVER_GAIN_K2</code> )	Can't set observer gain K2.	
4052	Can't set observer gain KJ ( <code>_ecCANNOT_SET_OBSERVER_GAIN_KJ</code> )	Can't set observer gain KJ.	
4053	Can't enable integral position control ( <code>_ecCANNOT_SET_KINT_MODE</code> )	Can't enable integral position control.	
4054	Can't set integral term limit ( <code>_ecCANNOT_SET_KINT_LIMIT</code> )	Can't set integral term limit.	



Code	Error	Cause	What to do
4055	Invalid autotuning operation number ( <code>_ecINVALID_OPERATION</code> )	This will only occur if Mint WorkBench attempts to run an autotuning operation not supported by the firmware.	Check Drive parameters and Re run Autotuning tests
4060	Cannot enable drive ( <code>_ecCANNOT_ENABLE_DRIVE</code> )	A drive cannot be enabled unless; the hardware enable is configured but not active or the AC supply (or shared DC bus supply) is present.	Go to Mint WorkBench Parameter view and Check; Enabling > DriveEnableInput setting is correct - if so ensure that the input is active before running autotune. To check drives connected voltage Go to Mint WorkBench Parameter view and Check; Drive > DriveBusVolts is at the correct level (325VDC for 230VAC supply)
4061	Drive communications error ( <code>_ecDRIVE_COMMS_ERROR</code> )	Communication between the host PC and the controller has failed.	Check the serial or USB cable.
4062	Absolute encoder is wired incorrectly ( <code>_ecABS_ENCODER_WIRING_INCORRECT</code> )	Absolute encoder is wired incorrectly. This error can occur for EnDat (absolute) encoders during the Test the feedback test. It indicates that the direction of increasing absolute position, as read from the communications channel, is different to the direction of the count derived from the sine and cosine signals. This will only occur if the sine and cosine channels are wired incorrectly.	Check the sine and cosine wiring of EnDat 2.1 encoder.
4063	Encoder fault ( <code>_ecPOSSIBLE_ENCODER_FAULT</code> )	General Encoder fault	Check encoder configuration, wiring and encoder operation when rotating by hand.
4065	Test move will take too long	Test move takes too long time in.	Check that test moves are set so that they will not take an excessive amount of time, Also check scaling is set correctly by checking SCALEFACTOR
4066	Test move velocity is too high	Calculated velocity > DriveSpeedMax in velocity autotune.	Re-run commissioning and check that DriveSpeedMax is set correctly
4067	Motor rated current undefined	Motor rated current < 0.2A	Check Motor data is correct, if the motor current is below 0.2A then its too small to be controlled by the drive
4068	Current control loop is not tuned	Current loop has not been tuned before performing the Rotor parameters autotuning (applicable to asynchronous motors only)	Re-run Autotuning
4069	Autotuning doesn't support motor type	Cannot do the wanted Autotune for this motor type.	Check Motor data is correct

Code	Error	Cause	What to do
4070	Can't set flex control proportional gain	Can't set flux control loop proportional gain.	Check Motor data is correct
4071	Can't set flex control integral gain	Cannot be shown because there is no error in API.	Check Motor data is correct
4074	Can't set magnetizing inductance	Cannot set motor Lm.	Check Motor data is correct

## ■ Parameter errors

Code	Error	Cause	What to do
6001	Parameter value out of range ( <code>_ecPARAM_VALUE_OUT_OF_RANGE</code> )	The value supplied for the parameter is out of range.	The value you have entered or that is stored in the parameter file (.ptx) you have loaded does not fit within the limits specified by the drive firmware version loaded. If needed update the firmware first then load the parameter file. To do this in Mint WorkBench go to Tools > Download Firmware > Select and download firmware file. Once complete try again
6004	Parameter definition has changed ( <code>_ecPARAM_DEFINITION_ERROR</code> )	The specified parameter exists, but its definition has changed.	Check the latest documentation for the parameter.

## ■ Communication errors

Code	Error	Cause	What to do
8000	EtherCAT AL status code ( <code>_ecETHERCAT_AL_STATUS_CODE</code> )	This error is listed together with a Profile Code in the Mint WorkBench Error Log. Note: The displayed profile code must be converted to hexadecimal to give the specific EtherCAT error code.	This error status indicates that the EtherCAT master has been sent an error code by the drive. Check the error log to determine what the “real” drive error code is.
8001	CIP configuration error ( <code>_ecCIP_CFG_ERROR</code> )	This error is listed together with a Profile Code in the Mint WorkBench Error Log. The displayed profile code must be converted to hexadecimal to give the specific CIP general status code.	This error status indicates that the EtherCAT master has been sent a CIP error code by the drive. Check the error log to determine what the “real” drive error code is.
8002	POWERLINK error code ( <code>_ecPOWERLINK_ERROR</code> )	This error is listed together with a Profile Code in the Mint WorkBench Error Log. The displayed profile code must be converted to hexadecimal to give the specific POWERLINK error code.	This error status indicates that the POWERLINK master has been sent an error code by the drive. Check the error log to determine what the “real” drive error code is.
8003	PROFINet error code ( <code>ecPROFINET_CFG_ERROR</code> )	This error is reported when multicast MAC filter configuration fails.	This error status indicates that the PROFINet master has tried to configure the device ID but has failed.

## Axis errors

Code	Error	Cause	What to do
10000	Motion aborted (_ecABORT)	This error is caused by using the ABORT keyword or breaking a Mint program. See ABORT and ABORTMODE.	The ABORT keyword has been issued by the mint program. This may be normal in the operation. If its not find the issue with the Mint program.
10001	Forward hard limit hit (_ecFWD_HARD_LIMIT)	Drive has been configured to have a Forward Limit input and its currently active.	Check Drive configuration, Mint Program and/or Parameter file. See LIMITFORWARD and LIMITMODE.
10002	Reverse hard limit hit (_ecREV_HARD_LIMIT)	See LIMITREVERSE and LIMITMODE.	Check Drive configuration, Mint Program and/or Parameter file. See LIMITREVERSE and LIMITMODE.
10003	Forward soft limit hit (_ecFWD_SOFT_LIMIT)	The axis may be configured to have a maximum and minimum limit of travel in software. If the axis position exceeds one of these limit values, a motion error will be generated.	Check Drive configuration, Mint Program and/or Parameter file. See SOFTLIMITFORWARD and SOFTLIMITMODE.
10004	Reverse soft limit hit (_ecREV_SOFT_LIMIT)	The axis may be configured to have a maximum and minimum limit of travel in software. If the axis position exceeds one of these limit values, a motion error will be generated.	Check Drive configuration, Mint Program and/or Parameter file. See SOFTLIMITREVERSE and SOFTLIMITMODE.
10005	Fatal following error exceeded (_ecFOLLOWING_ERROR)	FOLERRORFATAL sets the maximum permissible following error before an error is generated. The following error is defined as the demand position minus the actual motor position. If the following error exceeds the value set by FOLERRORFATAL (maximum following error) an error may be generated.	If this error occurs the axis may not be free to move, is moving when it should not (e.g. a suspended load with a bad motor brake) or there could be a limitation within the drive (e.g. current or speed limit) or motor size (e.g. Inertia) that stops it moving to the target position with the given ACCEL/DECEL rates before the following error is beyond the value set by the user. See FOLERRORFATAL and FOLERRORMODE. Note: If this error occurs when using a Smart Inc encoder, see Smart Inc encoders in Mint Help.
10006	Fatal velocity error exceeded (_ecVEL_FATAL)	VELFATAL, velocity error checking allows the measured velocity (VEL) of an axis to be compared to its demand velocity (VELDEMAND). If the difference between the two values exceeds the limit set with VELFATAL, then an error will be created.	Check the Mint program or other source of velocity demand is not attempting to run the axis faster than the programmed DRIVESPEEDMAX
10007	Error input active (_ecERROR_INPUT)	An input is defined as an ERRORINPUT and it is activated by an error condition.	See ERRORINPUT and ERRORINPUTMODE.

Code	Error	Cause	What to do
10009	Invalid trajectory (_ecPROFILE_ERROR)	Trajectory generation error. The controller was unable to perform the requested profile. This can occur during CAM moves if an invalid element is detected (e.g. a negative master distance). An axis performing a cam profile can skip over very short slave segments if the master velocity is such that the slave segment is less than one profiler tick in length. If more than 5 slave segments are skipped in one profiler tick, this error will be generated. The axis will be crash stopped and disabled.	Check Mint CAM parameter file for anomalous Data points. Excel is a helpful tool to help with this.
10010	Drive enable input is inactive (_ecDRIVE_ENABLE_INACTIVE)	DRIVEENABLEINPUTMODE is configured to _emCRASH_STOP_DISABLE and the input defined by DRIVEENABLEINPUT has become inactive whilst the drive was enabled.	Check Digital Input status and correct.
10011	Drive I.T exceeded limit (_ecDRIVE_OVERLOAD)	The drive overload algorithm has integrated up to 100% and has tripped the drive to protect it. This will happen if the RMS current for the application exceeds the DRIVERATEDCURRENT value.	Check tuning, check motion profile (especially acceleration and deceleration). If necessary select a larger drive (which may also require an alternative motor).
10012	Power base is not ready to enable (_ecPOWER_BASE_NOT_READY)	The Power base has been asked to enable but is not ready. For it to be so it must have the correct voltage and supply and not be overheated.	Check of power base ambient conditions and supply voltage. Include interlocks in any program being used that check DRIVEENBLEREDY.
10013	Power module has an error (_ecPOWER_MODULE_FAULT)	There's circuit detection in power unit and the signal is connected to the DSP. The power unit generated an error while in operation. <b>over current, earth fault, over temperature on power board</b>	Possible causes of this are Over temperature, Over Current, Brake chopper Short circuit or poor earthing or shielding (particularly of motor power cables). Power cycle to clear the error.
10014	Over current trip (_ecOVER_CURRENT)	Based on the drives currently configured DRIVERATINGZONE the drive has detected a motor overcurrent state. Measured current should not exceed the maximum current. The maximum current is related with the over current and the rated current.	Check the motor is free to rotate, has been sized correctly and there are no short circuits on the drive output wiring.

Code	Error	Cause	What to do
10015	Over speed trip (_ecOVER_SPEED)	The drive has detected the apparent motor velocity has exceeded the trip threshold set by DRIVESPEEDMAX and the VELFATAL parameters	Note: If this error occurs when using a Smart Inc encoder, see Smart Inc encoders (setting a high application max speed and 200% velocity threshold may be necessary when using Smartabs). For other feedback types check the integrity of the feedback wiring and the earthing/shielding of all cables to/from the drive.
10016	Over voltage trip (_ecBUS_OVER_VOLTAGE)	The drive has shut down to protect itself after the measured dc bus voltage exceeded the preset limit. This can often occur during deceleration, particularly with large inertial loads	Decrease deceleration rate, add a regen resistor if one is not fitted. Consider use of common dc bus if there are multiple drives where some regenerate and some motor.
10017	Under voltage trip (_ecBUS_UNDER_VOLTAGE)	The drive has shut down to protect itself after the measured dc bus voltage fell below a preset limit. This can often occur during acceleration, particularly with large inertial loads Note: if DRIVEBUSUNDERVOLTSOVERRIDE is 0, low limit will use power data, otherwise will use DRIVEBUSUNDERVOLTSOVERRIDE.	Decrease the acceleration rate. If the fault occurs when the axis is not accelerating check the supply connections to the drive. A larger motor/drive combination may be required if the needed acceleration cannot be achieved.
10018	Motor I <sup>2</sup> .T exceeded limit (_ecMOTOR_OVERLOAD)	The motor overload algorithm has integrated up to 100% and has tripped the drive to protect the motor. This will happen if the RMS current for the application exceeds the MOTORRATEDCURRENT value.	Check tuning, check motion profile. If necessary select a larger motor (which may also require an alternative drive).

Code	Error	Cause	What to do
10019	Motor temperature trip (_ecMOTOR_TEMP_IN PUT)	#1. Motor Over Temperature has been detected on the drive and the drives hardwired Thermistor X10 input has detected Motor overheating from the connected motor PTC sensor	When using feedback temperature monitoring, X10 connections TH1 and TH2 should be connected with a wire link (short-circuited) to suppress the normal temperature trip function. Note: MOTORTemperatureTRIP does not monitor the drive's X10 motor thermistor input. Also look for a fault with feedback cable or wiring.
		#2. Motor Over Temperature has been detected on the drive and the Motor Encoder is of a serial variety (such as Hiperface DSP which provides motor thermistor resistance as part of the feedback data). If this value exceeds MOTORTemperatureTRIP the drive trips with a motor overtemperature error	Set MOTORTemperatureTRIP to a resistance that is suitable for the motor's thermistor device. e.g. MOTORTemperatureTRIP(0) = 1200. Also look for a fault with feedback cable or wiring. Note: MOTORTemperatureTRIP operates only with motors that have a positive temperature coefficient (PTC) thermistor, where resistance increases with temperature, or with motors that have a switch that goes open-circuit at high temperatures.
10020	Phase search failure (_ecPHASE_SEARCH_FAILED)	Phase search must be completed to control a motor with type "encoder only"	Phase search must be completed to control a motor with type "encoder only" - if it does not finish successfully check encoder settings in drive and check the correct number of motor poles has been configured.
10021	Hall signals lost or incorrect (_ecHALL_SIGNAL_LOSS)	This error indicates that a feedback type of halls only or Encoder + Halls is used and has detected an error. If this is so the halls sensor state is checked by the drive and that the Hall state detected is illegal (0 or 7).	This error would normally indicate a faulty encoder in the motor (the encoders include simulated hall signals) or bad wiring to the motor encoder. Check the quality of installation, wiring and encoder type selection. Note: You can use Mint WorkBench to scope Encoder Hall State to look for problems.

Code	Error	Cause	What to do
10022	Encoder signals lost or incorrect (_ecENCODER_SIGNAL_LOSS)	This indicates that either there has been a total break or total disruption with the encoder signals.	Check the quality of installation, wiring and encoder type selection. Note: You can use Mint WorkBench to scope Encoder Hall State and Encoder to look for problems. Note: To get more information on this error connect to the Drive with Mint WorkBench go to "Parameters > Encoder > Channel 0 > Encoder Parameter(Encoder0, Fault Register)" If this contains a value other than 0 you can use this value to give you more help on the error. See help file subject: ENCODERPARAMETER. Check all earthing and shielding arrangements are as per the instruction manual.
10023	Encoder power supply loss (_ecENCODER_SUPPLY_LOSS)	Power supply to encoder has been lost or has dropped below the minimum level for the selected encoder type. Note: encoder voltage is supplied by the drive.encoder power is given from power board, then transferred from 8v to 5v by control board.	Check that there are no shorts in the encoder wiring to the encoder supply (e.g. ensure the shields are not shorting to the supply or other signal pins). If the wiring is OK and the problem persists then it is likely one of the internal power supplies is failing.
10026	PDO data is not present (Mn to Cn) (_ecPDO_DATA_MISSING_MN_TO_CN)	EtherCAT or EPL PDO data from the manager (MN) to the remote axis (CN) has been lost. This error occurs if the remote axis detects that at least two consecutive PDO packets have not been received correctly.	This error will occur on the drive if it has lost its connection to the Manager. Check that the Manager is running, configured correctly and the network is operating correctly.
10027	Remote motion command failed (_ecREMOTE_MOTION_FAILED)	Unable to load motion on the remote axis. Generally speaking, this error indicates MML in drive is not ready for operation.	This can be caused by a number of reasons, such as incorrect operating mode, the motor brake being enabled or the move buffer being full.
10028	Encoder not ready to operate (_ecENCODER_NOT_READY)	The drive is configured to use a Serial Encoder and it is not able to provide position information.	The encoder may take several seconds to become ready and this error will be generated if an attempt is made to enable the axis before the encoder is ready. This error can also occur if the resolution configured on the drive is not compatible with the encoder. The axis will be crash stopped and disabled. Note: To get more information on this error connect to the Drive with Mint WorkBench go to "Parameters > Encoder > Channel 0 > Encoder Parameter(Encoder0, Fault Register)" If this contains a value other than 0 you can use this value to give you more help on the error. See help file subject: ENCODERPARAMETER



Code	Error	Cause	What to do
10029	Supply phase loss detected (_ecSUPPLY_PHASE_LOSS)	The three phase drive has detected that one of the AC supply phases may be lost. The drive can normally only operate using a three phase supply. MotiFlex e100 drives have dedicated phase monitoring hardware, MotiFlex e180 drives monitor the ripple on the dc bus and if this becomes excessive then they assume an input phase has been lost	Check the connection of the input phases. If the connections are OK and a MotiFlex e180 is tripping spuriously (e.g. because the application requires harsh repeated accel and decel cycles) then you can disable phase loss detection using PHASELOSSMODE(0) = 0
10030	PDO data is not present (Cn to Mn) (_ecPDO_DATA_MISSING_CN_TO_MN)	PDO data from the remote axis (CN) to the manager (MN) has been lost. This error occurs if the manager detects that at least two consecutive PDO packets have not been received correctly.	This error will occur on the NextMove e100 if it detects a drive disappears from the network. This may be "normal" for an optional node (and the error must be handled via the ONERROR event). If this error is unexpected check the drive is not resetting and check the integrity of the Ethernet (EPL) cabling.
10032	PDO value out of range (_ecPDO_VALUE_OUT_OF_RANGE)	When controlling an axis using Real time Ethernet one of the PDOs sent to the drive were out of range. This is often the velocity reference PDO and can be caused when an axis is geared to a master axis/encoder and the master position/encoder value is changed via the program to a new value causing an infinite velocity demand.	Connect to the drive whilst the error is active and use the Error Log to determine which PDO is out of range. If it's velocity then check the Mint program to ensure axes that are geared to master references are not geared when those master references position/encoder values are written to.
10033	STO active (_ecSTO_ACTIVE)	Either one or both of the Safe Torque Off inputs is not powered. This error can occur only when the drive is enabled.	Check drive STO inputs, if used check the wiring of the safety circuit or for open guards or Emergency stops etc.
10034	STO hardware fault (_ecSTO_HARDWARE_FAULT)	Either one or both of the internal fault circuit outputs has been asserted, indicating an internal hardware fault in the STO circuits. This error can occur when the drive is enabled or disabled.	Check drive STO inputs, if used check the wiring of the safety circuit or for open guards or Emergency stops etc.
10035	STO input mismatch (_ecSTO_INPUT_MISMATCH)	The drive has detected a mismatch in its internal STO registers. This error can occur when the drive is enabled or disabled.	Check the two drive STO inputs are in the same state with a multimeter. It may be necessary to adjust STOMISMATCHTIME to account for any timing discrepancies in the connected safety circuit.
10036	Encoder reading wrong or Hall fault (_ecENCODER_READING_WRONG)	The drive has detected that the measured Hall transition angle differs from the electrical angle used in the control by at least 70 degrees.	Check the quality of installation, wiring and encoder type selection. Note: You can use Mint WorkBench to scope Encoder Hall State and Encoder to look for problems. Check that all earthing / shielding is as per the drive installation manual.

Code	Error	Cause	What to do
10037	All axis errors cleared (_ecAXIS_ERRORS_CLEARED)	This information message can appear in the error log to indicate that all axis errors have been cleared.	No action required.
10038	Encoder battery dead (_ecENCODER_BATTERY_DEAD)	This error will only appear at start up if the battery backup supply for SmartABS encoder has failed.	Change the Encoder battery. Note: If battery becomes flat when drive is under power off then the error will appear after power on and manually acknowledge is needed to clear this error and after that warning 20004 will be generated until battery issue is solved.
10039	Resolver signals lost or incorrect (_ecRESOLVER_SIGNAL_LOSS)	An error has occurred when using the Resolver Adapter (OPT-MF-201 or FB-03). The error is caused by the loss of resolver signals.	Check the wiring to the motor's feedback device, the integrity of the motor connector, and the connections inside to the adapter.
10040	Hiperface DSL encoder error (_ecHIPERFACE_DSL_ENCODER_ERROR)	An error has occurred when reading the position over Hiperface DSL.	Note: To get more information on this error connect to the Drive with Mint WorkBench go to "Parameters > Encoder > Channel 0 > Encoder Parameter(Encoder0, Fault Register)" If this contains a value other than 0 you can use this value to give you more help on the error. See help file subject: ENCODERPARAMETER. Check all earthing / shielding is as per the drive installation manual.
10041	Output frequency over limit (_ecOUTPUT_FREQ_OVER_LIMIT)	The drive has detected that the output frequency exceeded 550 Hz. This restriction is required to meet relevant European Export Control Regulation.	Reduce your application's speed.
10042	Drive speed Maximum is out of range (ecDRIVESPEEDMAX_OUT_OF_RANGE)	Motor velocity is above parameter DriveSpeedMax(0)	Go to parameters > Drive > DriveSpeedMax and check value is set correctly. Check Commanded Drive Speed is not too high.
10045	Position and velocity encoder deviation exceeded	The drive has detected that the axis exceeds its deviation error limit during the dual encoder operation. The drive acts according to the stop mode configured by POSVELENCODERDEVIATIONERROR MODE.	1 Check the motor, the encoders, other equipments and connections. 2 Check the value of the keyword POSVELENCODERDEVIATIONFATAL is not too low.

## ■ Controller errors

Code	Error	Cause	What to do
30001	Controller over-temperature (_ecOVER_TEMPERATUR E)	The drive has detected it is dangerously hot.	Check the drive ambient conditions allow for sufficient cooling. Note: TEMPERATURE will return the current temperature, in degrees Celsius, from the drive's internal temperature sensor. If the temperature exceeds the predefined TEMPERATURELIMITFATAL value (model dependent), then an overtemperature trip will be caused. TEMPERATURELIMITFATAL for e180 drive is 75°C.
30003	Controller reset on watchdog time-out (_ecCPU_WATCHDOG_R RESET)	-	Please ensure you are using the latest firmware and if problem persists please contact ABB technical support.
30005	FPGA failed to initialise (_ecFPGA_INITIALISATIO N_ERROR)	The controller FPGA has failed to initialize.	Power cycle. If Error Persists Replace the Drive.
30007	Error accessing non-volatile memory (_ecNON_VOL_MEMORY _FAILURE)	Unable to access non-volatile memory.	Power cycle. If Error Persists Replace the Drive.
30008	Error applying parameter value (_ecPARAM_ERROR)	Errors have occurred during a parameter table download or during startup. Some of the parameters could not be applied correctly. See the <a href="#">Error Log</a> for details of the failures. The controller's status display will flash only 'E', and will not be followed with the usual error code digits.	This Error is most commonly associated with either a parameter file (.ptx) issue. It is a common problem if the parameter file is generated from an older firmware version with either different parameters or different parameter limits. Read the Error log for specific guidance on the effected parameters.
30009	General internal controller error (_ecINTERNAL_ERROR)	An internal error has occurred. Read parameter failed.	Power cycle. If Error Persists Replace the Drive.
30010	Fan is not operating correctly (_ecFAN_LOSS)	The drive has detected that an internal cooling fan has failed.	Check the bottom of the drive to determine that the fan inlets are not blocked and the fan is rotating. If the drive fan does not turn, the general is the fan hardware failure, need to replace the fan.
30023	Mint option card comms error tx (_ecMINT_OPTION_CAR D_COMMS_ERROR_TX)	A communication error between the drive and the Mint option has been detected by the drive.	Power cycle. If Error Persists contact ABB technical support.

Code	Error	Cause	What to do
30029	Controller under-temperature (_ecUNDER_TEMPERATURE)	The controller has detected an ambient temperature lower than -5 °C.	The ambient temperature must be increased before the drive can be enabled.
30030	All controller errors cleared (_ecCONTROLLER_ERRORS_CLEARED)	This information message can appear in the <a href="#">error log</a> to indicate that all controller errors have been cleared.	No Action.
30031	Internal error	-	Please ensure you are using the latest firmware and if problem persists please contact ABB technical support.
30032	Hardware revision does not support EPL (_ecHARDWARE_DOES_NOT_SUPPORT_EPL)	The controller does not support Ethernet POWERLINK.	Earlier Hardware revisions of e180 (with GCU-01 control cards before Rev A) do not support EPL and on these old hardware revisions if the EPL address switches are not both set at '0' then this error will be generated. Old drives will still work in every other mode but if EPL is needed the Hardware will need to be exchanged.
30033	CPU Exception	MCU has serious error occur.	If problem persists please contact ABB technical support.

See [AN00267 ABB Motion Drives Error trouble shooting manual](#) for more details on error handling.

## 11

# Maintenance

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## What this chapter contains

This chapter contains preventive maintenance instructions.

## Safety

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**WARNING!** Read the [Safety](#) instructions on the first pages of this manual before performing any maintenance on the equipment. Ignoring the safety instructions can cause injury or death.

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## Maintenance intervals

If installed in an appropriate environment, the drive requires very little maintenance. This table lists the routine maintenance intervals recommended by ABB.

Maintenance	Interval	Instruction
Capacitor reforming	Every year of storage	See <a href="#">Reforming the capacitors</a> .
Heatsink temperature check and cleaning	Depends on the dustiness of the environment (every 6 to 12 months)	See <a href="#">Heatsink</a> .

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Cooling fan change	<b>Every 6 years</b> if the ambient temperature does not exceed 40 °C (104 °F). <b>Every 3 years</b> if the ambient temperature is higher than 40 °C (104 °F).	See <i>Cooling fan</i> .
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## Heatsink

The heatsink fins pick up dust from the cooling air. The drive runs into overtemperature warnings and faults if the heatsink is not clean. In a normal environment, the heatsink should be checked annually, in a dusty environment more often.

Clean the heatsink as follows (when necessary):

1. Remove the cooling fan (see section *Cooling fan*).
2. Blow clean compressed air (not humid) 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 the dust entering adjoining equipment, perform the cleaning in another room.
3. Replace the cooling fan.

## Cooling fan

The actual lifespan of the cooling fan depends on the drive usage and ambient temperature. Fan failure can be predicted by the increasing noise from fan bearings and the gradual rise in the heatsink temperature in spite of heatsink cleaning. If the drive is operated in a critical part of a process, fan replacement is recommended once these symptoms start appearing. Replacement fans are available from ABB. Do not use other than ABB-specified spare parts.

### ■ Fan replacement: 3 A - 16 A models (frames A and B)

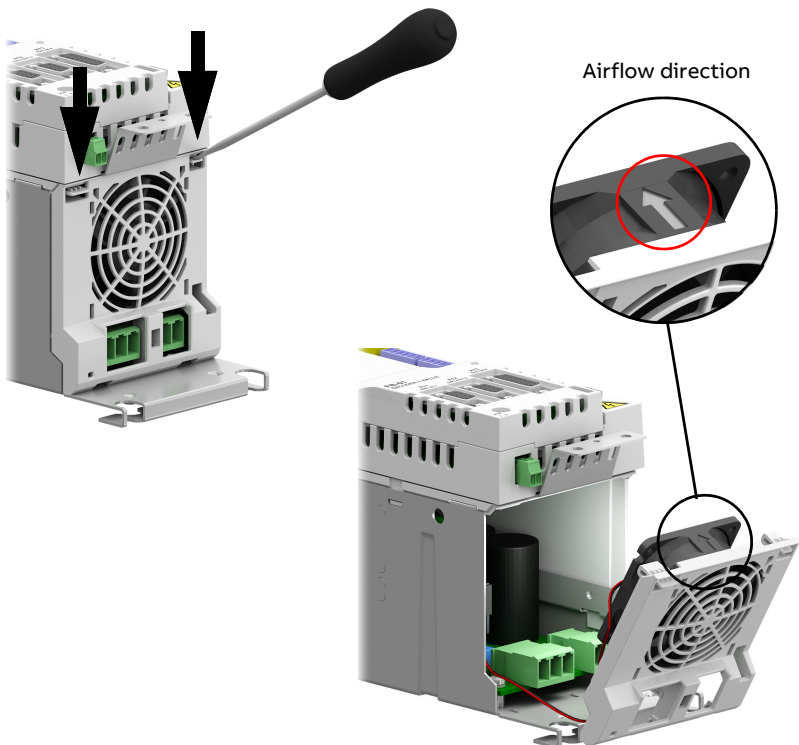
Detach the power cable clamp plate and terminal blocks. Release the retaining clips (arrowed) carefully using a screwdriver. Pull the fan holder out. Disconnect the fan cable. Carefully bend the clips on the fan holder to free the fan.

Install new fan in reverse order.

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**Note:** The airflow direction is bottom-to-top. Install the fan so that the airflow arrow points up.

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### ■ Fan replacement: 31 A - 90 A air cooled models (frames C and D)

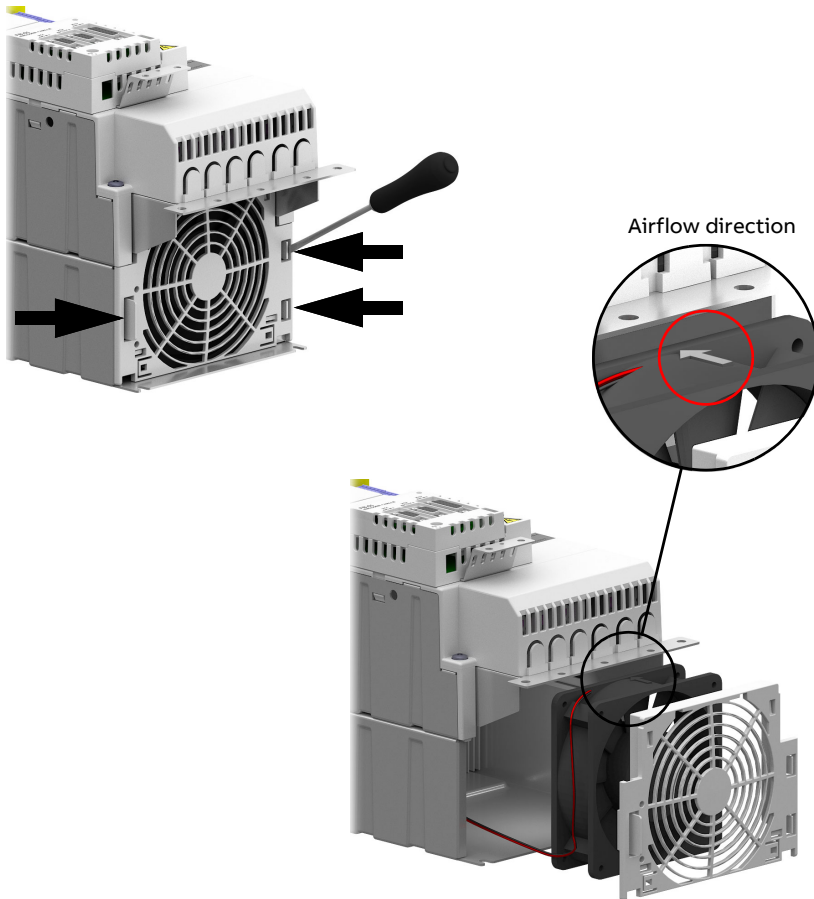
To remove the fan, release the retaining clips (arrowed) carefully using a screwdriver. Pull the fan holder out. Disconnect the fan cable. Carefully bend the clips on the fan holder to free the fan.

Install the new fan in reverse order.

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**Note:** The airflow direction is bottom-to-top. Install the fan so that the airflow arrow points up.

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## Reforming the capacitors

The capacitors must be reformed if the drive has been stored for a year or more. See page 30 for information on finding out the manufacturing date. For information on reforming the capacitors, contact your local ABB representative.

### ■ Overview of the reforming

Electrolytic DC capacitors in the servo drive DC link need to be reformed (re-aged) if the drive has been non-operational for a year or more. The reforming time depends on how long the drive has been non-operational.

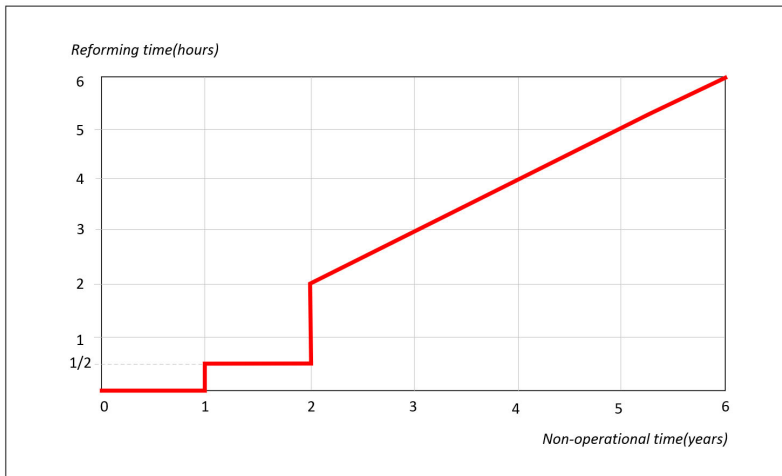
Without reforming, the capacitors can get damaged when the drive starts to operate.

Besides the reforming methods presented in this manual, ABB can supply you with ready-made reforming devices. For more information, contact your local ABB representative.

### ■ Reforming time

The intermediate circuit (DC link) of the drive is connected to its nominal voltage for the reforming time to “wake up” the capacitors. The diagram below shows the required reforming time.

- If the drive has been non-operational for less than one year, the capacitors do not need reforming.
  - If the drive has been stocked (non-operational) for one to two years, it can be reformed with power on for 30 minutes method. See section [Reforming with power on for 30 minutes](#) on page 158.
  - If the drive has been stocked (non-operational) for more two years, it can be reformed using the method in section [Reforming with external DC power supply](#) on page 158 or [Reforming with another e180 drive](#) on page 161.
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### ■ Checking the drive age

The serial number (S/N) defines the year and the week when the drive was manufactured:

- The 2nd and 3rd digits indicate the year of manufacture.
- The 4th and 5th digits indicate the week.

See page 30 for information on finding out the manufacturing date.

For example, in S/N W195260084, 19 denotes manufacturing year (2019), 52 denotes manufacturing week.

### ■ Reforming with power on for 30 minutes

This method can be used for capacitor reforming if the drive has been stocked (non-operational) for one to two years.

1. Switch the power on to the drive for 30 minutes.
2. Do not load the drive while the reforming is ongoing.

The drive “wakes up” its capacitors on its own, after which it is ready for use.

### ■ Reforming with external DC power supply

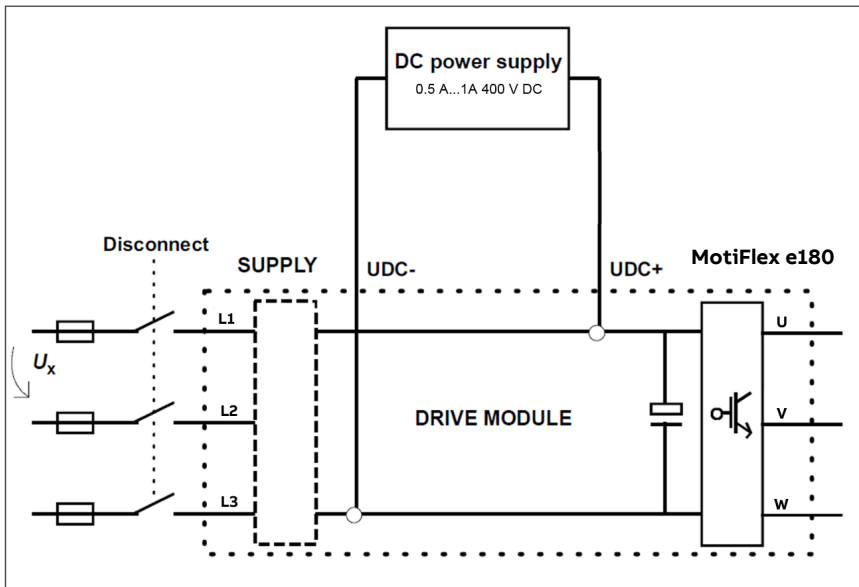
This method can be used for capacitor reforming if the drive has been stocked (non-operational) for two years or longer.



**WARNING!** Obey the safety instructions in section [Safety](#) on page 13. If you ignore them, injury or death, or damage to the equipment can occur.

Never switch on the drive power supply while the reforming circuit is connected. Lock the disconnector (if any) to an open position.

1. Make sure that the drive is disconnected from all possible power sources (all AC and DC inputs/outputs are disconnected).
2. Measure that the installation is de-energized:
  - Use a multimeter with an impedance of at least 1 M $\Omega$ .
  - Make sure that the voltage between the drive input power terminals (L1, L2 and L3) and the grounding terminal (PE) is close to 0 V.
  - Make sure that the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding terminal (PE) is close to 0 V.
3. Make this reforming circuit and connect it to the DC terminals of the drive.
4. Switch on the reforming circuit for the time defined in section [Reforming time](#) on page 157.



**Note:** Limit the reforming current to max. 200 mA. If the DC power supply does not have an adjustable current limiter, increase the voltage gradually from 0 V to 400 V.



**WARNING!** The capacitors can get damaged if you use excessive DC voltage during the reforming.

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5. Switch off the reforming circuit.
6. Wait for 5 minutes to let the DC capacitors discharge.
7. Measure that the voltage of the DC terminals of the drive is close to 0 V.
8. Disconnect the reforming circuit from the drive.

## ■ Reforming with another e180 drive

This method can be used for capacitor reforming if the drive has been stocked (non-operational) for two years or longer and only external AC power supply can be provided.



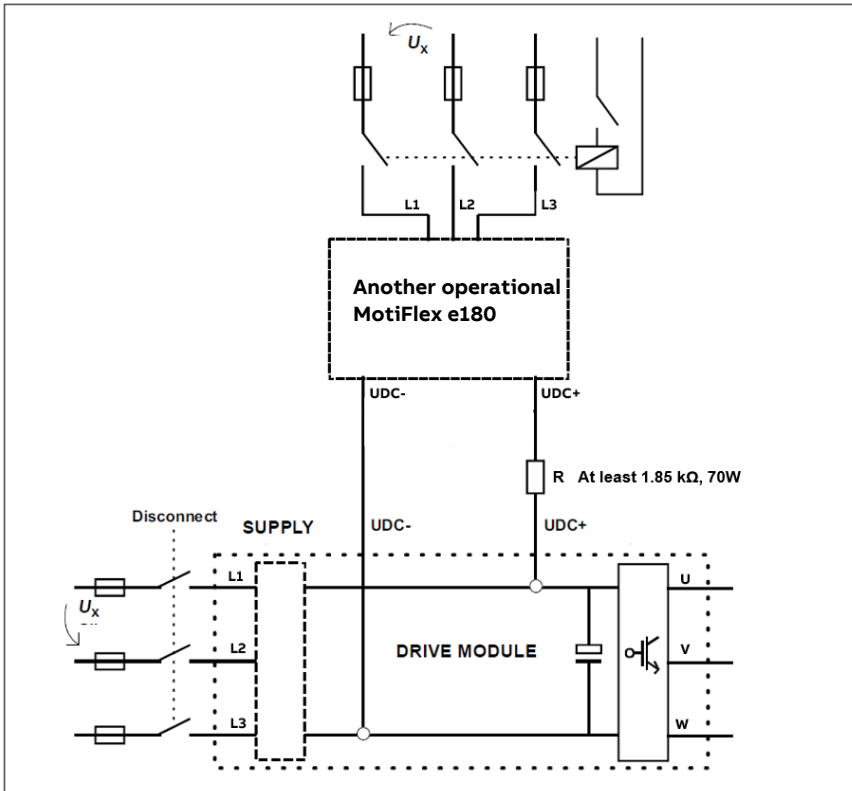
**WARNING!** Obey the safety instructions in section [Safety](#) on page 13. If you ignore them, injury or death, or damage to the equipment can occur. Never switch on the drive power supply while the reforming circuit is connected. Lock the disconnecter (if any) to an open position.

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1. Make sure that the drive is disconnected from all possible power sources (all AC and DC inputs/outputs are disconnected).
2. Measure that the installation is de-energized:
  - Use a multimeter with an impedance of at least 1 MΩ.
  - Make sure that the voltage between the drive input power terminals (L1, L2 and L3) and the grounding terminal (PE) is close to 0 V.
  - Make sure that the voltage between the drive DC terminals (UDC+ and UDC-) and the grounding terminal (PE) is close to 0 V.
3. Make this reforming circuit and connect it to the DC terminals of the drive.

As shown below, the another normal operational e180 needs to be connected to AC power supply (1-phase or 3-phase) to provide DC power supply to the drive which need to be reformed.

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4. Switch on the AC power supply of the reforming circuit for the time defined in section *Reforming time* on page 157.
  5. Switch off and disconnect the AC power supply of the reforming circuit.
  6. Wait for 5 minutes to let the DC capacitors discharge.
  7. Measure that the voltage of the DC terminals of the drive is close to 0 V.
- Disconnect the reforming circuit from the drive.

## Other maintenance actions

### ■ Transferring the memory unit to a new drive

When a drive is replaced, the parameter settings can be retained by transferring the memory unit from the defective drive to the new. However, non-volatile data stored using the `NVRAM...` keywords are not stored on the memory unit.



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

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■ **Modification, replacement, or removal of control unit (GCU-xx)**

If a control unit is modified, replaced, or disconnected from the power unit, the *Start-up, acceptance, and proof test interval checklist* (page 240) must be performed when the units are reconnected. See [Validating the operation of a safety function](#) on page 239.

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# 12

## Technical data

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### What this chapter contains

The chapter contains the technical specifications of the drive, for example, the ratings, sizes and technical requirements as well as provisions for fulfilling the requirements for CE and other marks.

## Ratings

The nominal current ratings for the MotiFlex e180 with 400 V AC supply are given below.

Drive type MFE180-04xx...	PWM switching frequency (Hz)	Overload	Drive rated current ( $A_{rms}$ )	Duration (s)
-03A0-4	4000	300%	2.0	3
		200%	3.0	
		150%	3.0	60
		110%	4.1	
	8000	300%	1.6	3
		200%	2.3	
		150%	3.0	60
		110%	4.1	

Drive type MFE180-04xx...	PWM switching frequency (Hz)	Overload	Drive rated current ( $A_{rms}$ )	Duration (s)
-05A0-4	4000	300%	2.7	3
		200%	4.0	
		150%	5.0	60
		110%	6.8	
	8000	300%	2.2	3
		200%	3.0	
		150%	4.0	60
		110%	5.5	

Drive type MFE180-04xx...	PWM switching frequency (Hz)	Overload	Drive rated current ( $A_{rms}$ )	Duration (s)
-07A0-4	4000	300%	3.2	3
		200%	4.7	
		150%	6.0	60
		110%	6.4	
	8000	300%	3.0	3
		200%	4.0	
		150%	4.0	60
		110%	5.5	

Drive type MFE180-04xx...	PWM switching frequency (Hz)	Overload	Drive rated current (A <sub>rms</sub> )	Duration (s)
-016A-4	4000	300%	7.0	3
		200%	9.0	
		150%	11.0	60
		110%	15.0	
	8000	300%	5.0	3
		200%	7.0	
		150%	9.0	60
		110%	12.0	

**Note:** The 110% and 150% frame C and frame D models(-024A-4 ... -090A-4) ratings are listed separately by with and without choke.

Drive type MFE180-04xx...	PWM switching frequency (Hz)	Overload	Drive rated current (A <sub>rms</sub> )	Drive rated current with choke (A <sub>rms</sub> )	Duration (s)
-024A-4	4000	300%	10.0	-	3
		200%	13.5	-	
		150%	13.5	17.0	60
		110%	18.5	21.5	
	8000	300%	9.0	-	3
		200%	12.0	-	
		150%	12.0	15.0	60
		110%	16.0	17.5	

Drive type MFE180-04xx...	PWM switching frequency (Hz)	Overload	Drive rated current (A <sub>rms</sub> )	Drive rated current with choke (A <sub>rms</sub> )	Duration (s)
-031A-4	4000	300%	16.0	-	3
		200%	21.0	-	
		150%	17.5	25.0	60
		110%	24.0	28.0	
	8000	300%	13.0	-	3
		200%	18.0	-	
		150%	15.5	20.0	60
		110%	21.0	25.0	

Drive type MFE180-04xx...	PWM switching frequency (Hz)	Overload	Drive rated current (A <sub>rms</sub> )	Drive rated current with choke (A <sub>rms</sub> )	Duration (s)
-046A-4	4000	300%	20.0	-	3
		200%	28.0	-	
		150%	25.0	35.0	60
		110%	34.0	41.0	
	8000	300%	17.0	-	3
		200%	25.0	-	
		150%	19.0	31.0	60
		110%	26.0	33.0	

Drive type MFE180-04xx...	PWM switching frequency (Hz)	Overload	Drive rated current (A <sub>rms</sub> )	Drive rated current with choke (A <sub>rms</sub> )	Duration (s)
-060A-4	4000	300%	25.0	-	3
		200%	35.0	-	
		150%	35.0	46.0	60
		110%	47.0	62.0	
	8000	300%	21.0	-	3
		200%	28.0	-	
		150%	28.0	35.0	60
		110%	38.0	45.0	

Drive type MFE180-04xx...	PWM switching frequency (Hz)	Overload	Drive rated current (A <sub>rms</sub> )	Drive rated current with choke (A <sub>rms</sub> )	Duration (s)
-090A-4	4000	300%	40.0	-	3
		200%	55.0	-	
		150%	55.0	72.0	60
		110%	75.0	90.0	
	8000	300%	30.0	-	3
		200%	40.0	-	
		150%	40.0	47.5	60
		110%	55.0	55.0	

The ServoSize dimensioning tool available from ABB is recommended for selecting the drive, motor and gear combination for the required motion profile.

## ■ Derating

The continuous output currents stated above must be derated if any of the following conditions apply:

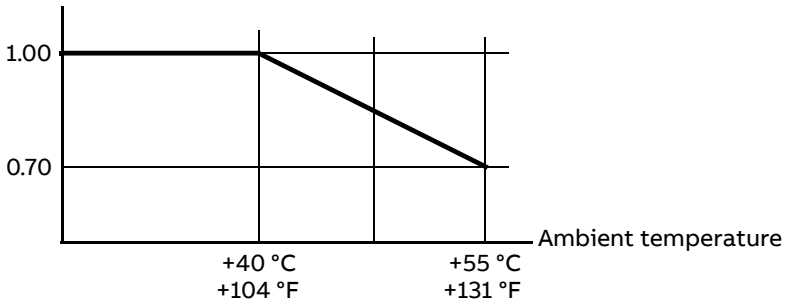
- the ambient temperature exceeds +40 °C (+104 °F)
- the drive is installed higher than 1000 m above sea level.

**Note:** The final derating factor is a multiplication of all applicable derating factors.

### Ambient temperature derating

In the temperature range +40...55 °C (+104...131 °F), the continuous output current is derated linearly as follows:

Derating factor



### Altitude derating

At altitudes from 1000 to 2000 m (3280 to 6560 ft) above sea level, the derating is 1% for every 100 m (328 ft). For a more accurate derating, use the ServoSize PC tool.

**Note:** If the installation site is higher than 2000 m (6560 ft) above sea level, connection of the drive to an ungrounded (IT) or corner-grounded delta network is not allowed.

Cooling

Method	Internal fan, flow from bottom to top, air-cooled heat sink.
Free space around the unit	See chapter <i>Cabinet construction</i> .

Cooling characteristics, noise levels

Drive type MFE180-04xx...	Power loss W	Air flow (MFE180-04Ax-...) m <sup>3</sup> /h	Noise level dBA
-03A0-4	44	24	47
-05A0-4	61	24	47
-07A0-4	94	24	47
-016A-4	246	48	39
-024A-4	246	142	63
-031A-4	354	142	63
-046A-4	446	200	71
-060A-4	807	290	70
-090A-4	1100	290	70

Energy efficiency data (ecodesign)

Energy efficiency data according to IEC 61800-9-2 is available from the ecodesign tool (<https://ecodesign.drivesmotors.abb.com/>).



## Supply cable fuses

Fuses for short circuit protection of the supply cable are listed below. The fuses also protect the adjoining equipment of the drive in case of a short circuit. Check that the operating time of the fuse is below 0.5 seconds. The operating time depends on the supply network impedance and the cross-sectional area and length of the supply cable. See also chapter [Planning the electrical installation](#).

**Note:** Fuses with a higher current rating must not be used.

Drive type MFE180-04xx...	Input current (A)	IEC fuse			UL fuse			Cross-sectional area of cable	
		Rated current (A)	Voltage (V)	Class	Rated current (A)	Voltage (V)	UL Class	mm <sup>2</sup>	AWG
-03A0-4	4.0*	6	500	gG	6	600	T	1.5 ... 4	16...12
-05A0-4	6.0*	10	500	gG	10	600	T	1.5 ... 4	16...12
-07A0-4	7.8*	16	500	gG	15	600	T	1.5 ... 4	16...12
-016A-4	18.3*	25	500	gG	25	600	T	1.5 ... 10	16...8
-024A-4	20	25	500	gG	25	600	T	6...35	9...2
-031A-4	27	32	500	gG	35	600	T	6...35	9...2
-046A-4	39	50	500	gG	50	600	T	6...35	9...2
-060A-4	55	63	500	gG	70	600	T	10...70	6 ... 2/0
-090A-4	78	100	500	gG	100	600	T	10...70	6 ... 2/0

\*Without mains choke

AC input (supply) connection

Voltage ( $U_1$ )	200 ... 480 V AC $\pm 10\%$ , 3-phase
Frequency	50 ... 60 Hz $\pm 5\%$
Network type	Grounded (TN, TT) or ungrounded (IT). Note: Connection to an ungrounded (IT) or corner-grounded delta network is not allowed at altitudes of 2000 m (6600 ft) or higher.
Imbalance	Max. $\pm 3\%$ of nominal phase to phase input voltage
Fundamental power factor ( $\cos \phi_{i1}$ )	0.98 (at nominal load)
Terminals	Frame A: Detachable screw terminal block for 0.25 ... 4 mm <sup>2</sup> wire. Frame B: Detachable screw terminal block for 0.5 ... 6 mm <sup>2</sup> wire. Frames C and D: Screw lugs for 6...70 mm <sup>2</sup> wire included. Suitable crimp lugs can be used instead.

DC connection

Voltage	270 ... 650 V DC $\pm 10\%$		
Ratings	Drive type MFE180-04xx...	$I_{dcN}$ (A)	C ( $\mu F$ )
	-03A0-4	3.5	140
	-05A0-4	5.5	280
	-07A0-4	7	
	-016A-4	16	865
	-024A-4	22.5	785
	-031A-4	30	
	-046A-4	43	1178
	-060A-4	65	1570
	-090A-4	98	2355
$I_{dcN}$ is the average DC input current requirement when running at 4 kHz, 110% load, at a DC link voltage of 560 V (which corresponds to an AC input voltage of 415 V).			
Terminals	Frame A: Detachable screw terminal block for 0.25 ... 4 mm <sup>2</sup> wire. Frame B: Detachable screw terminal block for 0.5 ... 6 mm <sup>2</sup> wire. Frames C and D: Screw lugs for 6...70 mm <sup>2</sup> wire included. Suitable crimp lugs can be used instead.		



## Motor connection

<b>Motor types</b>	Asynchronous induction motors, asynchronous servo motors, synchronous permanent magnet motors
<b>Frequency</b>	0 ... 500 Hz
<b>Current</b>	See section <a href="#">Ratings</a> .
<b>Switching frequency</b>	Selectable between 4 or 8 kHz. Default: 8 kHz (current derating applies)
<b>Maximum motor cable length</b>	Frames A, B & D: Motor cable length (with screened cable) does not exceed 50 metres (164 ft). Frame C: Motor cable length (with screened cable) does not exceed 30 metres (98 ft).
<b>Terminals</b>	Frame A: Detachable screw terminal block for 0.25 ... 4 mm <sup>2</sup> wire. Frame B: Detachable screw terminal block for 0.5 ... 6 mm <sup>2</sup> wire. Frames C and D: Screw lugs for 6...70 mm <sup>2</sup> wire included. Suitable crimp lugs can be used instead.

## Circuit breaker connection

Recommended circuit breaker (and limiter) selection table for the AC supply cable protection with the drive.

**Note:** supply cable and network variables (cable size, short circuit current, etc.) must always be evaluated before commissioning any circuit breakers.

Drive		MCB (S 200 series)			MCB (S 800 series)			LIMITER (S 800 series)		
Frame Size	MFE180-04AN-xxxx-4	S 203 M-Kxx*			S 803 S-Kxx*			S 803 S-SCLxx*		
	I <sub>2n</sub> [A]	I <sub>n</sub> [A]	U <sub>e</sub> [V <sub>AC</sub> ]	I <sub>cu</sub> [kA]	I <sub>n</sub> [A]	U <sub>e</sub> [V <sub>AC</sub> ]	I <sub>cu</sub> [kA]	I <sub>n</sub> [A]	U <sub>e</sub> [V <sub>AC</sub> ]	I <sub>cu</sub> [kA]
A	03A0	6	400	15	10	500	15	32	400/500	100/50
	05A0	13	400	15	13	500	15	32	400/500	100/50
	07A0	16	400	15	16	500	15	32	400/500	100/50
B	016A	25	400	15	25	500	15	32	400/500	100/50
C	024A	32	400	15	32	500	15	63	400/500	100/50
	031A	40	400	15	40	500	15	63	400/500	100/50
	046A	63	400	15	63	500	15	63	400/500	100/50
D	060A	-	-	-	80	500	15	125	400/500	100/50
	090A	-	-	-	100	500	10	125	400/500	100/50

### Nomenclature:

I<sub>2n</sub> = nominal output current of the drive

I<sub>n</sub> = nominal current of the circuit breaker (or limiter)

U<sub>e</sub> = rate supply voltage

I<sub>cu</sub> = breaking capacity of the circuit breaker (or limiter + circuit breaker) with supply voltage U<sub>e</sub> (x/y, x = with 400V supply, y = with 500V supply)

xx\* = I<sub>n</sub>

## Control unit

<b>X9: Power supply</b>	24 V ( $\pm 10\%$ ) DC, 1 A Supplied from the power unit of the drive, or from external power supply through connector X9 (pitch 3.5 mm, wire size 1.5 mm <sup>2</sup> ).
<b>X7: Analogue inputs AI0...AI1</b>	Connector pitch 3.5 mm, wire size 1.5 mm <sup>2</sup> Voltage input: $-10 \dots 10$ V, $R_{in}$ : 60 kohm Differential inputs, common mode $\pm 10$ V Sampling interval per channel: 0.25 ms Filtering: Adjustable using <code>ADCTIMECONSTANT</code> keyword (see Mint WorkBench help file) Resolution: 11 bit + sign bit ( $\pm 4.9$ mV)
<b>X8: Analogue output AO0</b>	Connector pitch 3.5 mm, wire size 1.5 mm <sup>2</sup> AO0 (voltage): $-10 \dots 10$ V, $R_{load} > 1$ kohm Update interval: 1 kHz Resolution: 16 bit ( $\pm 153$ $\mu$ V)
<b>X3: Digital inputs DI1...DI2</b>	Connector pitch 3.5 mm, wire size 1.5 mm <sup>2</sup> Logic levels: "0" < 2 V, "1" > 12 V $R_{in}$ : 3.3 kohm Hardware latching: Minimum pulse width: 250 ns Minimum step time: 250 ns Minimum space time: 250 ns Direction input setup time: 250 ns Direction input hold time: 100 ns Maximum input frequency: 2 MHz Sampling interval: 1 kHz Filtering: Adjustable using <code>INPUTDEBOUNCE</code> keyword (see Mint WorkBench help file)
<b>X4: Digital inputs DI0, DI3...DI4</b> <b>X5: Digital inputs DI5...DI7</b>	Connector pitch 3.5 mm, wire size 1.5 mm <sup>2</sup> Logic levels: "0" < 2 V, "1" > 12 V $R_{in}$ : 3.3 kohm Minimum pulse width: 5 $\mu$ s Filtering: Adjustable using <code>INPUTDEBOUNCE</code> keyword (see Mint WorkBench help file)
<b>X6: Digital outputs DO0...DO3</b>	User supply: 24 V DC Output current: 100 mA max., per output, $R_{load} > 250$ ohm
<b>X1: Relay output (DO4)</b>	Connector pitch 5 mm, wire size 2.5 mm <sup>2</sup> 250 V AC / 30 V DC, 2 A Protected by varistors

<b>X10: Thermistor input</b>	Connector pitch 3.5 mm, wire size 1.5 mm <sup>2</sup> Input device: PTC thermistor(s) Up to three PTCs can be connected in series Logic levels: “0” < 2.8kohm, “1” > 3.2 kohm Sampling interval: Immediate
<b>X2: Safe Torque Off (STO)</b>	Connector pitch 5 mm, wire size 2.5 mm <sup>2</sup> Output supply: 24 V DC, 30 mA per input Pulse tolerance: < 1 ms For the drive to start, both connections STO1 and STO2 must be powered.
<b>E1: Ethernet host PC connection</b>	Connector: RJ-45 Cable length < 3 m

## Feedback modules

### ■ All modules, X11

Encoder interface	RS422 A/B differential, Z index
Max. input frequency	2 MHz
Output power supply to encoder	5 V, 200 mA max.
Maximum recommended cable length	30 m

### ■ All modules, X12

Encoder interface	RS422 A/B differential, Z index
Max. output frequency	2 MHz
Propagation delay X11 to X12, all models X13 to X12, FB-01 X13 to X12, FB-01 X13 to X12, FB-02 /-03 /-04	62.5 µs 0 µs (matching resolutions; no synthesis) 62.5 µs (non-matching resolutions) 62.5 µs
Maximum recommended cable length	30 m

### ■ FB-01: X13 Incremental encoder with Halls

Encoder interface	RS422 A/B differential, Z index
Max. input frequency A / B	2 MHz (8 MHz quadrature counts)
Hall inputs	RS422 A/B differential
Output power supply to encoder	5.5 V, 250 mA max.
Maximum recommended cable length	30 m

■ **FB-02: X13 Serial interfaces + SinCos**

Supports BiSS, SSI, EnDat 2.1, EnDat 2.2, Smart Abs, Hiperface, and SinCos using required combinations of the following inputs:

Signals	Differential input pairs for Data, Clock, Sin, Cos.
Device types: BiSS, Smart Abs, Hiperface SSI EnDat, SinCos	Single or multi-turn devices. Single turn devices up to 18-bit. Single or multi-turn devices, 512 or 2048 cycles per turn, absolute positioning up to 65536 steps. SinCos signal: 1 V pk-pk sine wave centered on a 2.5 V reference.
Output power supply to encoder	5.5 V or 8 V set by switch, 250 mA max.
Maximum recommended cable length	30 m

**Hiperface**

Encoder Type	Encoder Detail	Absolute position resolution (counts/rev )	Single or multi turn	Sine/cosine cycles per revolution	Example Motor
Hiperface single turn	32h (SKS36)	4096	Single	128	BSM80N-275AD3X (STEGMANN SKS36)
Hiperface multi turn	37h (SKM36)	4096	Multi (4096 unique revolutions)	128	1. BSM80N-375AD4X (STEGMANN SKM36) 2. HDS130C-0817BD4KNN (SKM36-HFA0-K02)
Hiperface single turn hollow shaft	FFh (SEM90*)	4096	Multi (4096 unique revolutions)	64	3rd party motors only
Hiperface DSL single turn	(EKS36)	4096	Single	NA	HDSxxxx-xxxxxGxxx
Hiperface DSL multi turn	(EKM36)	4096	Multi	NA	HDSxxxx-xxxxxDxxx

\*as of Firmware 5905.

■ **FB-03: X13 Resolver**

Resolver interface	Sin / Cos pairs
Maximum input speed	60000 rpm (2 pole resolver)
Resolver winding ratio	0.5±10%
Excitation frequency	2 kHz - 10 kHz (default: 5 kHz), adjustable using ENCODERPARAMETER Mint keyword.
Excitation supply load	100 mA max
Typical accuracy	±11 arc minutes
Maximum recommended cable length	50 m
Resolution	12 bit
Resolver voltage	5 Vrms(and above)

■ **FB-04: X13 Hiperface DSL**

Device types	Single or multi-turn devices
Maximum input speed (typical)	9000 rpm
Maximum recommended cable length	30 m

**Dimensions and weights**

For basic dimensions, see [Main dimensions and free space requirements](#) on page 37. For detailed dimensions, see [Dimension drawings](#) starting on page 211.

Frame size	Weight kg (lbs)
A	2.8 (6.2)
B	4.8 (10.6)
C	10 (22)
D	17 (37.5)

**Note:** The wiring to the I/O options requires about 50 mm (2") of additional depth.

## Ambient conditions

Environmental limits for the drive are given below. The drive is to be used in a heated, indoor, controlled environment.

	Operation installed for stationary use	Storage in the protective package	Transportation in the protective package
<b>Installation site altitude</b>	0 to 2000 m (6560 ft) above sea level. [See also section <a href="#">Altitude derating</a> on page 169.]	-	-
<b>Air temperature</b>	0 to +55°C (32 to 131°F). No frost allowed. See section <a href="#">Derating</a> on page 169.	-40 to +70°C (-40 to +158°F)	-40 to +70°C (-40 to +158°F)
<b>Relative humidity</b>	0 to 95%	Max. 95%	Max. 95%
	No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.		
<b>Contamination levels</b>	No conductive dust allowed.		
	The drive must be installed in clean air according to enclosure classification. Cooling air must be clean, free from corrosive materials and electrically conductive dust.		
<b>Sinusoidal vibration (EN 60068-2-6: 2008)</b>	Tested according to, mechanical conditions: 2...9 Hz: 3.0 mm (0.12") 9...200 Hz: 1g	—	—
<b>Shock: EN 60068-2-27: 2009</b>	—	According to ISTA 1A. Max. 100 m/s <sup>2</sup> (330 ft/s <sup>2</sup> ), 11 ms	According to ISTA 1A. Max. 100 m/s <sup>2</sup> (330 ft/s <sup>2</sup> ), 11 ms
<b>Free fall</b>	Not allowed	76 cm (30")	76 cm (30")



## Degrees of protection

MotiFlex e180 complies with EN 60529, IP20.

For UL purposes the MotiFlex e180 is defined as an open-type, three phase single axis servo amplifier.

The drive must be installed in a cabinet to fulfil the requirements for shielding from contact. Access to the cabinet should be restricted to trained maintenance staff.

See chapter [Cabinet construction](#).

The top surface of cabinets/enclosures which are accessible when the equipment is energized shall meet at least the requirement of protective type IP3x with regard to vertical access only.

## Materials

<b>Drive enclosure</b>	PC/ABS, colour NCS 1502-Y (RAL 9002 / PMS 420 C). Hot-dip zinc coated steel sheet extruded aluminium AISi.
<b>Packaging</b>	Corrugated cardboard, PP bands.
<b>Disposal</b>	The drive contains raw materials that should be recycled to preserve energy and natural resources. The package materials are environmentally compatible and recyclable. All metal parts can be recycled. The plastic parts can either be recycled or burned under controlled circumstances, according to local regulations. Most recyclable parts are marked with recycling marks. If recycling is not feasible, all parts excluding electrolytic capacitors and printed circuit boards can be landfilled. The DC capacitors contain electrolyte, which is classified as hazardous waste within the EU. They must be removed and handled according to local regulations. For further information on environmental aspects and more detailed recycling instructions, contact your local ABB distributor.

### ■ RoHS compliance

MotiFlex e180 is in conformity with Directive 2011/65/EU of the European parliament and of the council of 8th June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment. The RoHS declaration 3AXD10000429165 is available on [new.abb.com/drives](http://new.abb.com/drives).

## Applicable standards

MotiFlex e180 complies with the following standards.

### ■ Design and test standards

<b>UL508C (2010)</b>	Power Conversion Equipment.
<b>EN 61800-5-1:2007</b>	Adjustable speed electrical power drive systems. Safety requirements. Electrical, thermal and energy.
<b>EN 60529:1991 + A2:2013</b>	Degrees of protection provided by enclosures.
<b>EN 61800-3:2004 + A1:2012</b>	Adjustable speed electrical power drive systems. Electromagnetic compatibility.  Conducted emissions: When installed as directed in this manual, MotiFlex e180 conforms to Category C3 conducted limits.  Radiated emissions: When installed as directed in this manual, MotiFlex e180 conforms to Category C2 radiated limits.  All frame sizes conform to the 'second environment' immunity requirements defined by this standard.

See also the CE Declaration of Conformity available on the internet; see [Document library on the Internet](#) on page 249.

### ■ Environmental test standards:

<b>EN 60068-1:2014</b>	Environmental testing, general and guidance.
<b>EN 60068-2-1:2007</b>	Environmental testing, Test A. Cold.
<b>EN 60068-2-2:2007</b>	Environmental testing, Test B. Dry heat.
<b>EN 60068-2-6:2008</b>	Environmental testing, Test Fc. Vibration (sinusoidal).
<b>EN 60068-2-27:2009</b>	Environmental testing, Test Ea. Shock.
<b>EN 60068-2-30:2005</b>	Environmental testing, Test Db. Damp heat, cyclic.
<b>EN 60068-2-31:2008</b>	Environmental testing, Test Ec. Rough handling shocks
<b>EN 60068-2-78:2013</b>	Environmental testing, Test Cab. Damp heat, steady state.

## ■ Functional safety standards:

<b>EN 61508:2010</b>	Functional safety of electrical/electronic/programmable electronic safety-related systems.
<b>EN 61800-5-2:2007</b> <b>IEC 61800-5-2:2016</b>	Adjustable speed electrical power drive systems: Safety requirements, Functional.
<b>EN ISO 13849-1:2015</b>	Safety of machinery: Safety-related parts of control systems, Basic principles.
<b>EN 62061:2005 + A1:2013</b>	Safety of machinery: Functional safety of safety-related electrical, electronic and programmable electronic control systems.

## CE marking

A CE mark is attached to the drive to verify that the unit follows the provisions of the European, EMC, and machinery directives.

### CE Declaration of Conformity

The declaration (3AXD10000371048) is available on the internet. See [Document library on the Internet](#) on page 249.

## Compliance with the European EMC Directive

The cabinet builder is responsible for the compliance of the drive system with the European EMC Directive. For information on items to consider, see:

- Subsections [Compliance with EN 61800-3, category C3](#); and [Compliance with EN 61800-3, category C4](#) below
- The chapter [Planning the electrical installation](#) in this manual
- *Technical Guide No. 3 – EMC Compliant Installation and Configuration for a Power Drive System* (3AFE61348280 [English]).

### 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 domestic premises. It also includes establishments directly connected without intermediate transformers to a low-voltage network which supplies buildings used for domestic purposes.

*Second environment* includes all establishments other than those directly connected to a low-voltage network which supplies buildings used for domestic purposes.

*Drive of category C2.* Power drive system with rated voltage less than 1000 V which is neither a plug-in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by a professional.

*Drive of category C3.* Power drive system with rated voltage less than 1000 V, intended for use in the second environment and not intended for use in the first environment.

*Drive of category C4.* Power drive system with 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.



**WARNING!** The drive can cause radio interference if used in residential or domestic environment. The user is required to take measures to prevent interference, in association to the requirements for the CE compliance listed above, if necessary.

---

### **Compliance with EN 61800-3, category C3**

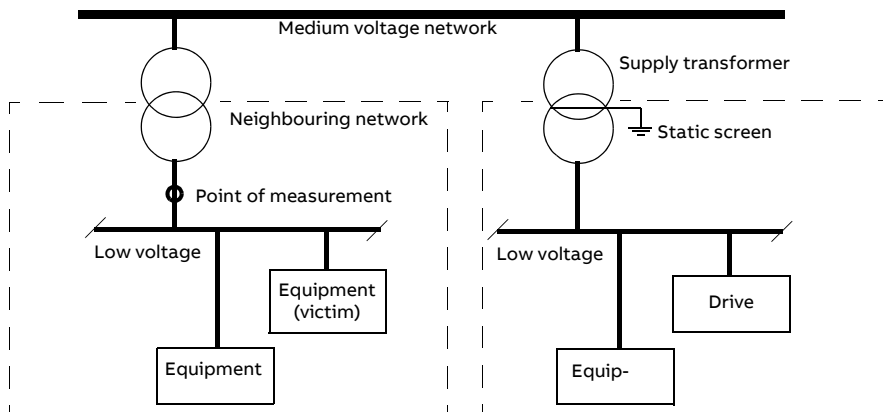
The drive meets the requirements of the EMC Directive with the following provisions:

1. The drive is equipped with optional mains filter JFI-xx.
  2. The motor and control cables are selected as specified in the chapter [\*Planning the electrical installation\*](#).
  3. The drive is installed according to the instructions given in this manual.
  4. Frames A, B & D: Motor cable length does not exceed 50 metres (164 ft).  
Frame C: Motor cable length does not exceed 30 metres (98 ft).
-

## Compliance with EN 61800-3, category C4

The drive meets the requirements of the EMC Directive with the following provisions:

1. It is ensured that no excessive emission is propagated to neighbouring low-voltage networks. In some cases, the natural suppression in transformers and cables is sufficient. If in doubt, a 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 chapter [Planning the electrical installation](#).
4. The drive is installed according to the instructions given in this manual.

## Compliance with the European Machinery Directive

This safety related drive complies with the European Union Machinery Directive requirements for a safety component intended to be integrated into machinery. Compliance with the machinery directive has been verified according to standards EN 61800-5-2, IEC 61800-5-2, EN ISO 13849-1, EN 62061, and EN 61508 parts 1 & 2. The drive has been designed, constructed and equipped in such a way that when installed as instructed in this manual, all hazards of an electrical nature are, or can be, prevented. The drive complies with EN 61800-5-1 which specifies safety requirements in terms of electrical, thermal and energy.

**Note:** The final assembler of the machinery must take the necessary precautions to prevent all hazards of an electrical nature when integrating this equipment. General specifications for design of electrical equipment of machinery is given in EN 60204-1 and EN 60204-11. Specifications for electrical

equipment are also given in many standards for specific categories of machinery.

## C-tick



"C-tick" marking is required in Australia and New Zealand. A "C-tick" mark is attached to each drive in order to verify compliance with the relevant standard (IEC 61800-3, *Adjustable speed electrical power drive systems - Part 3: EMC product standard including specific test methods*), mandated by the Trans-Tasman Mutual Recognition

Arrangement (TTMRA).



RCM marking is pending for the drive.

## UKCA (UK Conformity Assessed) marking

A UKCA mark is attached to the drive to verify that the unit follows the applicable United Kingdom's legislation (Statutory Instruments).

### Declaration of Conformity

The UK declaration (3AXD10001409694) is available on the Internet. See [Document library on the Internet](#) on page 249.

## UL marking

See the type designation label for the valid markings of your drive.

### ■ UL checklist

Input power connection – See section [AC input \(supply\) connection](#) on page 172.

Disconnecting device (Disconnecting means) – See section [Supply disconnecting device](#) on page 44.

Ambient conditions – The drive is to be used in a heated indoor controlled environment. See section [Ambient conditions](#) on page 180 for specific limits.

Input cable fuses – For installation in the United States, branch circuit protection must be provided in accordance with the National Electrical Code (NEC) and any applicable local codes. To fulfill this requirement, use the UL classified fuses given in section [Supply cable fuses](#) on page 171.

For installation in Canada, branch circuit protection must be provided in accordance with the Canadian Electrical Code and any applicable provincial codes. To fulfil this requirement, use the UL classified fuses given in section [Supply cable fuses](#) on page 171.

Power cable selection – See section [Selecting the power cables](#) on page 48.

Power cable connections – For the connection diagram and tightening torques, see section [Power cable connection](#) on page 55.

Control connections – For the connection diagram and tightening torques, see section [Connecting the control cables](#) on page 66.

Overload protection – The drive provides overload protection in accordance with the National Electrical Code (US).

Braking – The MotiFlex e180 has an internal braking chopper. When applied with appropriately sized braking resistors, the braking chopper allows the drive to dissipate regenerative energy (normally associated with quickly decelerating a motor). Braking resistor selection is discussed in the chapter [Resistor braking](#) on page 201.

UL standards – See section [Applicable standards](#) on page 182.

---





# 13

## Mains chokes

---

### What this chapter contains

This chapter describes how to select and install mains chokes for the MotiFlex e180. The chapter also contains the relevant technical data.

### When is a mains choke required?

The MotiFlex e180 does not necessarily require a mains choke for operation; the need for a choke should be determined on a case-by-case basis. Mains chokes are typically used to

- reduce harmonics in the input current
  - achieve a reduction in the r.m.s. input current
  - reduce supply disturbance and low-frequency interference
  - increase the allowed DC bus continuous power
  - ensure even current distribution in common DC configurations (see page [62](#)).
-

## Selection table

Mains chokes for MotiFlex e180		
Drive type MFE180-04xx...	Type	Inductance μH
-03A0-4	CHK-01	6370
-05A0-4	CHK-02	4610
-07A0-4		
-016A-4	CHK-04	1475
-024A-4	CHK-05	1130
-031A-4		
-046A-4	CHK-06	700
-060A-4	CHK-07	450
-090A-4	CHK-08	355

The mains chokes are protected to IP20. Refer to page [220](#) for dimensions, wire sizes and tightening torques.

## Installation guidelines

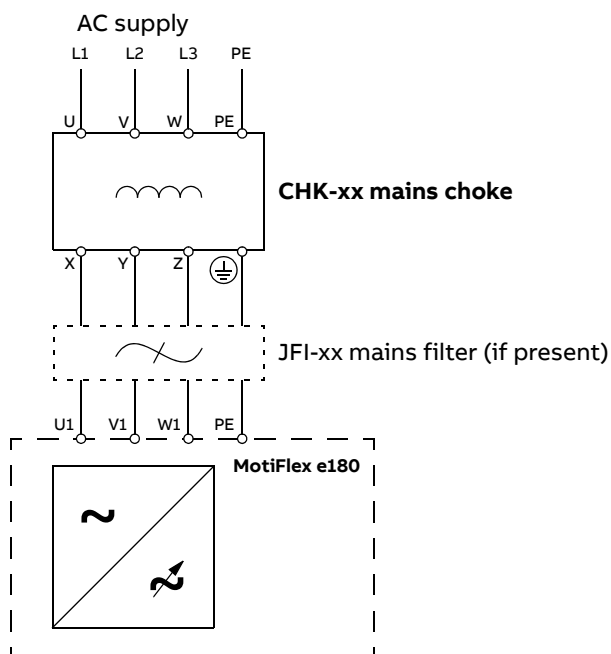
- If a mains filter is also installed, the mains choke is connected between the supply and the mains filter. See the diagram below.
- For optimal operation of the choke, the drive and the choke must be mounted on the same conductive surface.
- Ensure the choke does not block the airflow through the drive, and that the air rising from the choke is deflected away from the air inlet of the drive
- Keep the cable between the drive and the choke as short as possible.



**WARNING!** The surface of the mains choke becomes hot when in use.

---

# ■ Connection diagram





## 14

# DC chokes

---

## What this chapter contains

This chapter describes how to select and install DC chokes for the MotiFlex e180. The chapter also contains the relevant technical data.

## When is a DC choke required?

A DC choke can be installed as an alternative to a mains choke (page [189](#)) in frame C and frame D MotiFlex e180 models. The DC choke is installed directly above the drive and is cooled by the drive's exhaust air.

The MotiFlex e180 does not necessarily require a DC choke for operation; the need for a choke should be determined on a case-by-case basis. DC chokes are typically used to:

- reduce harmonics in the input current
  - achieve a reduction in the r.m.s. input current
  - reduce supply disturbance and low-frequency interference
  - increase the allowed DC bus continuous power
  - ensure even current distribution in common DC configurations (see page [62](#)).
-

Selection table

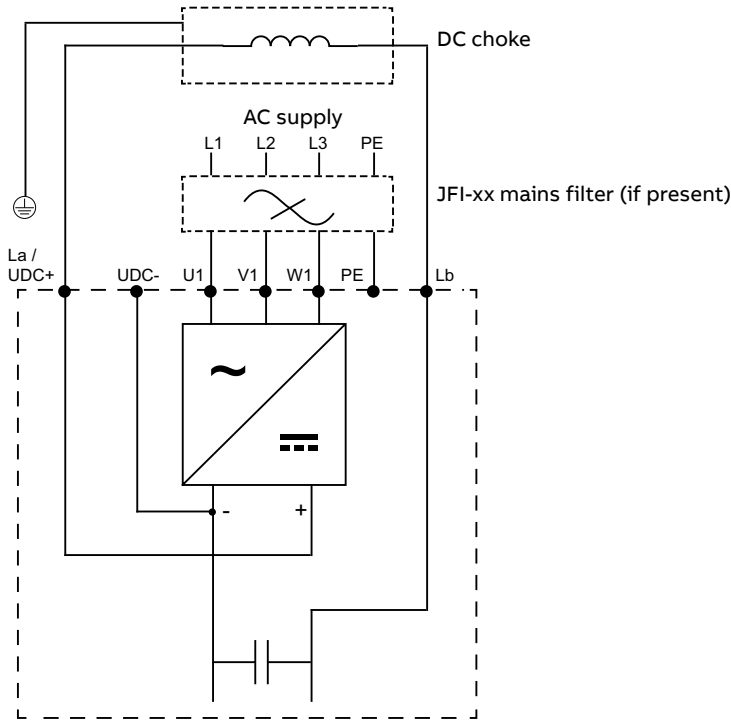
DC chokes for MotiFlex e180		
Drive type MFE180-04xx...	Type	Inductance μH
-024A-4	DCL-01	1540
-031A-4		
-046A-4	DCL-02	960
-060A-4	DCL-03	620
-090A-4	DCL-04	490

The DC chokes are protected to IP20. Refer to page 221 for dimensions.



**WARNING!** The surface of the DC choke becomes hot when in use.

■ Connection diagram

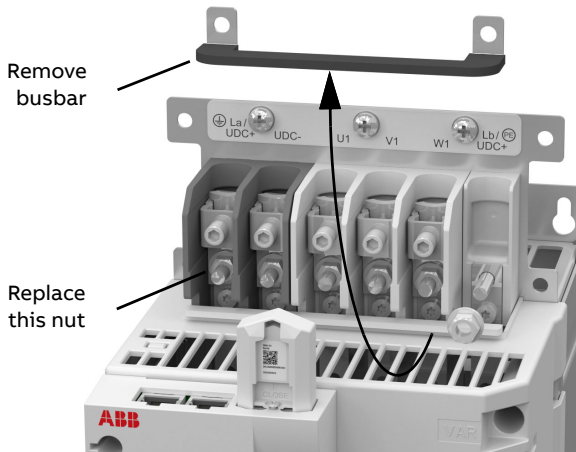


## Installation procedure

1. Remove the terminal cover screws and pull the terminal cover forwards.



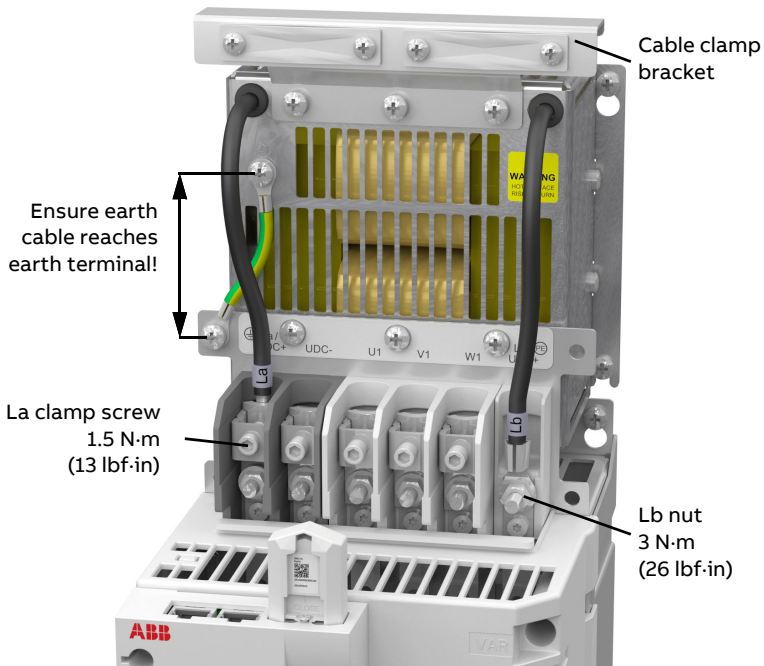
2. Remove the busbar connecting the La and Lb terminals.  
Replace the nut on the La terminal and tighten to 3 N·m (26 lbf·in).



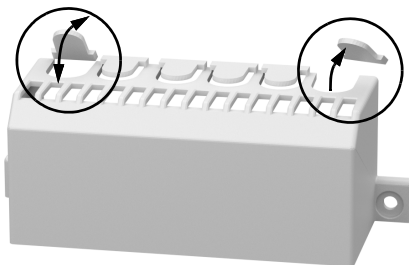
3. Attach the DC choke directly above the MotiFlex e180, ensuring that the green/yellow earth cable reaches the earth terminal on the MotiFlex e180.

Attach the cables to the La clamp and Lb terminal on the MotiFlex e180, as shown in the diagram. Tighten the La clamp screw to 1.5 N·m (13 lbf·in), and the Lb nut to 3 N·m (26 lbf·in).

The supplied cable clamp bracket can be attached to the DC choke to support power supply cables.



4. Break off the outer tabs and replace the terminal cover.





# 15

# Mains filters

---

## What this chapter contains

This chapter describes how to select and install mains filters for the MotiFlex e180. The chapter also contains the relevant technical data.

## When is a mains filter required?

The EMC product standard (EN 61800-3) covers the specific EMC requirements stated for drives (tested with motor and cable) within the EU. EMC standards such as EN 55011 or EN 61000-6-3/4 apply to industrial and household equipment and systems including drive components inside. Drive units complying with the requirements of EN 61800-3 are always compliant with comparable categories in EN 55011 and EN 61000-6-3/4, but not necessarily vice versa. EN 55011 and EN 61000-6-3/4 do neither specify cable length nor require a motor to be connected as a load. The emission limits are comparable according to the following table.

EMC standards in general		
EN 61800-3, product standard	EN 61800-3, product standard	EN 55011, product family standard for industrial, scientific and medical (ISM) equipment
1st environment, unrestricted distribution	Category C1	Group 1 Class B
1st environment, restricted distribution	Category C2	Group 1 Class A
2nd environment, unrestricted distribution	Category C3	Group 2 Class A
2nd environment, restricted distribution	Category C4	Not applicable

---

A mains filter is required in order for MotiFlex e180 to meet the category C3 level, using a motor with a max. 50 m cable (30 m for Frame C models). This level corresponds to the A limits for Group 2 equipment according to EN 55011.



**WARNING!** A mains filter must not be installed if the drive is connected to an IT power system (i.e. an ungrounded, or a high resistance grounded [over 30 ohm] power system).

## Selection table

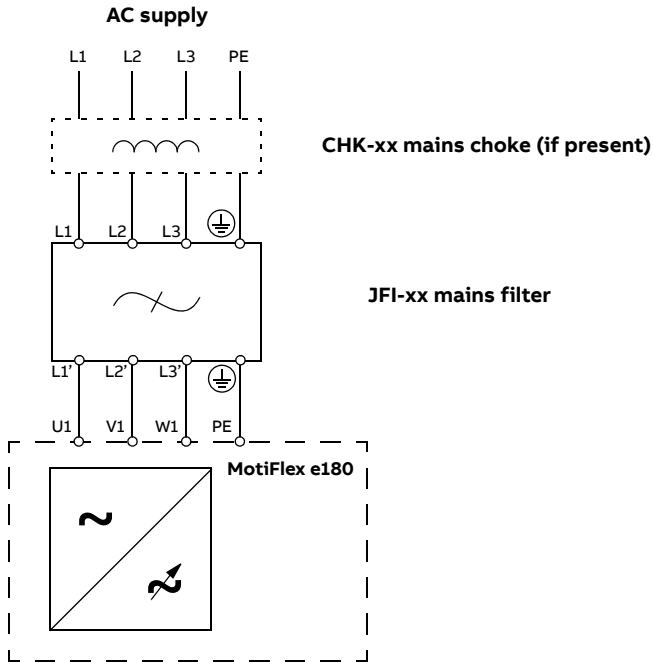
Mains filters for MotiFlex e180 (maximum 50 m motor cable unless otherwise specified)	
Drive type MFE180-04.xx...	Filter type to meet EN 61800-3, category C3
-03A0-4	JFI-02
-05A0-4	
-07A0-4	
-016A-4	JFI-03
-024A-4	JFI-05 (max. 30 m cable)
-031A-4	
-046A-4	
-060A-4	JFI-07
-090A-4	

The mains filters are protected to IP20. Refer to pages [222-223](#) for dimensions, wire sizes and tightening torques.

## Installation guidelines

- If a mains choke is also installed, the mains filter is connected between the mains choke and the drive. See the diagram below.
- For optimal operation of the filter, the drive and the filter must be mounted on the same conductive surface
- Ensure the filter does not block the airflow through the drive
- Keep the cable between the drive and the filter as short as possible.

## ■ Connection diagram





# 16

## Resistor braking

---

### **What this chapter contains**

This chapter contains information about calculating the regenerative power created by the motor when it decelerates or is driven by the load. The chapter then describes the process for selecting an appropriate resistor to dissipate the regenerative power.

Introduction

Each drive has a *braking capacity* that defines the amount of regenerative energy its DC bus capacitors can store before the voltage on the capacitors exceeds the drive’s overvoltage level. In a common DC system, all of the drive’s DC bus capacitors are connected, so the system braking capacity becomes the sum of all the drives’ braking capacities. If the total regenerative energy in the system exceeds the system braking capacity, the excess energy must be diverted into a regeneration resistor to be dissipated as heat. The regeneration resistor can be connected to one drive in the system, but if that drive’s braking chopper cannot withstand the total regenerative power in the system, more than one drive must be fitted with a regeneration resistor.

System braking capacity

The braking capacity of the drive is calculated from the following formula:

$$B_{dc} = 0.5 \times DC\ bus\ capacitance \times \left( (Brake\ switching\ threshold)^2 - (\sqrt{2} \times Supply\ volt- \right)$$

where the *Brake switching threshold* is 776 V. This gives the following typical values:

MotiFlex e180		DC bus capacitance (µF)	Braking capacity, B <sub>dc</sub> (J)	
Model	Frame		230 V AC supply	480 V AC supply
03A0-4	A	140	35.2	10.4
05A0-4	A	280	70.4	20.7
07A0-4	A			
016A-4	B	865	217.4	63.8
024A-4	C	785	197.3	57.9
031A-4	C			
046A-4	D	1178	296.0	86.9
060A-4	D	1570	394.5	115.9
090A-4	D	2355	591.8	173.8

## Braking energy calculation

The following calculations can be used to estimate the type of brake resistor that will be required for the application. To complete the calculation, some basic information is required. Remember to use the worst-case values to ensure that the braking power is not underestimated. For example, use the maximum possible motor speed, maximum inertia, minimum deceleration time and minimum cycle time that the application might encounter.

Requirement	Enter value here
a) Initial motor speed, before deceleration begins, in radians per second.  <i>Multiply RPM by 0.1047 to give radians per second.</i>	Initial motor speed, $U = \underline{\hspace{2cm}}$ rad/s
b) Final motor speed after deceleration is complete, in radians per second.  <i>Multiply RPM by 0.1047 to get radians per second. This value will be zero if the load is going to be stopped.</i>	Final motor speed, $V = \underline{\hspace{2cm}}$ rad/s
c) The deceleration time from initial speed to final speed, in seconds.	Decel time, $D = \underline{\hspace{2cm}}$ s
d) The total cycle time (i.e. how frequently the process is repeated), in seconds.	Cycle time, $C = \underline{\hspace{2cm}}$ s
e) Total inertia.  <i>This is the total inertia seen by the drive, accounting for motor inertia, load inertia and gearing. Use the Mint WorkBench Autotune tool to tune the motor, with the load attached, to determine the value. This will be displayed in <math>\text{kg}\cdot\text{m}^2</math> in the Autotune tool. If you already know the motor inertia (from the motor spec.) and the load inertia (by calculation) insert the total here.</i>  <i>Multiply <math>\text{kg}\cdot\text{cm}^2</math> by 0.0001 to give <math>\text{kg}\cdot\text{m}^2</math>. Multiply <math>\text{lb}\cdot\text{ft}^2</math> by 0.04214 to give <math>\text{kg}\cdot\text{m}^2</math>. Multiply <math>\text{lb}\cdot\text{in}\cdot\text{s}^2</math> by 0.113 to give <math>\text{kg}\cdot\text{m}^2</math>.</i>	Total inertia, $J = \underline{\hspace{2cm}}$ $\text{kg}\cdot\text{m}^2$

### ■ Braking energy

The braking energy to be dissipated,  $E$ , is the difference between the initial energy in the system (before deceleration begins) and the final energy in the system (after deceleration has finished). If the system is brought to rest then the final energy is zero.

The energy of a rotating object is given by the formula:

$$E = \frac{1}{2} \times J \times \omega^2$$

where  $E$  is energy,  $J$  is the moment of inertia, and  $\omega$  is the angular velocity.

The braking energy, which is the difference between the initial energy and the final energy, is therefore:

$$E = \left( \frac{1}{2} \times J \times U^2 \right) - \left( \frac{1}{2} \times J \times V^2 \right)$$

$$= \frac{1}{2} \times J \times (U^2 - V^2)$$

$$= \underline{\hspace{2cm}} \text{ J (joules)}$$

Calculate the braking energy for the motor. If the value is less than the system braking capacity  $B_{dc}$ , calculated on page [202](#), a brake resistor will not be required.

---



### ■ Braking power and average power

The braking power,  $P_{\text{gen}}$ , is the *rate* at which the braking energy is dissipated. This rate is defined by the deceleration period,  $D$  (see page 202). The shorter the deceleration period, the greater the braking power.

$$P_{\text{gen,max}} = \frac{E}{D}$$

$$P_{\text{gen,max}} = \underline{\hspace{2cm}} \text{ W (watts)}$$

The regeneration resistors shown in the table on page 206 can withstand brief overloads, but the average power dissipation must not exceed the stated continuous power rating. The average power dissipation is determined by the proportion of the application cycle time spent braking. The greater the proportion of time spent braking, the greater the average power dissipation. This average value can be used to represent an equivalent continuous braking power, where  $C$  is the cycle time (see page 203):

$$P_{\text{gen,ave}} = P_{\text{gen,max}} \times \frac{D}{C}$$

$$= \underline{\hspace{2cm}} \text{ W (watts)}$$

Calculate the maximum braking power  $P_{\text{gen,max}}$  and the equivalent continuous braking power  $P_{\text{gen,ave}}$  for the motor.

Resistor selection

$P_{gen,ave}$  is the value to use when assessing which brake resistor to use. However, a safety margin of 1.25 times is recommended to ensure the resistor operates well within its limits, so:

*Required resistor power rating* = 1.25 x  $P_{gen,ave}$

$P_{gen,ave}$  = \_\_\_\_\_ **W (watts)**

The selected resistor must satisfy the following conditions:

- Its resistance must be equal to or greater than the minimum resistance  $R_{min}$  stated for the MotiFlex e180 to which it is connected.
- Its continuous power rating must be equal to or greater than  $P_{gen,ave}$ .
- Its pulse load rating must be sufficient to satisfy fast dynamic situations; see [Pulse load rating](#) on page 207.

The following table lists the resistors suitable for use with the MotiFlex e180 range.

Frame	Drive type MFE180-04xx-...	$R_{min}$ (ohm)	Resistor data / Type
A	03A0-4	80	120 ohm, 145 W / JBR-01 80 ohm, 185 W / JBR-03
	05A0-4		
	07A0-4	60	
B	016A-4	33	40 ohm, 360 W / JBR-04
C	024A-4	12	20 ohm, 570 W / JBR-05 13 ohm, 790 W / JBR-06
	031A-4		
	046A-4		
D	060A-4		
	090A-4		

$R_{min}$  The minimum allowed resistance of the braking resistor.

**Resistor data / type** Rated resistance and nominal continuous power of listed JBR-xx resistors.

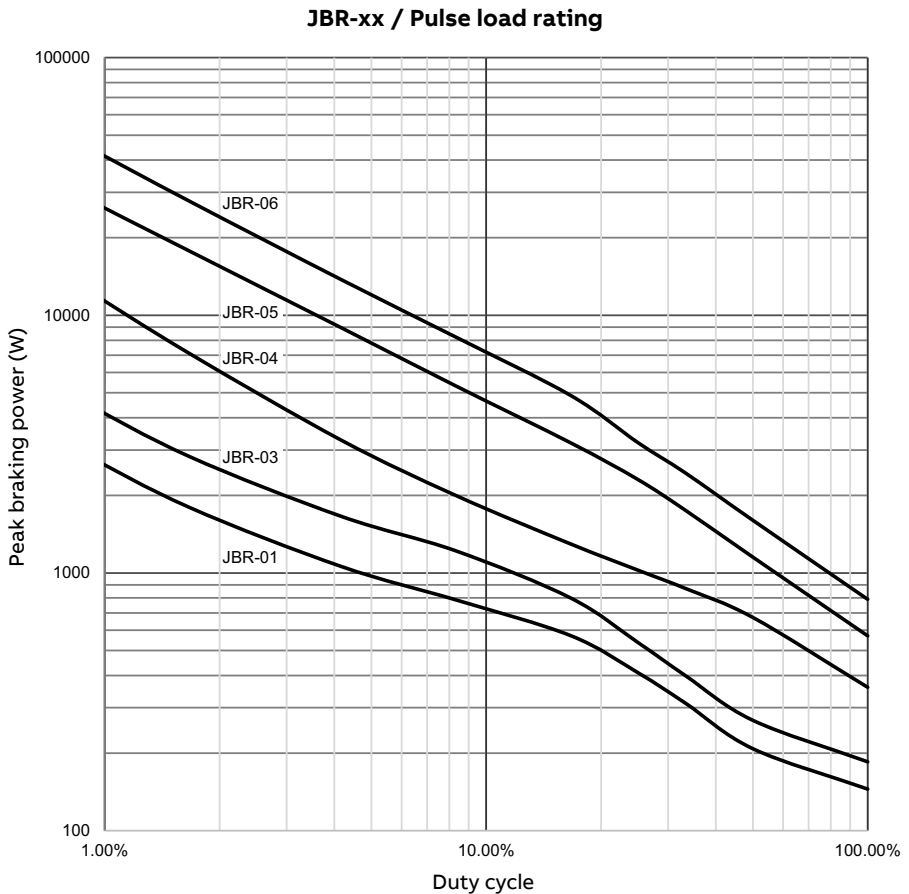
The ratings apply at an ambient temperature of 40°C (104°F).

## ■ Pulse load rating

The braking resistor capacity with different duty cycles can be defined by the following pulse load curves. These curves are valid for a maximum 120 s cycle time. In higher ambient temperatures between 40°C and 70°C (maximum) the braking power values should be derated by 15% per 10°C.

**Duty cycle** This is the load (active braking) time as a proportion of the total cycle time. For example, 1 s braking time every 10 s represents a 10% duty cycle.

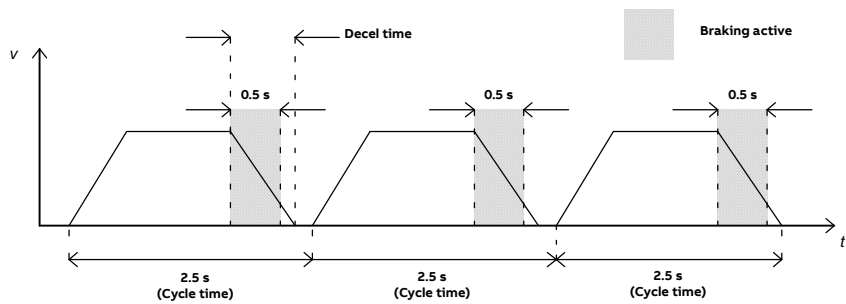
**Peak power** Peak braking power (W) during the braking time.



■ Duty cycle

The braking duty cycle is the amount of time taken braking as a proportion of the overall application cycle time. For example, the following diagram shows a system which performs a trapezoidal move profile, with braking during part of the deceleration phase.

The braking duty is 0.2 (0.5 second braking / 2.5 second cycle time):



## Resistor installation and wiring

All resistors must be installed outside the drive in a place where they are cooled sufficiently, do not block the airflow to other equipment, or dissipate hot air into the air inlets of other equipment.



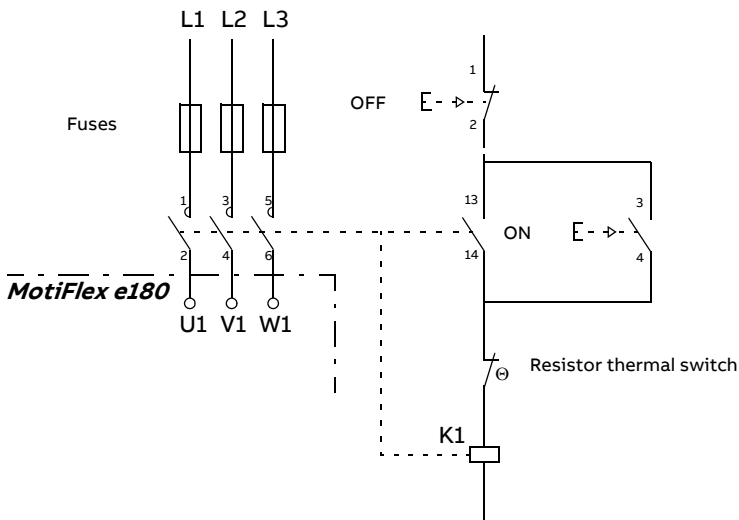
**WARNING!** The materials near the braking resistor must be non-flammable. The surface temperature of the resistor may rise above 200 °C (400 °F), and the temperature of the air flowing from the resistor is hundreds of degrees Celsius. Protect the resistor against contact.

The maximum length of the resistor cable(s) is 20 m (65 ft). For the connections, see section [Power cable connection](#) on page 55.

### ■ Contactor protection of drive

It is highly recommended to equip the drive with a main contactor for safety reasons. Wire the contactor so that it opens in case the resistor overheats. This is essential for safety since the drive will not otherwise be able to interrupt the main supply if the chopper remains conductive in a fault situation.

Below is a simple example wiring diagram.





# 17

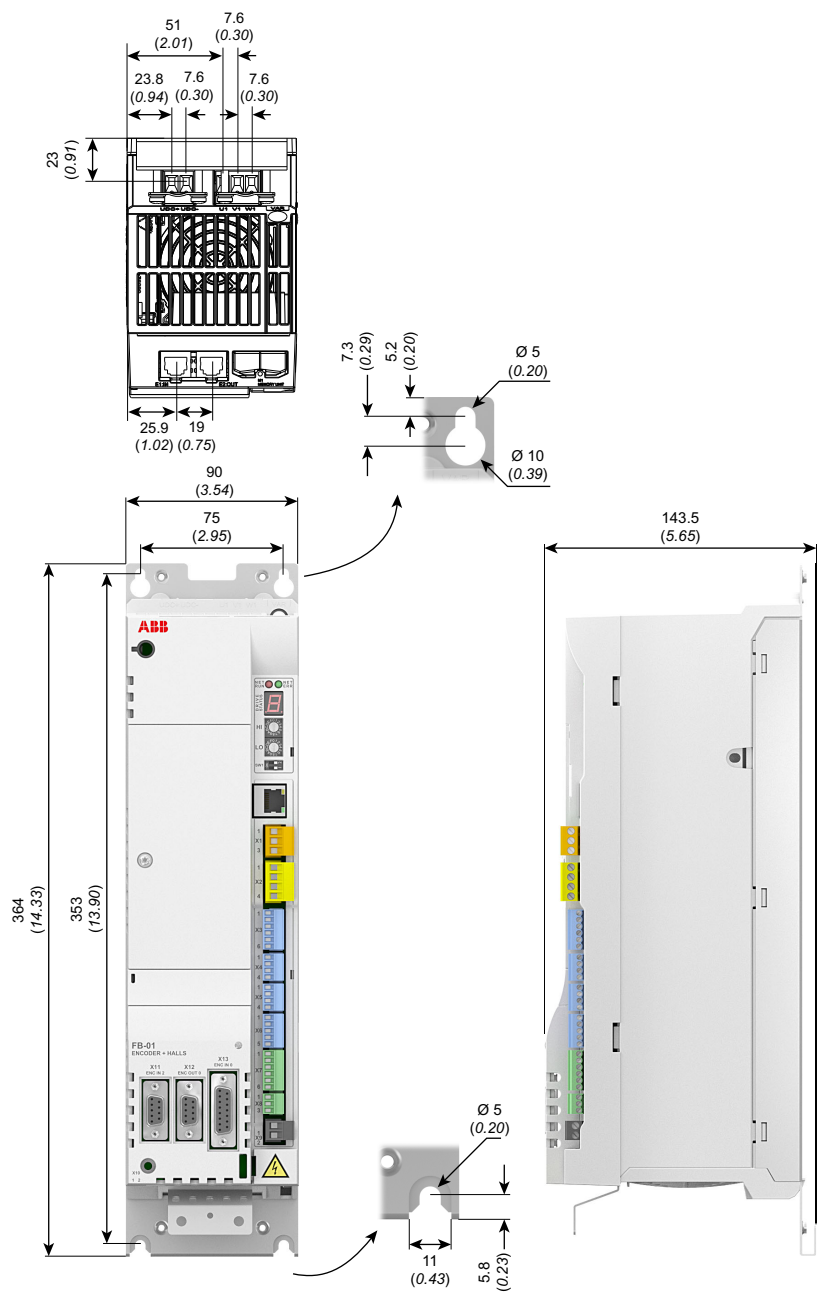
## Dimension drawings

---

### What this chapter contains

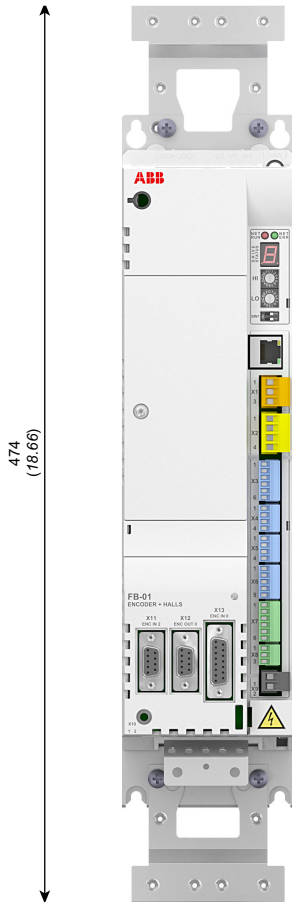
Dimension drawings of the MotiFlex e180 and related accessories are shown below. The dimensions are given as millimetres (*inches*).

Frame A

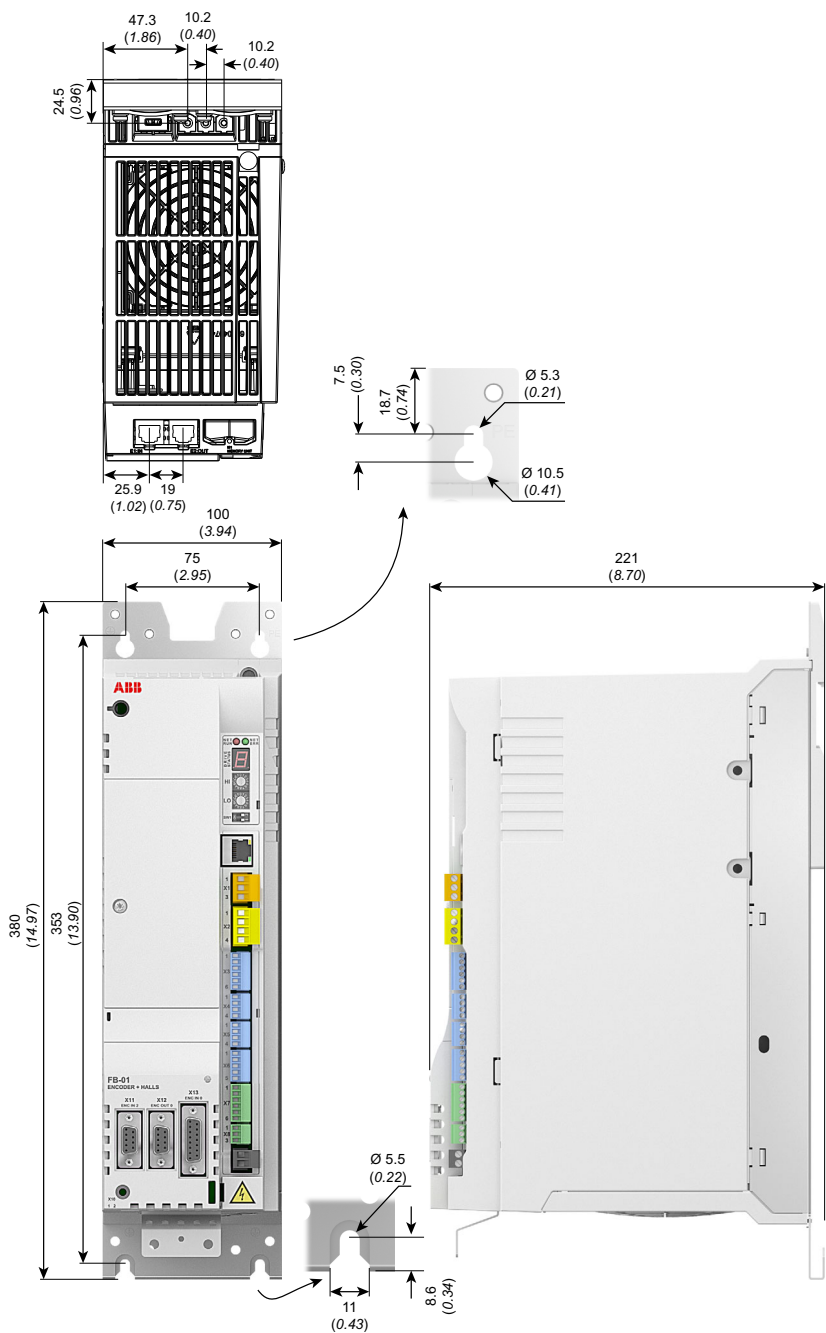




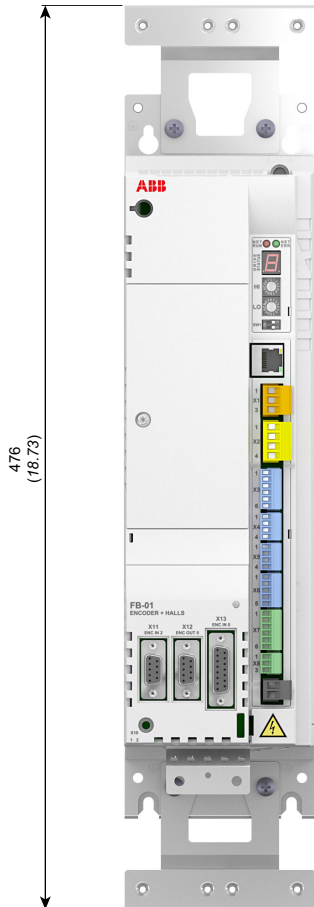
## Frame A with accessory brackets



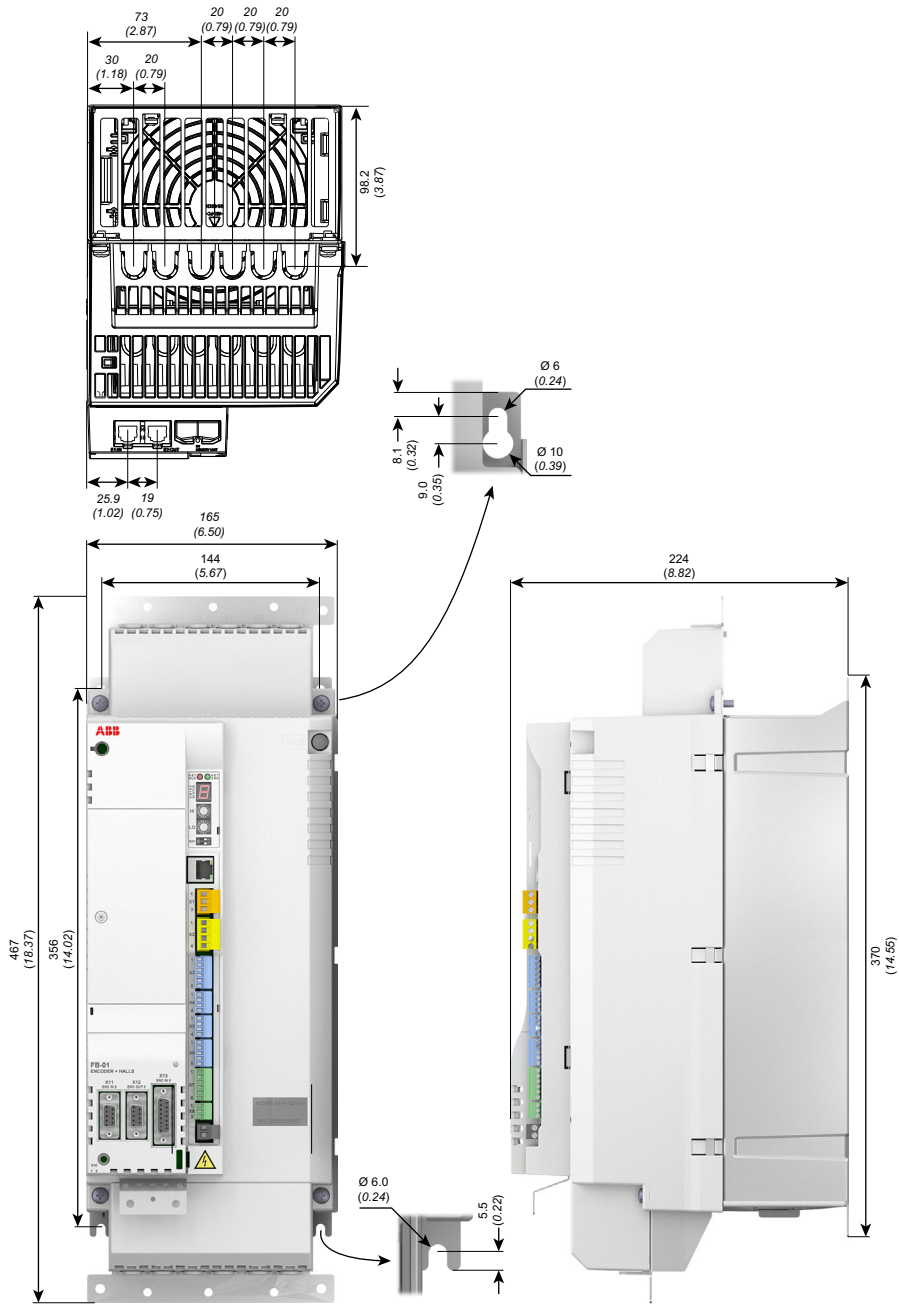
Frame B



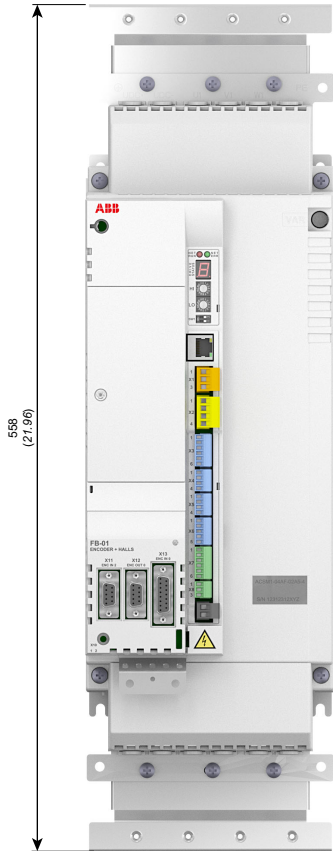
## Frame B with accessory brackets



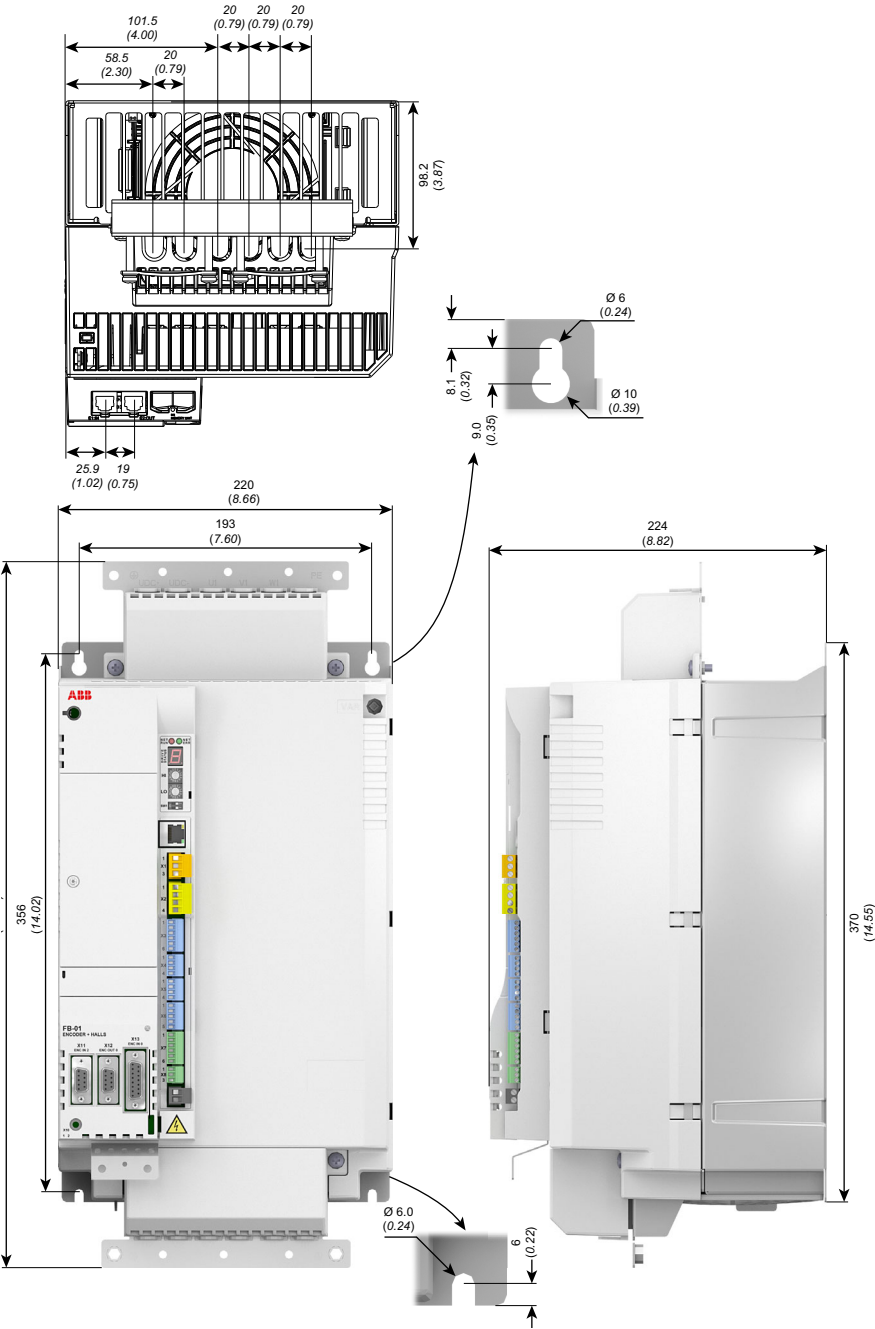
Frame C



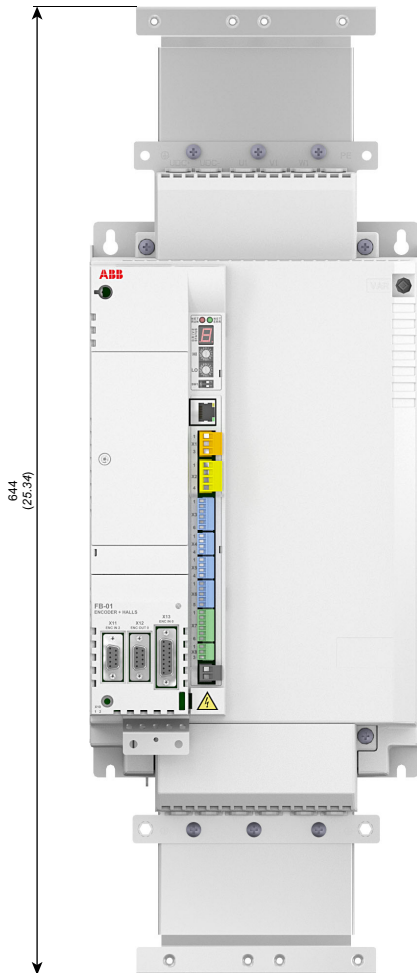
## Frame C with accessory brackets



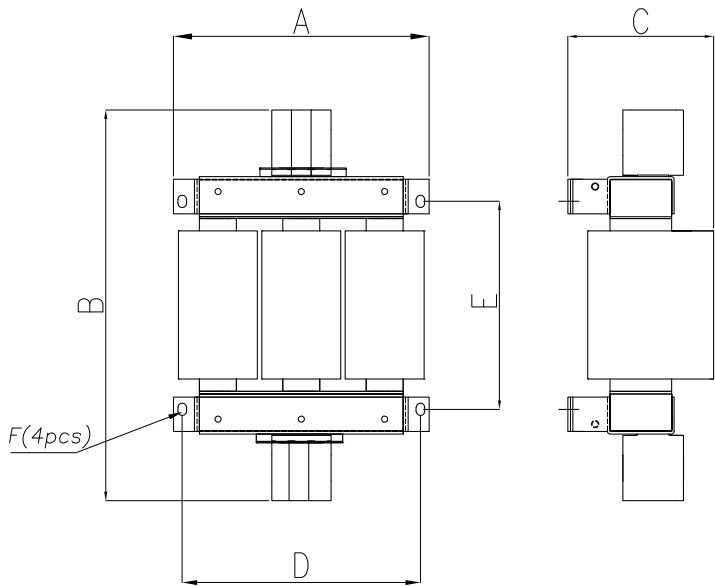
Frame D



## Frame D with accessory brackets



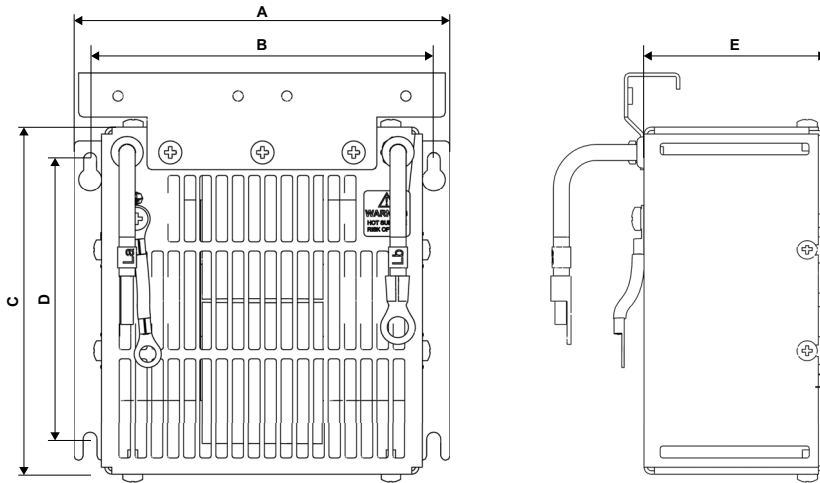
Mains chokes (type CHK-0x)



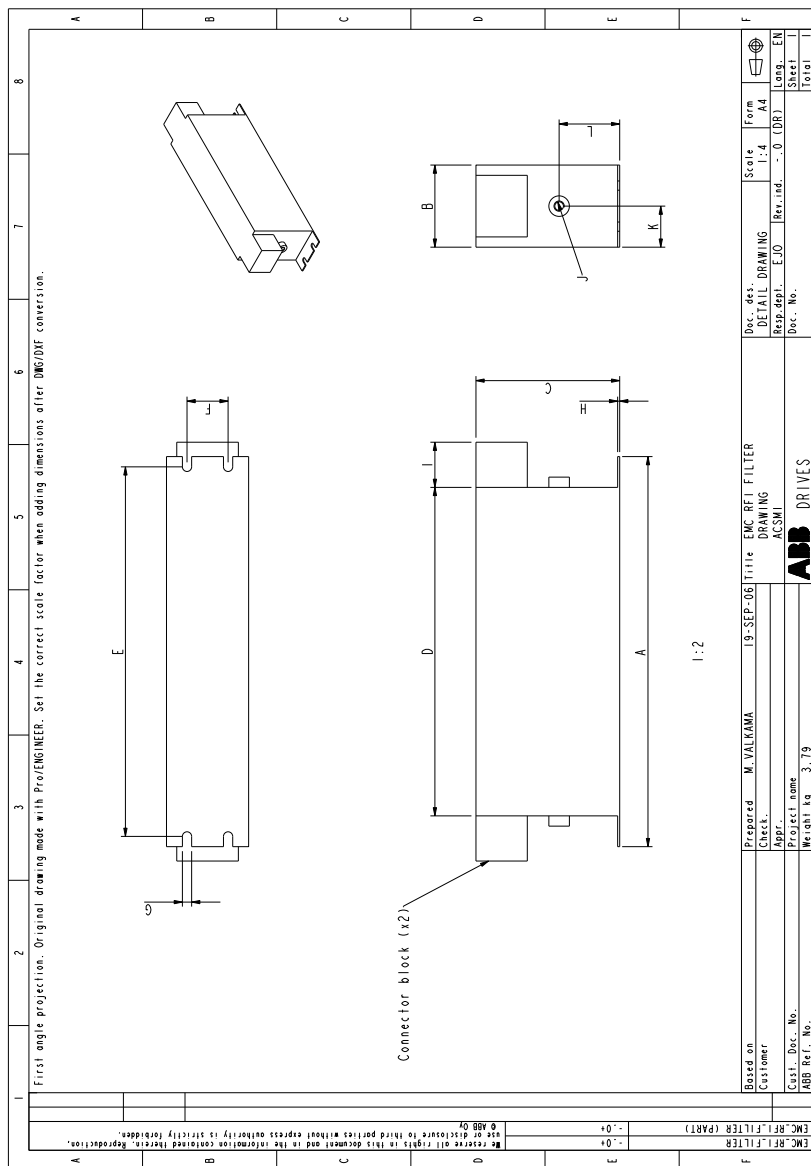
CHK-xx dimensions								
Parameter	Choke type							
	CHK-01	CHK-02	CHK-03	CHK-04	CHK-05	CHK-06	CHK-07	CHK-08
dim A mm (in.)	120 (4.72)	150 (5.91)	150 (5.91)	150 (5.91)	207 (8.15)	207 (8.15)	249 (9.80)	249 (9.80)
dim B mm (in.)	146 (5.75)	175 (6.89)	175 (6.89)	175 (6.89)	272 (10.71)	326 (12.83)	326 (12.83)	346 (13.62)
dim C mm (in.)	79 (3.11)	86 (3.39)	100 (3.94)	100 (3.94)	154 (6.06)	154 (6.06)	167 (6.57)	167 (6.57)
dim D mm (in.)	77 (3.03)	105 (4.13)	105 (4.13)	105 (4.13)	193 (7.60)	193 (7.60)	235 (9.25)	235 (9.25)
dim E mm (in.)	114 (4.49)	148 (5.83)	148 (5.83)	148 (5.83)	118 (4.65)	169 (6.65)	125 (4.92)	147 (5.79)
F screw size	M5	M5	M5	M5	M6	M6	M6	M6
Weight kg (lbs)	1.8 (4.0)	3.8 (8.4)	5.4 (11.9)	5.2 (11.5)	10 (22)	12 (26.5)	14 (31)	16 (35)
Wire size – Main terminals mm <sup>2</sup> (AWG)	0.5 ... 10 (20...6)	0.5 ... 10 (20...6)	0.5 ... 10 (20...6)	0.5 ... 10 (20...6)	1.5 ... 35 (16...0)	1.5 ... 35 (16...0)	25 ... 50 (6...0)	25 ... 50 (6...0)
Tightening torque – Main terminals N·m (lbf·in)	1.5 (13)	1.5 (13)	1.5 (13)	1.5 (13)	3.2 (28)	3.2 (28)	6 (53)	6 (53)
PE/Chassis terminals	M4	M5	M5	M5	M6	M6	M6	M8
Tightening torque – PE/Chassis terminals N·m (lbf·in)	3 (26)	4 (35)	4 (35)	4 (35)	8 (70)	8 (70)	8 (70)	15 (135)



## DC chokes (type DCL-0x)



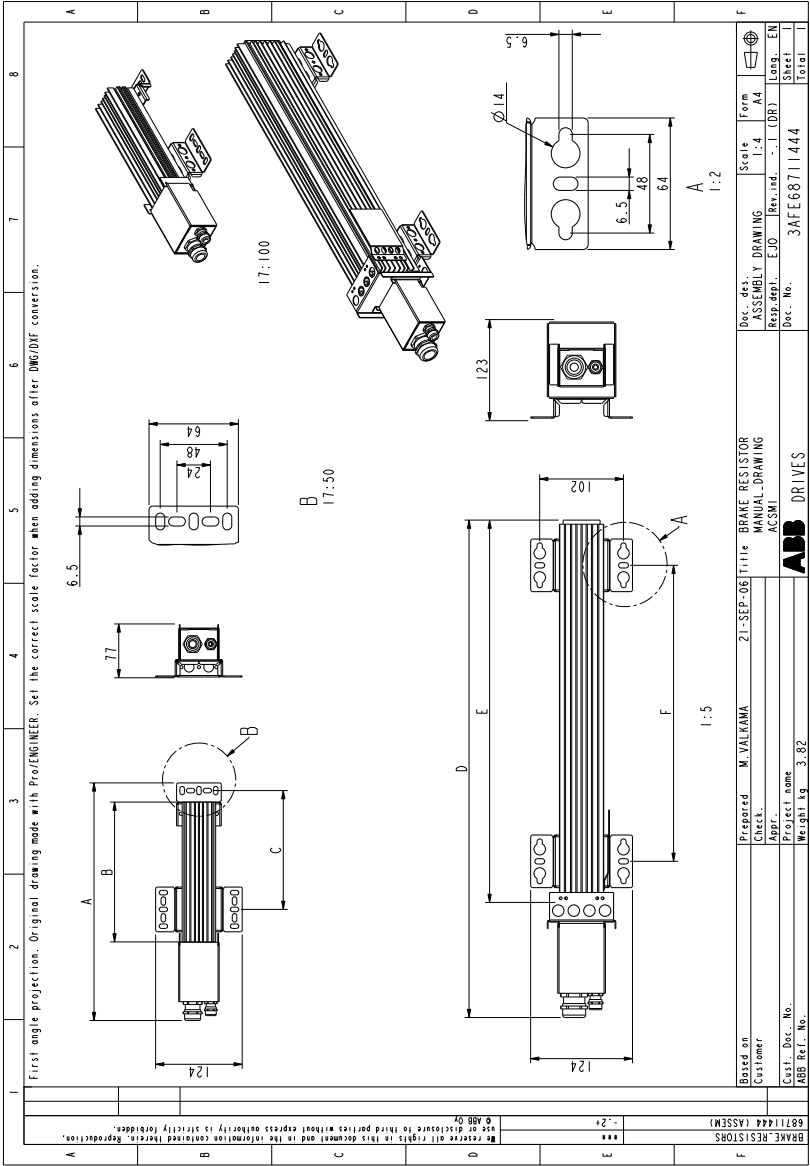
<i>DCL-0x dimensions</i>		
Parameter	Choke type	
	DCL-01 / -02	DCL-03 / -04
dim A mm (in.)	163 (6.42)	216 (8.50)
dim B mm (in.)	149 (5.87)	200 (7.87)
dim C mm (in.)	151 (5.94)	145 (5.71)
dim D mm (in.)	122 (4.80)	116 (4.57)
dim E mm (in.)	79 (3.11)	74 (2.91)
F screw size	M5	M5
Weight kg (lb) with bracket	DCL-02: 4.41 (9.7) 4.56 (10.1)	DCL-04: 6.00 (13.2) 6.15 (13.6)



## Mains filters: wire sizes (type JFI-xx)

<i>JFI-xx dimensions</i>					
Parameter	Filter type				
	JFI-02	JFI-03	JFI-05	JFI-07	
Dim. A mm (in.)	250 (9.84)	250 (9.84)	250 (9.84)	270 (10.63)	
Dim. B mm (in.)	45 (1.77)	50 (1.97)	85 (3.35)	90 (3.54)	
Dim. C mm (in.)	70 (2.76)	85 (3.35)	90 (3.54)	150 (5.91)	
Dim. D mm (in.)	220 (8.66)	240 (9.45)	220 (8.66)	240 (9.45)	
Dim. E mm (in.)	235 (9.25)	255 (10.04)	235 (9.25)	255 (10.04)	
Dim. F mm (in.)	25 (0.98)	30 (1.18)	60 (2.36)	65 (2.56)	
Dim. G mm (in.)	5.4 (0.21)	5.4 (0.21)	5.4 (0.21)	6.5 (0.26)	
Dim. H mm (in.)	1 (0.04)	1 (0.04)	1 (0.04)	1.5 (0.06)	
Dim. I mm (in.)	22 (0.87)	25 (0.98)	39 (1.54)	45 (1.77)	
Dim. J	M5	M5	M6	M10	
Dim. K mm (in.)	22.5 (0.89)	25 (0.98)	42.5 (1.67)	45 (1.77)	
Dim. L mm (in.)	29.5 (1.16)	39.5 (1.56)	26.5 (1.04)	64 (2.52)	
Weight kg (lbs)	0.8 (1.75)	1.1 (2.4)	1.8 (4.0)	3.9 (8.5)	
Wire size (solid) mm <sup>2</sup> (AWG)	0.2 ... 10 (AWG24...8)	0.5 ... 16 (AWG20...6)	6...35 (AWG8...2)	16...50 (AWG4...1/0)	
Wire size (stranded) mm <sup>2</sup> (AWG)	0.2 ... 6 (AWG24...10)	0.5 ... 10 (AWG20...8)	10...25 (AWG6...4)	16...50 (AWG4...1/0)	
Tightening torque of terminals N·m (lbf·in)	1.5 ... 1.8 (13.3 ... 15.9)	1.5 ... 1.8 (13.3 ... 15.9)	4.0 ... 4.5 (35 ... 40)	7...8 (60...70)	

Braking resistors: dimensions (type JBR-xx)



Braking resistors: wire sizes (type JBR-xx)

<i>JBR-xx dimensions</i>						
Parameter	Resistor type					
	JBR-01	JBR-03	JBR-04	JBR-05	JBR-06	
Dim. A mm (in.)	295 (11.61)	340 (13.39)	-	-	-	
Dim. B mm (in.)	155 (6.10)	200 (7.87)	-	-	-	
Dim. C mm (in.)	125 (4.92)	170 (6.69)	-	-	-	
Dim. D mm (in.)	-	-	345 (13.58)	465 (18.31)	595 (23.43)	
Dim. E mm (in.)	-	-	210 (8.27)	330 (12.99)	460 (18.11)	
Dim. F mm (in.)	-	-	110 (4.33)	230 (9.06)	360 (14.17)	
Weight kg (lbs)	0.75 (1.7)	0.8 (1.8)	1.8 (4.0)	3.0 (6.6)	3.9 (8.6)	
Max. wire size – Main terminals	10 mm <sup>2</sup> (AWG6)					
Tightening torque – Main terminals	1.5 ... 1.8 N·m (13 ... 16 lbf·in)					
Max. wire size – Thermal switch terminals	4 mm <sup>2</sup> (AWG12)					
Tightening torque – Thermal switch terminals	0.6 ... 0.8 N·m (5.3 ... 7.1 lbf·in)					



# 18

## Appendix: Safe Torque Off (STO)

---

### What this chapter contains

The appendix describes the basics of the Safe torque off function (STO) for the MotiFlex e180. In addition, application features and technical data for the safety system calculation are presented.

### Basics

The drive supports the Safe Torque Off (STO) function according to standards:

EN 61800-5-2: 2007, IEC 61800-5-2: 2016

EN 61508-1/-2: 2010

EN ISO 13849-1: 2015

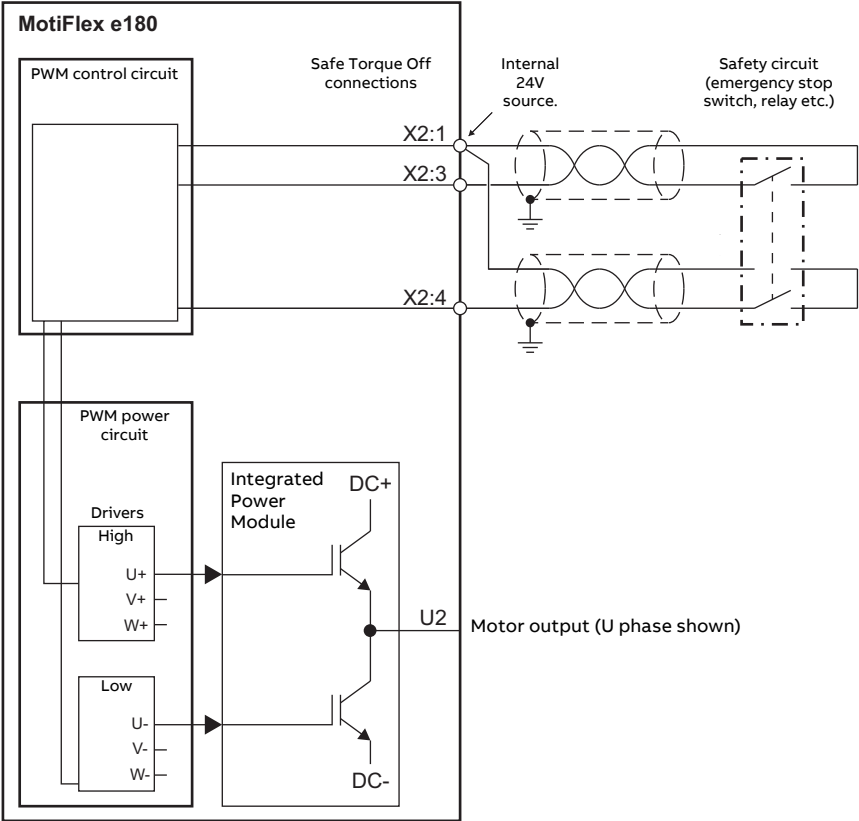
EN ISO 13849-2: 2012

EN 62061: 2005 + A1: 2013.

The STO function disables the control voltage of the power semiconductors of the drive output stage, which prevents the inverter generating the voltage required to rotate the motor (see diagram below). By using this function, short-time operations (like cleaning) and/or maintenance work on non-electrical parts of the machinery can be performed without switching off the power supply to the drive.

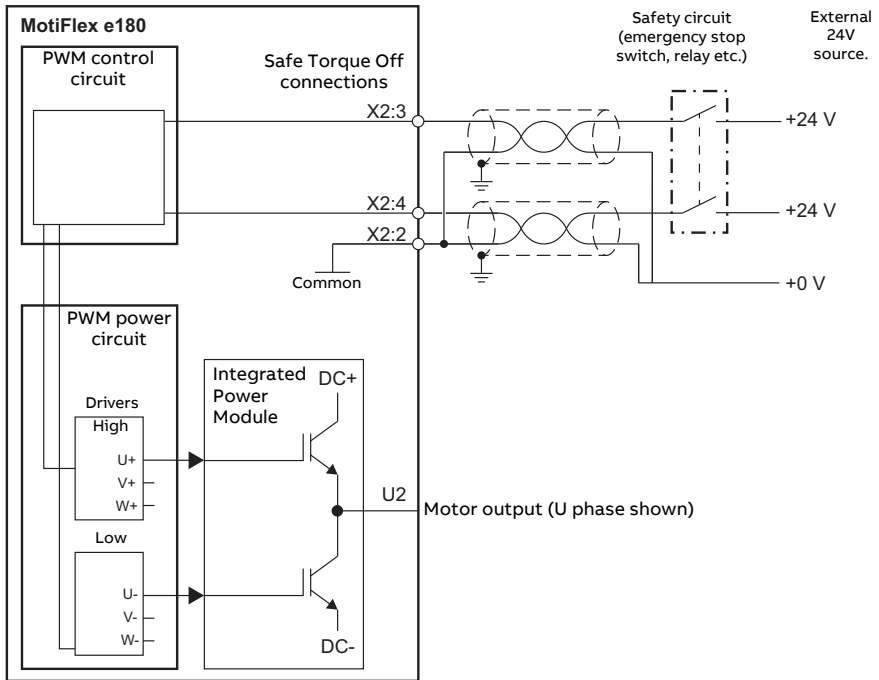
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Using internal 24 V drive source:





Using external 24V sources:



**Notes:**

- \* The STO function is activated when one or both of the safety circuit contacts open. If the period between both contacts opening or closing exceeds a predefined value, a fault in the safety circuit or wiring is assumed and an error is reported.
- \* The maximum cable length between drive and the safety switch is 30 m (98 ft).



**WARNING!** The STO 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 system from the main supply. If the drive was connected to the input power, wait for 5 minutes after disconnecting the input power.

## Special considerations for using the STO function

### ■ Drive location

The MotiFlex e180 and all associated STO wiring must be installed in an indoor location. The MotiFlex e180 must be installed in a cabinet. The suitability of the cabinet for the intended environment must be determined by the installer. See [Ambient conditions](#) on page 180 for further details.

### ■ Hazard analysis

A hazard analysis of the application should be performed before using the STO function in the application.

### ■ Additional stopping methods

It is not recommended to stop the drive by using the STO function. If a running drive is stopped by using the function, the drive trips and stops by coasting. If this is not acceptable e.g. causes danger, the drive and machinery must be stopped using the appropriate stopping mode before using this function. For example, suspended or tensioned loads (e.g. cranes, hoists) will require additional brakes or mechanical interlocks.

### ■ IGBT failure

If a permanent magnet motor drive experiences multiple power semiconductor failure, the drive system can produce an alignment torque which maximally rotates the motor shaft by  $180/p$  degrees ( $p$  = pole pair number), even if the STO function has been correctly activated.

Failure of one or more IGBTs can cause the drive output to fail due to:

- IGBT desaturation protection causing all IGBTs to be stopped.
- Rupture of the AC input fuse.

## Terminology

‘Active’ or ‘activated’ means that the STO *function* has been triggered. This removes power from the motor and disables the drive. The drive cannot be restarted without further operator intervention.

‘Standby’ means that the STO *function* has not been triggered. The drive can power the motor, provided all other criteria are satisfied to allow motor operation.

---

## Wiring principles

The Safe Torque Off connector is X2 on MotiFlex e180 drives.

Wiring principles are shown in the diagrams below. See chapter [Technical data](#) for the cable specification and possible safety relay types.

- The wiring to each STO input must be routed separately.
- Wiring the STO inputs in accordance with the following diagrams provides Safety Integrity Level 3 (SIL3). It is not permissible to control both STO inputs from one safety circuit, as this does not provide SIL3 protection.
- The Safe Torque Off (STO) function provides a stop function equivalent to 'stop category 0' according to EN 60204-1.
- The STO element is classified as type A, according to EN 61508-2.

### ■ Connected components

Ensure that all components controlling the STO inputs, including cabling, do not cause the STO inputs to become constantly powered (a 'dangerous failure') or constantly unpowered (a 'safe failure').

Diagnostic pulses produced by Safe Digital Output devices are not recognised by the MotiFlex e180, and will not activate the STO function provided they have a period of less than 1 ms.

### ■ Short circuit testing

Short circuit conditions on the STO inputs must be tested within the proof test interval.

### ■ Power supply

It is recommended to use the 24 V DC supply provided on pin 1 of connector X2. This supply is derived from the bus voltage (if present) or from the 24 V logic supply on connector X9.

If an external 24 V DC power supply is connected to X2 it must fulfil the following criteria:

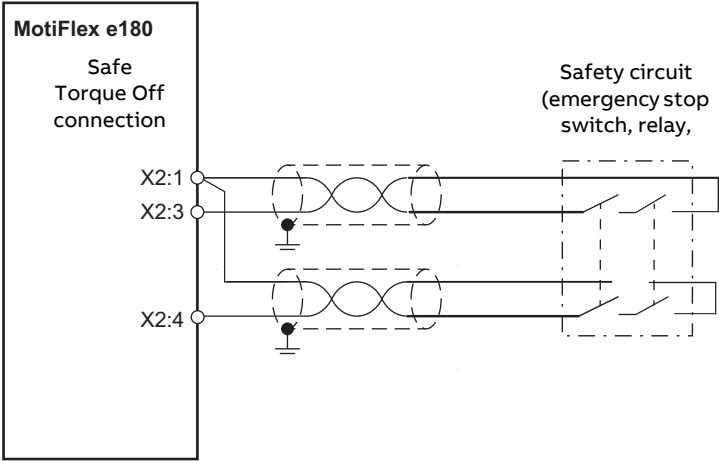
- It must be a Safety Extra Low Voltage (SELV) supply.
- It must be suitable for the desired safe application and safety integrity level.
- It must be protected against over voltages.
- It must limit the output voltage under all fault conditions <60V.
- It must be TÜV certified to EN 60950.

### ■ Drive enable input

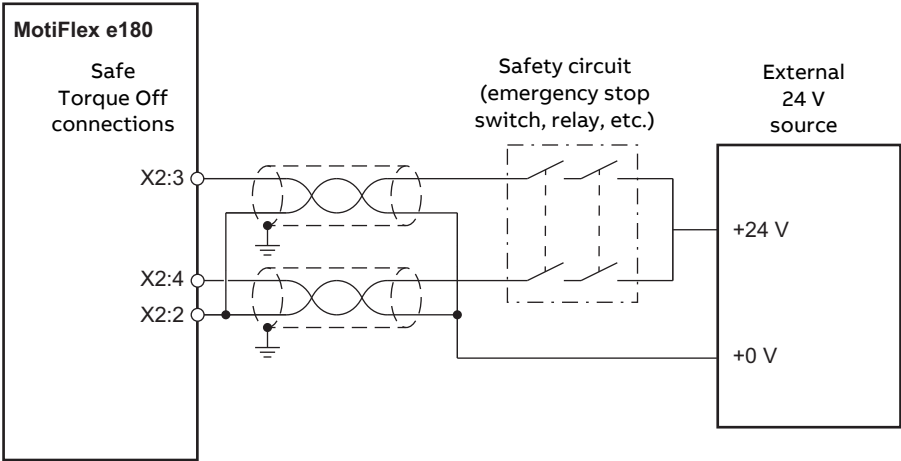
If an additional hardware 'drive enable' input is used to control the drive, it must not be wired as part of the STO input circuit.

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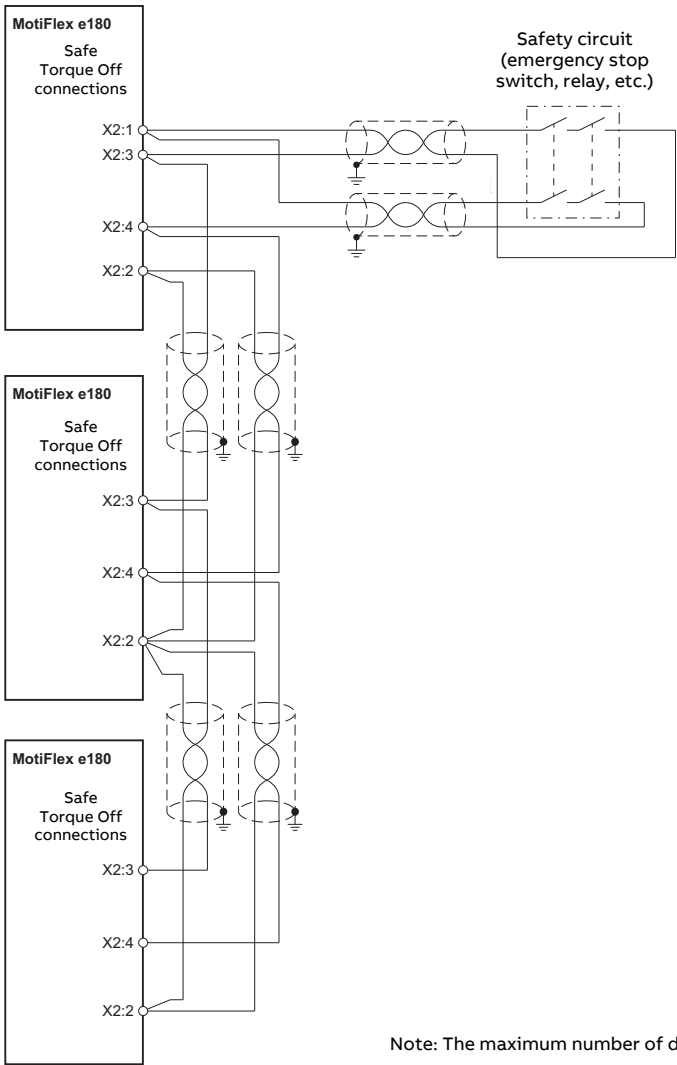
■ Single drive module: internal power supply



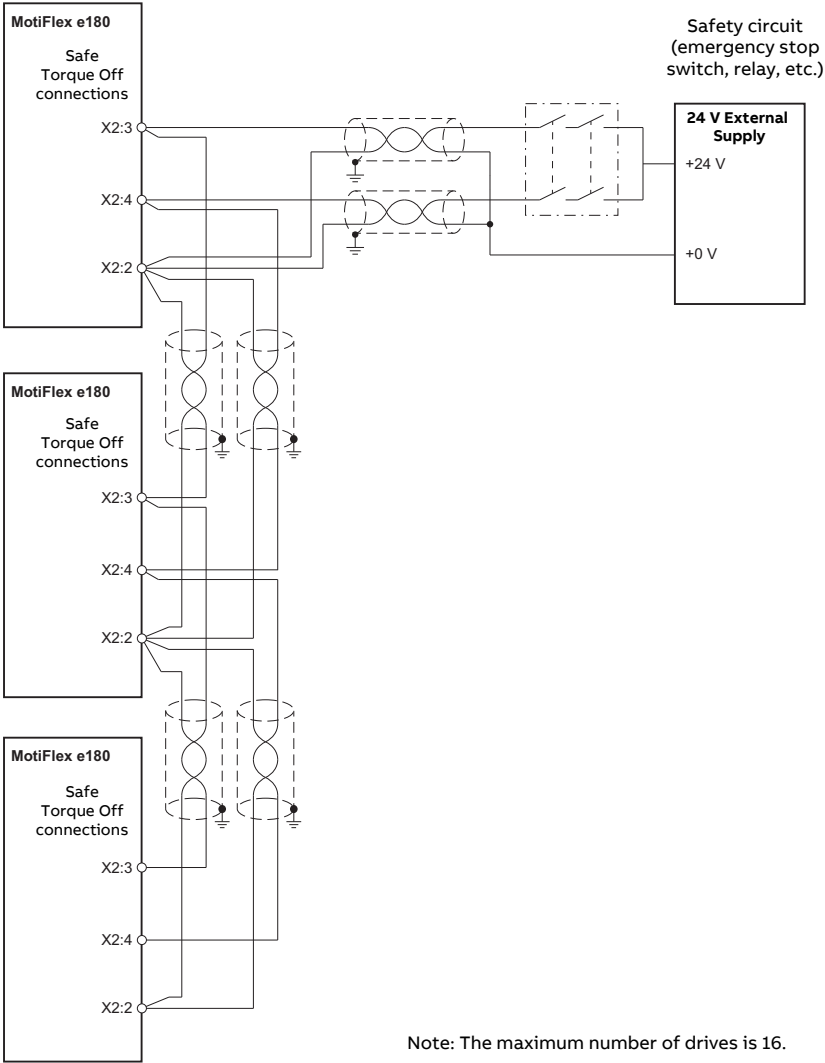
■ Single drive module: external power supply



■ Multiple drive modules: internal power supply



■ Multiple drive modules: external power supply



## Operation of the STO function and diagnostics

### ■ Hardware activation of the STO function

The drive contains two STO inputs. If both STO inputs are powered, the STO function is in the standby state and the drive operates normally.

If power is removed from one or both of the STO inputs, the STO function is activated. The drive motor output power stage is disabled. Enabling is possible only after both STO inputs have been powered, and the fault has been cleared.

### ■ Firmware monitoring of the STO function

#### STO function activation

The firmware detects when the STO function is activated and generates the 'STO active' error (10033). The drive can be enabled only after the fault has been cleared.

#### STO input states

The state of the STO inputs are monitored by the firmware. The state of the STO inputs are stored in a hardware register within the drive. The register is monitored by the drive over a period specified by the `STOINPUTMISMATCHTIME` Mint keyword. If the inputs are in different states after the specified period has elapsed, the 'STO input mismatch' error (10035) is generated.

---

■ Software monitoring of the STO function

The drive can be programmed using the Mint language. The software application *Mint WorkBench* is available for configuring, programming and monitoring the status of the drive. The `SAFETORQUEOFF` Mint keyword can be used to report the status of the STO hardware registers. `SAFETORQUEOFF` contains an array of values indicating the states of the STO1 and STO2 inputs, two internal hardware fault circuits, and one internal STO status output. This array is described in the following table:

Parameter	Meaning
<code>SAFETORQUEOFF (0)</code>	The combined state of the two STO inputs: STO1 = bit 0, STO2 = bit 1
<code>SAFETORQUEOFF (1)</code>	The state of STO1 input: 0 = not powered, 1 = powered
<code>SAFETORQUEOFF (2)</code>	The state of STO2 input: 0 = not powered, 1 = powered
<code>SAFETORQUEOFF (3)</code>	Not used.
<code>SAFETORQUEOFF (4)</code>	Not used.
<code>SAFETORQUEOFF (5)</code>	Not used.
<code>SAFETORQUEOFF (6)</code>	The state of the internal STO status output: 0 = fault, 1 = no fault
<code>SAFETORQUEOFF (7)</code>	The latch state of the internal STO status output: 0 = fault, latched, 1 = no fault, not latched The latched value (0) can not be cleared until the drive is enabled.

See the table in [STO status indications](#) on page 237 for a complete listing of `SAFETORQUEOFF` values.

See [Error messages generated by the drive](#) on page 242, which describes the error codes displayed by the drive.



## STO status indications

The following table lists the state of the STO function with reference to:

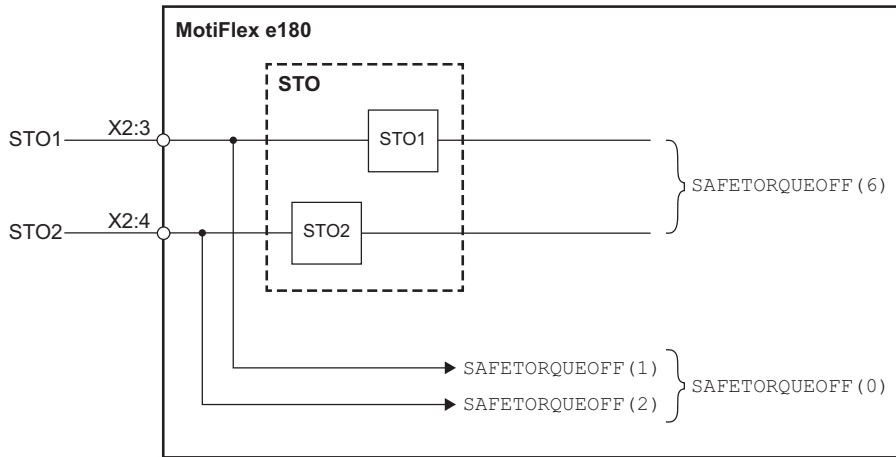
- values of the SAFETORQUEOFF Mint keyword (see page 236).
- status of the STO inputs STO1 and STO2.

SAFETORQUEOFF (1) and SAFETORQUEOFF (2) return 1 when the respective STO input is powered (STO in standby, motor output enabled).

SAFETORQUEOFF (6) returns 1 when both inputs are powered.

	No FAULTs	FAULT <sub>STO1</sub> present	FAULT <sub>STO2</sub> present	FAULT <sub>STO1</sub> FAULT <sub>STO2</sub> both present
<b>STO1 &amp; STO2 powered</b>	<b>STO in standby. Motor output enabled.</b> SAFETORQUEOFF (0) = 3 SAFETORQUEOFF (1) = 1 SAFETORQUEOFF (2) = 1 SAFETORQUEOFF (6) = 1	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 3 SAFETORQUEOFF (1) = 1 SAFETORQUEOFF (2) = 1 SAFETORQUEOFF (6) = 0	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 3 SAFETORQUEOFF (1) = 1 SAFETORQUEOFF (2) = 1 SAFETORQUEOFF (6) = 0	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 3 SAFETORQUEOFF (1) = 1 SAFETORQUEOFF (2) = 1 SAFETORQUEOFF (6) = 0
<b>STO1 not powered</b>	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 2 SAFETORQUEOFF (1) = 0 SAFETORQUEOFF (2) = 1 SAFETORQUEOFF (6) = 0	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 2 SAFETORQUEOFF (1) = 0 SAFETORQUEOFF (2) = 1 SAFETORQUEOFF (6) = 0	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 2 SAFETORQUEOFF (1) = 0 SAFETORQUEOFF (2) = 1 SAFETORQUEOFF (6) = 0	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 2 SAFETORQUEOFF (1) = 0 SAFETORQUEOFF (2) = 1 SAFETORQUEOFF (6) = 0
<b>STO2 not powered</b>	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 1 SAFETORQUEOFF (1) = 1 SAFETORQUEOFF (2) = 0 SAFETORQUEOFF (6) = 0	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 1 SAFETORQUEOFF (1) = 1 SAFETORQUEOFF (2) = 0 SAFETORQUEOFF (6) = 0	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 1 SAFETORQUEOFF (1) = 1 SAFETORQUEOFF (2) = 0 SAFETORQUEOFF (6) = 0	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 1 SAFETORQUEOFF (1) = 1 SAFETORQUEOFF (2) = 0 SAFETORQUEOFF (6) = 0
<b>STO1 STO2 both not powered</b>	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 0 SAFETORQUEOFF (1) = 0 SAFETORQUEOFF (2) = 0 SAFETORQUEOFF (6) = 0	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 0 SAFETORQUEOFF (1) = 0 SAFETORQUEOFF (2) = 0 SAFETORQUEOFF (6) = 0	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 0 SAFETORQUEOFF (1) = 0 SAFETORQUEOFF (2) = 0 SAFETORQUEOFF (6) = 0	<b>STO activated. Motor output disabled.</b> SAFETORQUEOFF (0) = 0 SAFETORQUEOFF (1) = 0 SAFETORQUEOFF (2) = 0 SAFETORQUEOFF (6) = 0

## ■ STO software functional diagram:



## Monitoring the delay between the STO inputs

The STO function monitors the switching time difference between the STO inputs. See [Operation of the STO function and diagnostics](#) on page 235.

## STO function activation and indication delays

Hardware activation delay (the delay between removing power from an STO input and switching off the drive output bridge): < 50 ms.

Hardware indication delay (the delay between switching off the drive output bridge and being indicated to the Mint program): < 50 ms.

Software STO indication delay, Mint program (the delay between a mismatch occurring on the STO inputs and being indicated to the Mint program): < 200 ms user defined period, set by `STOINPUTMISMATCHTIME`.

## Validating the operation of a safety function

EN 61508, EN 62061 and EN ISO 13849-1 require that the final assembler of the machine validates the operation of the safety function with an acceptance test at the installation site. The acceptance tests for the standard safety functions of the drive are described in the drive manual.

The acceptance test must be performed:

- by an authorized person
- at initial start-up of the safety function
- after any changes related to the safety function (wiring, components, settings, etc.)
- after any maintenance work related to the safety function.
- at the proof test interval,  $T_1$ .

### ■ Authorized person

Commissioning of the drive and the acceptance test of the safety function must be carried out by an authorized person with expertise and knowledge of the safety function. The test must be documented and signed by the authorized 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 recorded in the logbook.

### ■ Preliminary checks

Before powering the drive, check:

- Grounding has been properly connected.
  - Energy sources have been properly connected and are operational.
  - Transportation stops and packing materials have been removed.
  - No physical damage is present.
  - All instruments have been properly calibrated.
  - All field devices are operational.
  - Interfaces are operational.
  - Interfaces to other systems and peripherals are operational.
-

Start-up, acceptance, and proof test interval checklist

	Action
<input type="checkbox"/>	Ensure that the drive can be run and stopped freely during the commissioning.
<input type="checkbox"/>	Stop the drive (if running), switch the input power off and isolate the drive from the power line by a disconnecter.
<input type="checkbox"/>	Check the STO circuit connections against the circuit diagram.
<input type="checkbox"/>	Check that the shield of the STO input cable is grounded to the drive frame.
<input type="checkbox"/>	Close the disconnecter and switch the power on.
<input type="checkbox"/>	Test the operation of the STO function when the motor is stopped: <ul style="list-style-type: none"><li>• Disable the drive and ensure the motor shaft is not rotating.</li><li>• Activate the STO function (remove power from the STO inputs) and attempt to enable the drive.</li><li>• Ensure that the drive can not be enabled (see section <i>Operation of the STO function and diagnostics</i> on page 235.)</li><li>• Deactivate the STO function (apply power to the STO inputs).</li></ul>
<input type="checkbox"/>	Test the operation of the STO function when the motor is running: <ul style="list-style-type: none"><li>• Enable the drive and start motion. Ensure the motor is rotating.</li><li>• Activate the STO function (remove power from the STO inputs).</li><li>• Ensure that the drive disables and the motor stops rotating.</li><li>• Attempt to enable the drive.</li><li>• Ensure that the drive can not be enabled (see section <i>Operation of the STO function and diagnostics</i> on page 235.)</li><li>• Deactivate the STO circuit (apply power to the STO inputs).</li></ul>
<input type="checkbox"/>	Document and sign the acceptance test report which verifies that the safety function is safe and accepted to operation.

## Restarting the drive

Restarting the drive is not part of the STO test or certification processes, but is included here for convenience.

Action
<p>Deactivate the STO circuit (apply power to the STO inputs).</p> <p>If the drive holds a Mint program, or is connected to an Ethernet master device that can enable the drive, it is possible for the drive to restart and begin to control the motor without further intervention. If the drive does not hold a Mint program, some of the following actions are necessary, depending on the installation:</p> <ul style="list-style-type: none"> <li>• Activate the additional drive enable input (if present).</li> <li>• In Mint WorkBench (if connected), click the Clear errors button on the System toolbar, followed by the Drive Enable button on the Motion toolbar.</li> <li>• Enable the drive from the Ethernet master device (if connected).</li> </ul>

## Maintenance / servicing

Include the STO operation tests described in [Start-up, acceptance, and proof test interval checklist](#) on page 240 in the routine maintenance program of the machinery to which the drive is connected.

The STO function must be tested by authorized service personnel as frequently as required by the proof test interval  $T_1$ ; see [Start-up, acceptance, and proof test interval checklist](#) on page 240. See also [Data related to safety standards](#) on page 246.

The STO input terminals do not need any maintenance. Maintain the drive according to the instructions given in this manual.

The exchange of safety related systems or subsystems must be performed only in a powerless condition.

The drive may only be opened by ABB authorized personnel.

### Error messages generated by the drive

When an error occurs, the drive displays the error code on its front panel 7 segment display. The symbol E is displayed, followed by the digits of the error code in sequence.

For example, error code 10033 is displayed as E....1..0..3..3.

Additionally, the right decimal point is illuminated for any STO error.

The STO errors are listed in the following table:

**Note:** The STO function is activated when one or both of the safety circuit contacts open. If the period between both contacts opening or closing exceeds a predefined value (defined by the `STOINPUTMISMATCHTIME` Mint keyword) a fault in the safety circuit or wiring is assumed and an error is reported. The maximum allowed cable length between the drive and the activation switch is 30 m (98 ft).



Error	Cause	What to do
<b>10033</b> ecSTO_ACTIVE	<p>Either one or both of the STO inputs is not powered.</p> <p>This error is detected when the drive is enabled, or when attempting to enable the drive in software.</p> <ul style="list-style-type: none"> <li>- safe switch or relay has dropped an output that controls the STO input.</li> <li>- emergency stop switch has been operated.</li> <li>- faulty safety relay</li> </ul>	<p>Use a test meter to check that the device controlling the STO input is providing the required output.</p> <p>Check the operation of the emergency stop switch. Check that the contacts close correctly when the switch is reset.</p> <p>Check the operation of the safety relay.</p>
<b>10035</b> ecSTO_INPUT_MISMATCH	<p>The drive has detected a mismatch in its internal STO registers.</p> <p>This error can occur while the drive is enabled or disabled.</p> <ul style="list-style-type: none"> <li>- emergency stop switch fault</li> <li>- wiring fault</li> </ul>	<p>Check the operation of the emergency stop switch. Check that the contacts close correctly when the switch is reset.</p> <p>Check that the period defined by <code>STOINPUTMISMATCHTIME</code> is long enough to allow both STO inputs to settle.</p> <p>Check the operation of the emergency stop switch. Check that the contacts close correctly when the switch is reset.</p> <p>Check all wiring for the STO inputs.</p>

## Decommissioning

Before decommissioning any safety system from active service:

- Evaluate the impact of decommissioning on adjacent operating units and facilities or other field services.
- Conduct a proper review and obtain required authorization.
- Ensure that the safety functions remain appropriate during decommissioning activities.

Implement appropriate change management procedures for all decommissioning activities.

Technical data

■ STO safety relay type

General requirements	EN 61508 and/or EN 61511 and/or EN ISO 13849-1
Output requirements	
No. of current paths	2 independent paths (one for each STO path)
Switching voltage capability	30 V DC per contact
Switching current capability	10 mA per contact per drive
Maximum switching delay between contacts	<200 ms
Internal supply/multiple units	
Maximum length of safety circuit from operating contact to most distant drive	30 m (98.4 ft)
Maximum number of drives in circuit	16
External supply/multiple units	
External power supply	24 V DC $\pm$ 10% SELV
Current requirement	20 mA per connected drive
Example 1	Simple SIL3 approved safety relay
Type and manufacturer	PSR-SCP- 24UC/ESP4/2X1/1X2 by Phoenix Contacts
Approvals	EN 954-1, cat 4; EN 61508, SIL3
Example 2	Programmable safety logic
Type and manufacturer	PNOZ Multi M1p by Pilz
Approvals	EN 954-1, cat 4; EN 61508, SIL3; and EN ISO 13849-1, PL e



## ■ STO cable

Type	2×2×0.75 m <sup>2</sup> low voltage, single shielded, twisted pair cable
Maximum length	30 m between STO inputs and the operating contact
Example cable	Li YCY TP 2×2×0.75 mm <sup>2</sup> shielded twisted pair cable by HELUKABEL or CEAM

## ■ Ambient conditions

Description	Unit	All models	
Operating temperature range		°C	°F
Minimum	V DC	+0	+32
Maximum		+55*	+131*
Derate		Subject to derating; see <a href="#">Derating</a> on page 169.	Subject to derating; see <a href="#">Derating</a> on page 169.
Storage temperature range		-40 to +85	-40 to +185
Humidity (maximum, non-condensing)	%	95	
Maximum installation altitude (above m.s.l.)			
non-STO parts:	m	1000. Above 1000 m derate 1.1% / 100 m	
	ft	3280. Above 3280 ft derate 1.1% / 330 ft	
STO function:	m	2000	
	ft	6561	
Shock		10 G	
Vibration		1 G, 10-150 Hz	

\* Subject to derating. See [Derating](#) on page 169.

Data related to safety standards

■ Safety data

Frame	SIL / SILCL	PL	SFF [%]	PFH <sub>D</sub> [1/h]	PFD <sub>G</sub> [1/h]	MTTF <sub>d</sub> [a]	DC [%]	SC	Cat.	HFT	CCF	Lifetime [a]
A	3	e	98.48 %	2.01E-09	1.35E-05	13873	≥90	3	3	1	80	20
B	3	e	98.44 %	2.22E-09	1.42E-05	12896	≥90	3	3	1	80	20
C	3	e	98.07 %	2.25E-09	1.72E-05	8927	≥90	3	3	1	80	20
D	3	e	98.07 %	2.25E-09	1.72E-05	8927	≥90	3	3	1	80	20

Proof test interval (PTI) T<sub>1</sub> = 2 years.  
Mean repair time MRT = 0 h (circuit boards are not intended to be repaired).  
Mean time to restoration MTTR = 48 h (MRT plus time used to locate the failure).

■ Failure rates

Frame	Channel	λ <sub>sd</sub> [FIT]	λ <sub>su</sub> [FIT]	λ <sub>dd</sub> [FIT]	λ <sub>du</sub> [FIT]	SFF [%]
A	Total	203.0	217.8	1.7	6.5	98.5 %
	CHX	9.4	0.3	0.0	1.8	84.5 %
	CH1	193.6	217.5	1.7	4.7	98.9 %
	CH2	192.1	217.6	1.7	4.7	98.9 %
B	Total	205.4	220.0	2.1	6.8	98.4 %
	CHX	10.3	2.3	0.0	2.0	86.5 %
	CH1	195.0	217.5	2.1	4.8	98.9 %
	CH2	194.0	217.7	2.1	4.8	98.9 %
C	Total	203.0	359.2	1.7	11.1	98.1 %
	CHX	9.4	0.3	0.0	1.8	84.5 %
	CH1	193.6	358.8	1.7	9.3	98.3 %
	CH2	192.1	358.9	1.7	9.3	98.3 %
D	Total	203.0	359.2	1.7	11.1	98.1 %
	CHX	9.4	0.3	0.0	1.8	84.5 %
	CH1	193.6	358.8	1.7	9.3	98.3 %
	CH2	192.1	358.9	1.7	9.3	98.3 %

- Tested with:
- Control board build version 3AXD50000017333 rev- (PCB Z-PB0508rev3 / H771i3 and later).
  - Firmware build version MotiFlex e180 Build 5807.4.0 and later.

## Abbreviations

Abbreviation	Reference	Description
CCF	EN ISO 13849-1	Common Cause Failure (%)
DC	EN ISO 13849-1	Diagnostic Coverage
FIT	EN 61508	Failure In Time: $1 \times 10^{-9}$ hours
HFT	EN 61508	Hardware Fault Tolerance
IGBT		Insulated-gate bipolar transistor: The electrical components that drive the motor power outputs.
MTTF <sub>D</sub>	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.
PFD	EN 61508	Probability of Failure on Demand
PFH	EN 61508	Probability of Dangerous Failures per Hour
PL	EN ISO 13849-1	Performance Level: Corresponds SIL, Levels a-e
PTI	EN 61508	Proof Test Interval
SFF	EN 61508	Safe Failure Fraction (%)
SIL	EN 61508	Safety Integrity Level
STO	EN 61800-5-2 IEC 61800-5-2	Safe Torque Off

## Declaration of Conformity

The EU declaration (3AXD10000371048) and UK declaration (3AXD10001409694) are available on the internet. See [Document library on the Internet](#) on page 249.

## TÜV Certificate

The TÜV Certificate (3AXD10000391362) is available on the internet. See [Document library on the Internet](#) on page 249.



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## 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.

### Product training

For information on ABB product training, navigate to [new.abb.com/service/training](http://new.abb.com/service/training).

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### Document library on the Internet

You can find manuals and other product documents in PDF format on the Internet at [new.abb.com/drives](http://new.abb.com/drives).



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