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ABB SERVO PRODUCTS

MicroFlex e190 servo drive
User's manual

ABB

List of related manuals

Drive hardware manuals and guides	Code (English)
MicroFlex e190 Quick Installation Guide	3AXD50000037325
MicroFlex e190 Wall chart	3AXD50000037323

Certificates	
MicroFlex e190 EU Single Declaration of Conformity	3AXD10001229164
MicroFlex e190 UK Single Declaration of Conformity	3AXD10001398251
MicroFlex e190 STO (TÜV) Certificate	3AXD10001229165
MicroFlex e190 UL Certificate	3AXD10001251067

Option manuals and guides	
OPT-MF-200 Encoder Breakout Quick Installation Guide	3AXD10000692233
OPT-MF-201 Resolver Adapter Quick Installation Guide	3AXD10000688314
OPT-SIO-1 Option Card User's Manual	3AXD50000351336
OPT-SIO-1 Option Card Quick Installation Guide	3AXD50000296361

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

MicroFlex e190

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1

Safety

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. **Avertissement électrique** met en garde contre les dangers d'électricité qui peuvent causer des blessures corporelles et / ou des dommages à l'équipement.
⚠	**General warning** warns about conditions, other than those caused by electricity, which can result in physical injury and/or damage to the equipment. **Avertissement général** met en garde contre des conditions autres que celles causées par l'électricité qui peuvent entraîner des blessures physiques et / ou des dommages à l'équipement.

	Electrostatic sensitive devices warning warns of electrostatic discharge which can damage the equipment. **Avertissement des appareils sensibles électrostatiques** met en garde contre les décharges électrostatiques qui peuvent endommager l'équipement.
	Hot surface warning warns of component surfaces that may become hot enough to cause burns if touched. **Avertissement de surface chaude** avertit des surfaces des composants qui peuvent devenir suffisamment chaudes pour provoquer des brûlures si elles sont touchées.

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 or DC 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 MΩ) 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 that marked on the type designation label. Higher voltage can activate the brake chopper and lead to brake resistor overload, or activate the over-voltage controller which can lead to the motor rushing to maximum speed.
- If a drive is installed on a corner-grounded TN system, the drive could be damaged.
- All ELV (extra low voltage) circuits connected to the drive must be used within a zone of equipotential bonding, i.e. within a zone where all simultaneously accessible conductive parts are electrically connected to prevent hazardous voltages appearing between them. This is accomplished by proper factory grounding.
- To prevent equipment damage, be certain that input and output signals are powered and referenced correctly.
- To ensure reliable performance of this equipment be certain that all signals to/from the drive are shielded correctly.
- Do not tin (solder) exposed wires. Solder contracts over time and can cause loose connections. Use crimp connections where possible.

- If the drive is subjected to high potential ('hipot') testing, only DC voltages may be applied. AC voltage hipot tests could damage the drive. For further information please contact your local ABB representative.
- The safe integration of the drive into a machine system is the responsibility of the machine designer. Be sure to comply with the local safety requirements at the place where the machine is to be used. In Europe these are the Machinery Directive, the Electromagnetic Compatibility Directive and the Low Voltage Directive. In the United States this is the National Electrical code and local codes.
- To comply with CE directive 2014/13/EU an appropriate AC filter must be installed.
- Motor overtemperature sensing is required to satisfy UL 61800-5-1. The drive has no provisions for motor overtemperature protection, so external provisions are required. The motor thermistor connection must be isolated (see page 62).
- The AC supply, DC supply (if used) and the 24 V DC control circuit supply must be fused.
- The 24 V DC control circuit supply must be installed so that the 24 V DC supplied to the unit is isolated from the AC supply using double or reinforced insulation, or by using basic insulation with a protective earth.
- The input of the control circuit must be limited to Safety Extra Low Voltage circuits.
- For UL installations use 75 °C copper wiring only.
- For UL installations: Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes.
- For use in Canada: Transient surge suppression shall be installed on the line side of this equipment and shall be rated 240V (phase to ground), 240V (phase to phase), suitable for overvoltage category III, and shall provide protection for a rated impulse withstand voltage peak of 2.5kV.

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 that is approximately 1.4 times the AC supply voltage, e.g. 336 V DC when operating on a 240 V AC supply.
- 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 203.

■ 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.

Notes:

- 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^2 Cu or 16 mm^2 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 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, U, V, W, R+/UDC+, UDC-, 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 felt, nip, rope, etc. Check by measuring that there is no voltage present on the drive input or output terminals (L1, L2, L3, U, V, W, R+/UDC+, UDC-, 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 over-speed leads to over-voltage 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. When carrying, do not suspend the unit from the front panel as it could detach and cause the unit to be dropped.
- Beware of hot surfaces. The metal heat sink on the left side of the MicroFlex e190 can become very hot during normal operation. The surfaces of drive system components (such as a mains 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. A brake resistor can generate enough heat to ignite combustible materials. To avoid fire hazard, keep all combustible materials and flammable vapors away from brake resistors.
- 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.
- Drives must be installed inside an electrical cabinet that provides environmental control and protection. Installation information for the drive is provided in this manual. Motors and controlling devices that connect to the drive should have specifications compatible with the drive. If not installed in an electrical cabinet, barriers around the equipment are required.
- Avoid locating the drive immediately above or beside heat generating equipment, directly below water or steam pipes, or in the vicinity of corrosive substances or vapors, metal particles and dust.
- Ensure sufficient cooling.
- Do not attach the drive by riveting or welding.
- The MicroFlex e190 must be installed where the pollution degree according to UL and EN 61800-5-1 shall not exceed 2.

◼ **Printed circuit boards**

⚠️ **WARNING!** Ignoring the following instructions can cause damage to the printed circuit boards and/or void the warranty:

- 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.

- After changing or maintaining the fan, make sure that the bottom cover is correctly attached before connecting voltage to the drive. Keep the bottom cover attached 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 fieldbus or the I/O of the drive. The maximum allowed number of charging cycles of the DC capacitors (i.e. power-ups by applying power) is one per two minutes.
- 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 MicroFlex e190 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. 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.
- MEDICAL DEVICE / PACEMAKER DANGER: Magnetic and electromagnetic fields in the vicinity of current carrying conductors and industrial motors can result in a serious health hazard to persons with cardiac pacemakers, internal cardiac defibrillators, neurostimulators, metal implants, cochlear implants, hearing aids, and other medical devices. To avoid risk, stay away from the area surrounding a motor and its current carrying conductors.

■ 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.

Applicability

This manual is applicable to MicroFlex e190 drives with the type code MFE190-04UD-XXXX[1]. To check the type code of the drive, see *Type designation label* on page 33.

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.

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1. Supported firmware build version: Build 5903.4 onwards.

Contents of this manual

The manual consists of the following chapters:

Related documents

See *List of related manuals* on page 2 (inside the front cover).

Quick installation and start-up flowchart

Task	See
Plan the electrical installation and acquire the accessories needed (cables, fuses, etc.). **Check the ratings, required cooling air flow, input power connection, compatibility of the motor, motor connection, and other technical data.**	*Planning the electrical installation* (page 43) *Cooling and degrees of protection* (page 38) *Technical data* (page 159)
Check the installation site.	*Cabinet construction* (page 38)
Unpack and check the units (only intact units may be started up). **Check that all necessary optional modules and equipment are present and correct.** **Mount the drive.**	*Contents of the package* (page 36) *Installation procedure* (page 41)
Route the cables.	*Routing the cables* (page 49)
Check the insulation of the supply cable, the motor and the motor cable.	*Checking the insulation of the assembly* (page 54)
Connect the power cable. **Connect the motor cable.** **Connect the control cables.**	*Power cable connection* (page 55) *Electrical installation: input / output* (page 63)
Check the installation.	*Installation checklist* (page 97)
Start the drive.	*Start-up* (page 99)

Terms and abbreviations

The following units and abbreviations might appear in this manual.

■ General terms

Term /Abbreviation	Explanation
EMC	Electromagnetic Compatibility.
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.
MU-xx	The memory unit attached to the control unit of the drive.
RFI	Radio-frequency interference.
RGJxxx	Series of optional braking resistors for the MicroFlex e190.

See also page for safety related abbreviations.

■ Trademarks

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3

Operation principle and hardware description

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 MicroFlex e190 is an IP20 drive for controlling AC motors. It is to be installed into a cabinet by the customer. The MicroFlex e190 is available with several output power ratings.

■ **Layout - front**
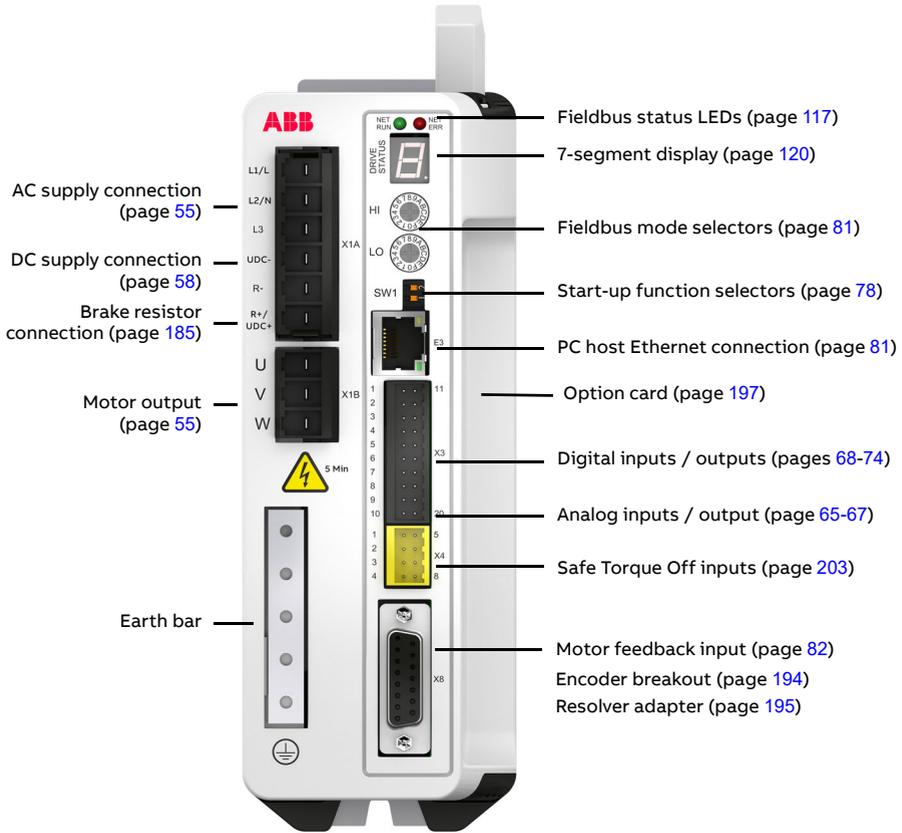
AC supply connection (page 55)

DC supply connection (page 58)

Brake resistor connection (page 185)

Motor output (page 55)

Earth bar

L1/L
L2/N
L3
X1A
UDC-
R-
R+/UDC+

U
V
W
X1B

5 Min

NET RUN   NET ERR

DRIVE STATUS

HI
LO

SW1

E3

X3

X4

X8

Fieldbus status LEDs (page 117)

7-segment display (page 120)

Fieldbus mode selectors (page 81)

Start-up function selectors (page 78)

PC host Ethernet connection (page 81)

Option card (page 197)

Digital inputs / outputs (pages 68-74)

Analog inputs / output (page 65-67)

Safe Torque Off inputs (page 203)

Motor feedback input (page 82)
Encoder breakout (page 194)
Resolver adapter (page 195)

■ **Layout - top**

Memory unit (page 34)

Ethernet fieldbus ports (page 80)

PE connection
(page 57)

■ **Layout - bottom**

Optional 24 V
control circuit
supply input
(page 60)

Incremental encoder feedback
input (page 90)

X8 voltage output selector (page 84)
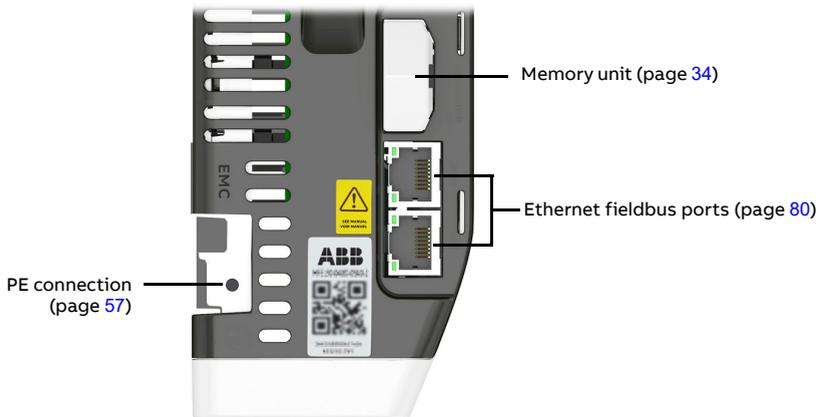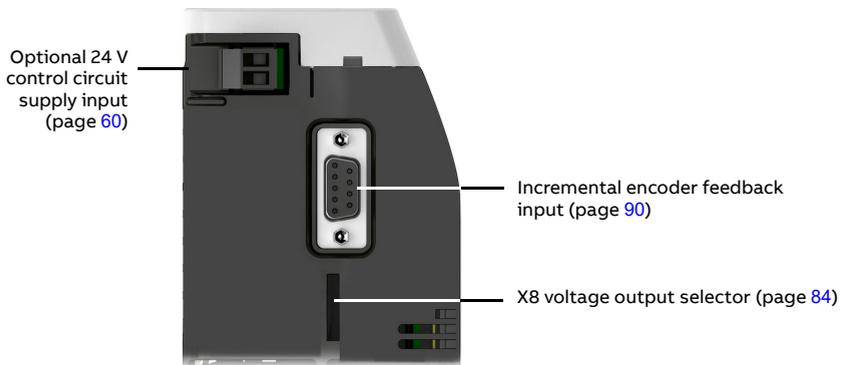
■ Main circuit

The diagram below shows the main circuit of the drive. For further information on the power unit, see the chapter *Electrical installation: AC input / DC input, motor and brake*.
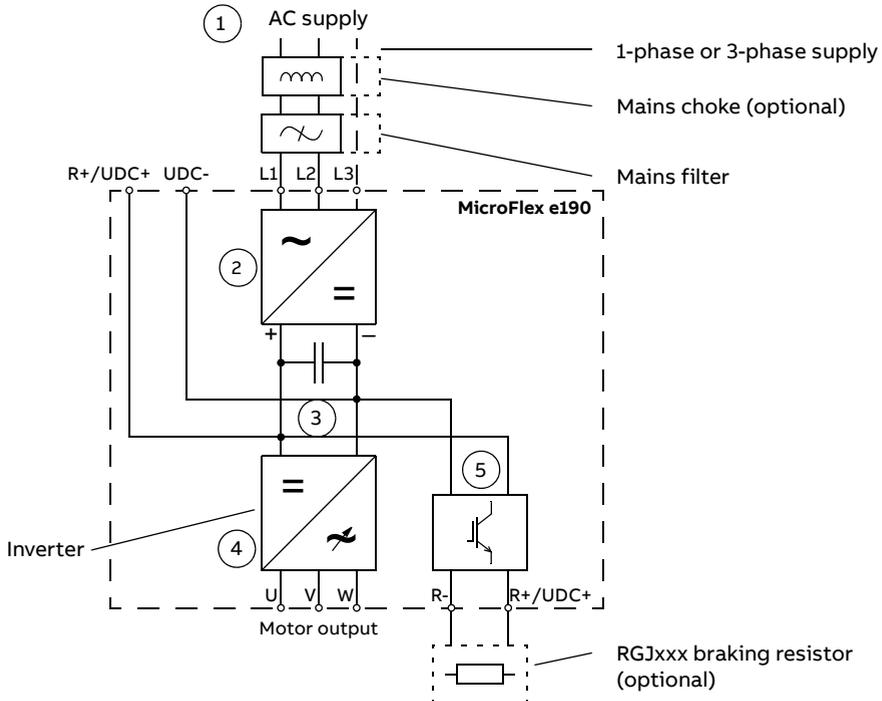
1. AC supply. 1-phase 200…240 V or 3-phase 200…240 V phase-to-phase (±10%).

2. Rectifier. Converts alternating current and voltage to direct current and voltage.

3. DC link. DC circuit between rectifier and inverter.

4. Inverter. Converts direct current and voltage to alternating current and voltage.

5. 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. The user must obtain and install a brake resistor when needed.

Type designation label

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

Type code (see description below)
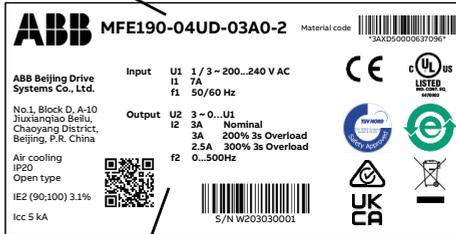
I1 = Input current
I2 = Output current

Serial number

Compliance markings

The first digit of the serial number refers to the manufacturing plant. The 2nd and 3rd digits indicate the year of manufacture, while the 4th and 5th digits indicate the week. The 6th digit indicates the rating. Digits 7 to 10 are a running integer starting every week at 0001.

◼ 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 MicroFlex e190 Ordering Information, available on request.

MFE190-04UD-03A0-2	
MFE190	MicroFlex e190
-04	Drive module
U	Universal encoder
D	Dual port PROFINET
-03A0	Size: 03A0 = 3 A, 06A0 = 6 A, 09A0 = 9 A. See page 160.
-2	Input voltage: 2 = 200...240 V AC ±10%

■ Part number

Type code	Part number (order code)
MFE190-04UD-03A0-2	3AXD50000637096
MFE190-04UD-06A0-2	3AXD50000637102
MFE190-04UD-09A0-2	3AXD50000637416

■ 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.

The memory unit can be inserted into an identical replacement drive. If the replacement drive does not have an identical specification, it must be re-tuned before using the memory unit to the drive. 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 MicroFlex e190 drives. It is not compatible with any other product that uses a similar unit, e.g. ZMU-02. The MicroFlex e190 memory unit can be identified by the part MFE190-MU-OCU+N8020 on the label and provide motion programming capability.

The older drive is not provided with the MFE190-MU-OCU+N8020 (order code: 3AXD50000048603) memory unit. Contact your local supplier for details.

4

Mechanical installation

What this chapter contains

The chapter describes the mechanical installation of the drive.

Contents of the package

The box contains:

- MicroFlex e190 drive
- Connector pack containing terminal blocks for the drive
- Installation pack containing screws and clamps
- Memory unit
- Quick installation guide

Quick installation guide

Connector pack (page 200)

Installation pack (page 201)

MicroFlex e190 drive
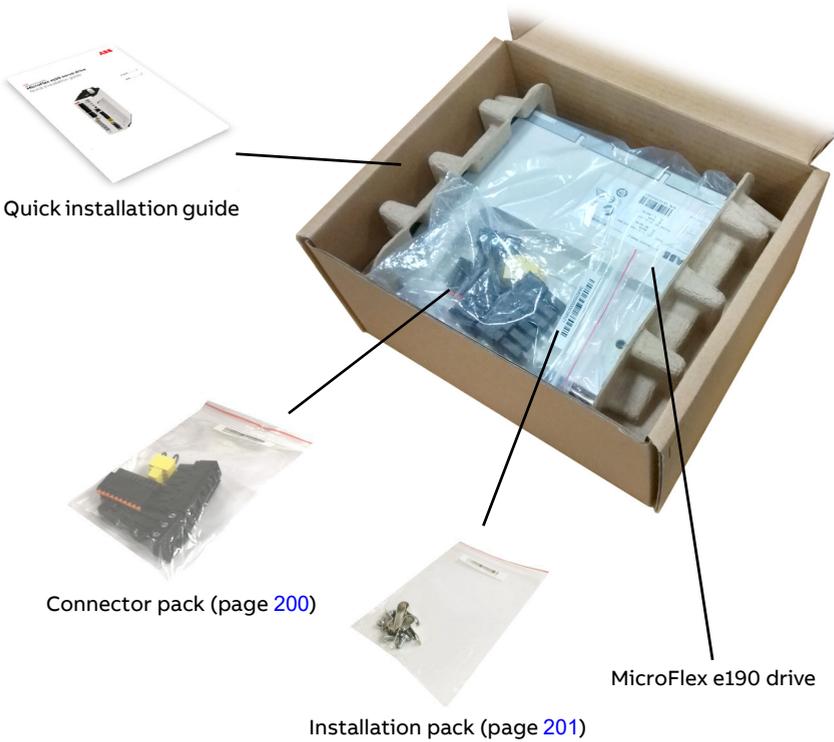
Main dimensions

MicroFlex e190 drives can be installed side by side. The main dimensions of the drive and free space requirements are shown below.
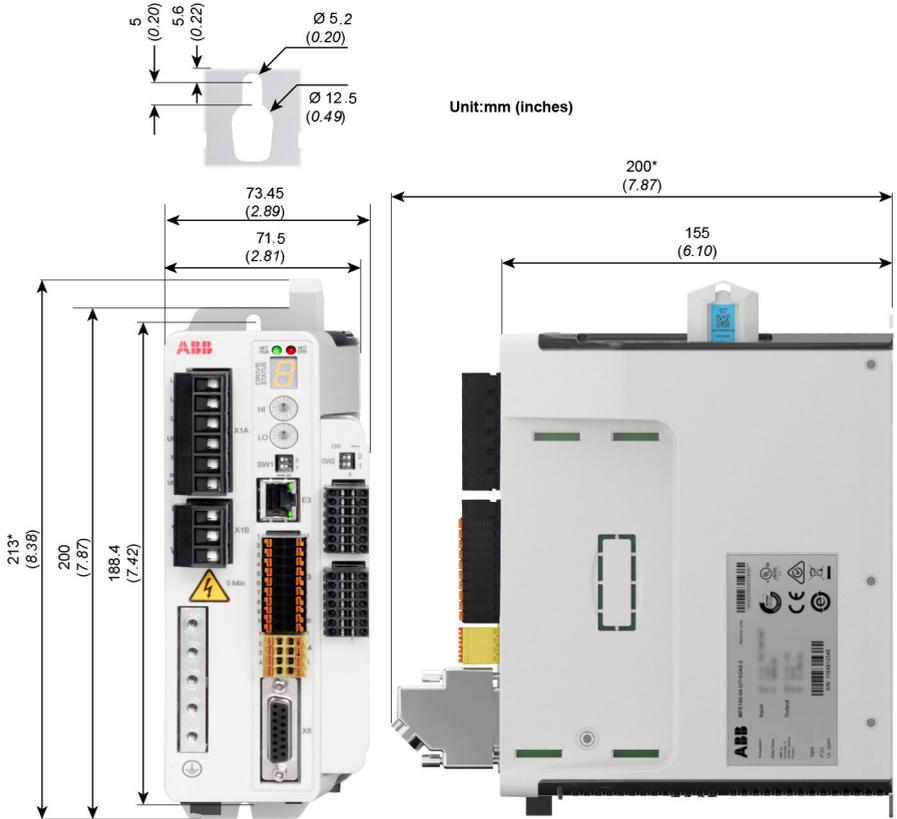
Unit:mm (inches)

* Approximate dimensions. Allow extra space for feedback and other control cables.
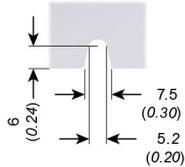
Weights:
3 A: 1.70 kg (3.75 lb)
6 A: 1.75 kg (3.86 lb)
9 A: 1.75 kg (3.86 lb)

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*).

■ **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.

90 mm [3.54"]

90 mm [3.54"]

0 mm [0"]
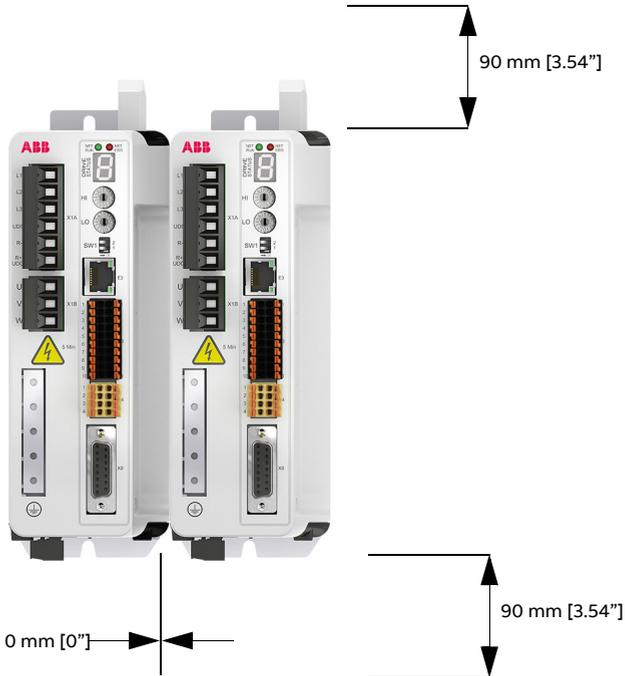
The air inlets and outlets must be equipped with gratings that
- guide the air flow
- protect against contact
- prevent water splashes from entering the cabinet.

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 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.

Air outlet

Air outlet

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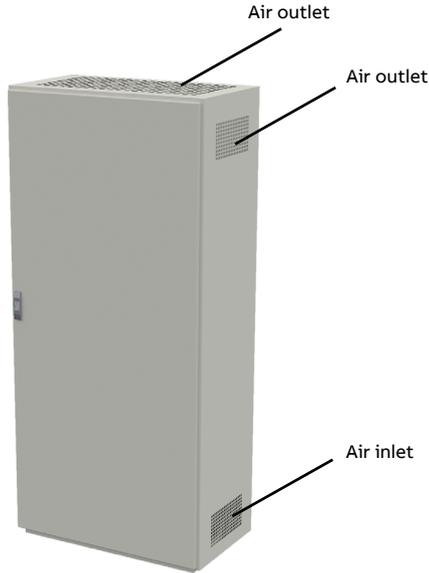
Arrange the cooling of the drives so that the requirements given in chapter *Technical data* are met:

• 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.

■ 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*.

■ Preventing the recirculation of hot air

Air baffle plates

COOL AREA
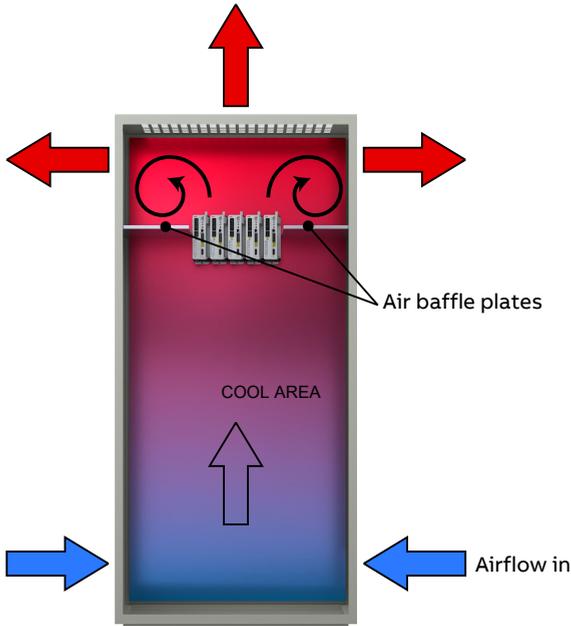
Airflow in

Outside the cabinet

Prevent hot air circulation outside the cabinet by leading the outgoing 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.

■ **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.

■ **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

■ **Requirements for the installation site**

The drive must be installed in an upright position with the mounting plate against a wall. MicroFlex e190 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 170).
• The wall is vertical, not flammable and strong enough to hold the weight of the drive. See *Dimensions and weights* (page 169).
• 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 MicroFlex e190.
• 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.

■ **Direct wall mounting**

1. Mark the locations for the two holes. The mounting points are shown in *Main dimensions* on page 37.

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.

■ **Mains filter installation**

See the chapter *Mains filters* on page 179.

■ **Braking resistor installation**

See the chapter *Resistor braking* on page 185.

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 or DC supply. Alternatively, the drive can be powered from a suitable fixed DC supply.

⚠ **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).

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.

■ 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. Fuse recommendations are given in the chapter *Technical data.* When placed at the distribution board, standard IEC gG fuses or UL type CC 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

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 CC "fast acting" type. Circuit breakers cannot be used with the MicroFlex e190 for UL compliant applications. Fuses must be used.

■ **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 can be configured to include a motor temperature input that protects the motor and switches off the current when necessary. For more information about motor thermal protection see *Thermal switch connection* on page 62, and the Mint keyword MOTORTEMPERATUREINPUT in the Mint Workbench help file.

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.

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

Residual current device (RCD) compatibility

MicroFlex e190 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.

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.
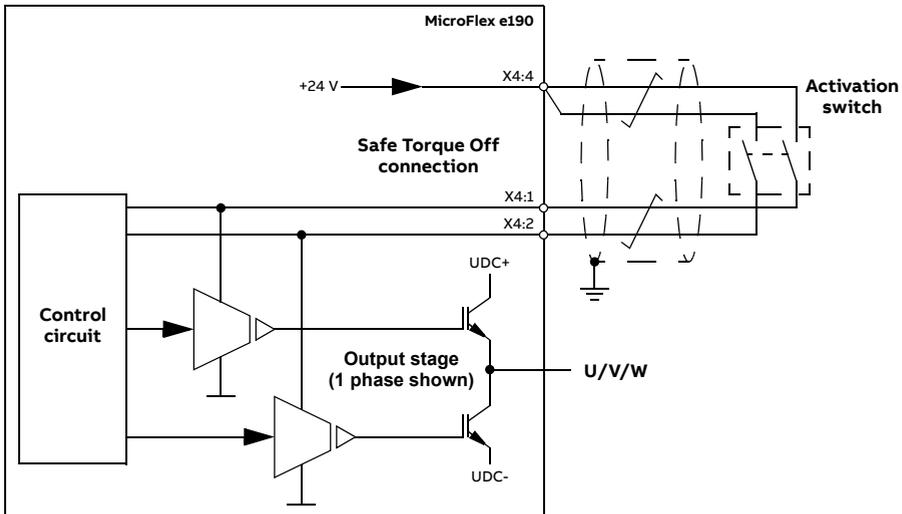
Notes:
- The STO function is activated when one or both of the safety circuit contacts open. If the period between both contacts opening or closing exceeds a predefined value, a fault in the safety circuit or wiring is assumed and an error is reported. See *Appendix: The Safe Torque Off (STO) function* on page *203*.
- 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: The Safe Torque Off (STO) function* on page 203.

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 maximum permissible temperature of conductor in continuous use. For UL installations use 75 °C copper wiring only.
- 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
(also recommended for supply cabling)

Symmetrical shielded cable: three phase conductors and a concentric or otherwise symmetrically constructed PE conductor, and a shield.

Note: A separate PE conductor is required if the conductivity of the cable shield is not sufficient for the purpose.

PE conductor and shield

Shield

Shield

PE

PE

Allowed for supply cabling

A four-conductor system: three phase conductors and a protective conductor.

Shield

PE

PE

■ **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 aluminum shield. The minimum requirement of the motor cable shield of the drive is shown below. It consists of a concentric layer of copper wires with an open helix of copper tape. The better and tighter the shield, the lower the emission level and the bearing currents.

Insulation jacket   Copper wire screen   Helix of copper tape   Inner insulation

Cable core
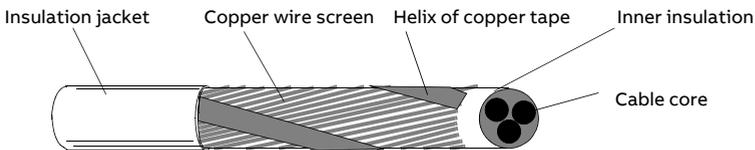
Selecting the control cables

It is recommended that all control cables be shielded.

Double-shielded twisted pair cable is recommended for analog 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 analog signals.

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

a   b
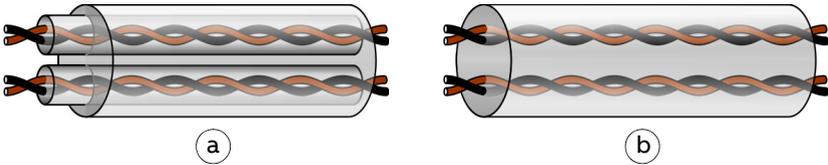
Run analog and digital signals in separate cables.

Never mix 24 VDC and 240 VAC signals in the same cable.

■ **Connection of a motor temperature sensor to the drive**

See page .

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. Aluminum tray systems can be used to improve local equalizing of potential.

A diagram of the cable routing:

Supply cable

min 200 mm (8")

90°

Supply cable

Motor cable

min 300 mm (12")

Drive

Control cables

min 500 mm (20")   Braking resistor cable

90°

Motor cable

90°

min 500 mm (20")
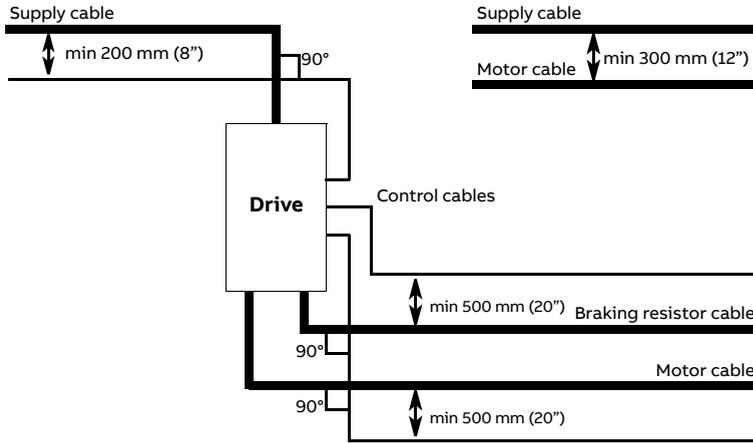
■ **Control cable ducts**

24 V   240 V

24 V   240 V
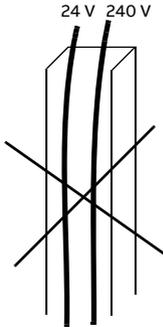
Not allowed unless the 24 V cable is insulated for 240 V or insulated with an insulation sleeving for 240 V.
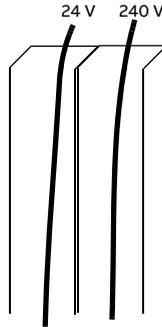
Lead 24 V and 240 V control cables in separate ducts inside the cabinet.

■ **Typical installation example**

CAUTION

DO NOT TOUCH!
Brake resistors can become extremely hot! Locate away from vulnerable components and wiring.

Protective Earth (PE)

Footprint filter OFI-01 saves panel space.
The filter can be inverted if the AC input is above the drive.

Drive earth wire must be at least 10 mm^2 (7 AWG)

Installation cabinet 'star point'

Connect AC power cable shield to metal panel, using conductive shield earth/ground clamps.
On painted panels, remove paint to expose bare metal.
AC power wires should be as short as possible, typically less than 0.3 m (1 ft).
Longer wires must be shielded as shown.
Wire colors may vary according to region.

AC power from fuses or reactor

6

Electrical installation: AC input / DC 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 U, V and W.
- 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 MΩ.
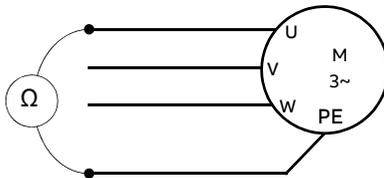
■ Braking resistor assembly

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 MΩ.
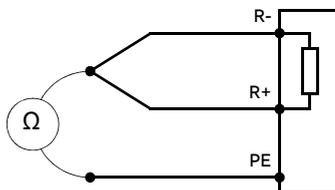
Power cable connection

■ AC power cable connection diagram

For alternatives, see *Planning the electrical installation: Supply disconnecting device* (page 44).

Mains filter (optional). See the chapter *Mains filters* (page 179).

The UDC+/UDC- connectors can be used for common DC configurations (page 58).

Optional braking resistor (see the chapter *Resistor braking* on page 44).
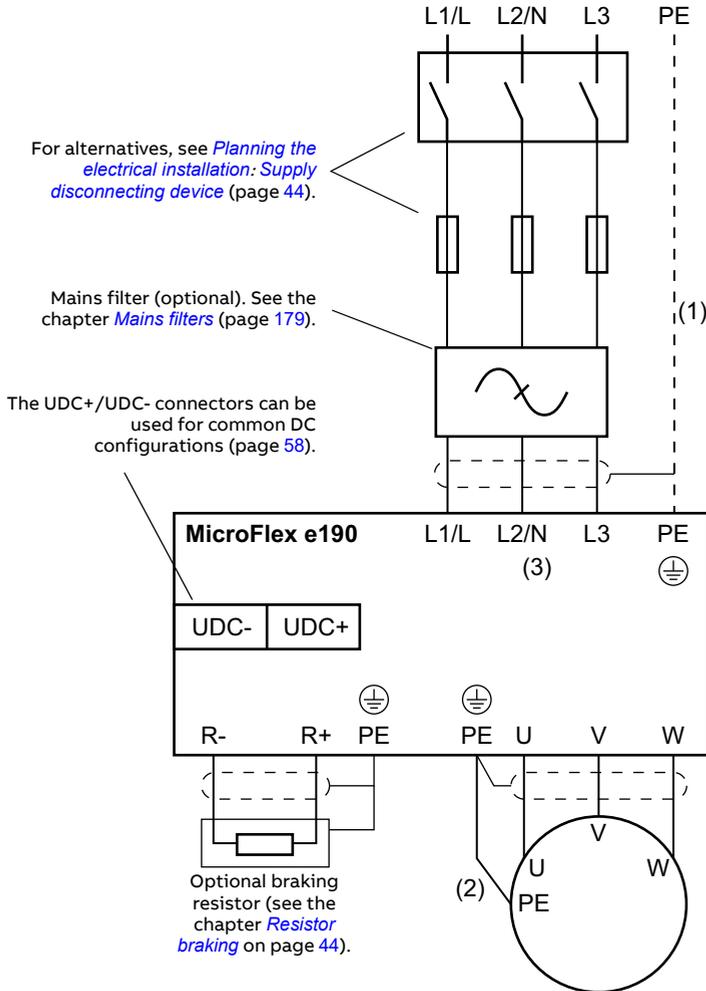
Notes:
- If shielded supply (input) cable is used, and the conductivity of the shield is less than 50% of the conductivity of a phase conductor, use a cable with a ground conductor or a separate PE cable (1).
- For motor cabling, use a separate ground cable (2) if the conductivity of the cable shield 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 47.
- AC supply (3), 1-phase **200...240 V** (±10%) or 3-phase **200...240 V** phase-to-phase (±10%). L1 and L2 are used for single phase supply.

■ Procedure

Cabling drawings with tightening torques are presented on page 57.

1. Strip the power cables so that the shields are bare at the cable clamps.

2. Twist the ends of the cable shield wires into pigtails.

3. Strip the ends of the phase conductors.

4. Connect the phase conductors of the supply cable to the L1 and L2 terminals of the drive (or L1, L2 and L3 for three phase supply).
   Connect the phase conductors of the motor cable to the U, V and W terminals.
   Connect the conductors of the resistor cable (if present) to the R- and R+ terminals.

5. Tighten the cable clamps onto the bare cable shields.

6. 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.

7. Cover visible bare shield and pigtail with insulating tape.

8. Secure the cables outside the unit mechanically.

9. 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.

360 degrees grounding

Conductive gaskets

$b \geq 1/5 \cdot a$

AC power cable connection

Supply cable

Cable clamp on bare shield

Cover bare shield with insulating tape

0.5...0.6 N·m (4.4...5.3 lbf·in)

M4, 10 mm max.
1.0...1.3 N·m (8.9...11.5 lbf·in)

0.5...0.6 N·m (4.4...5.3 lbf·in)

Motor earth wire

M4, 10 mm max.
1.0...1.3 N·m (8.9...11.5 lbf·in)

Cable clamp on bare shield

Motor cable
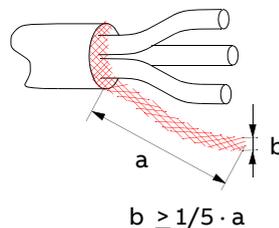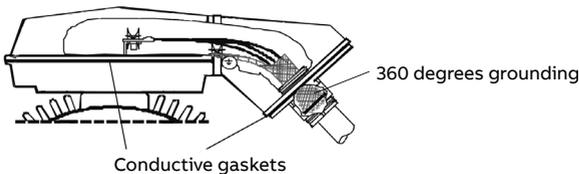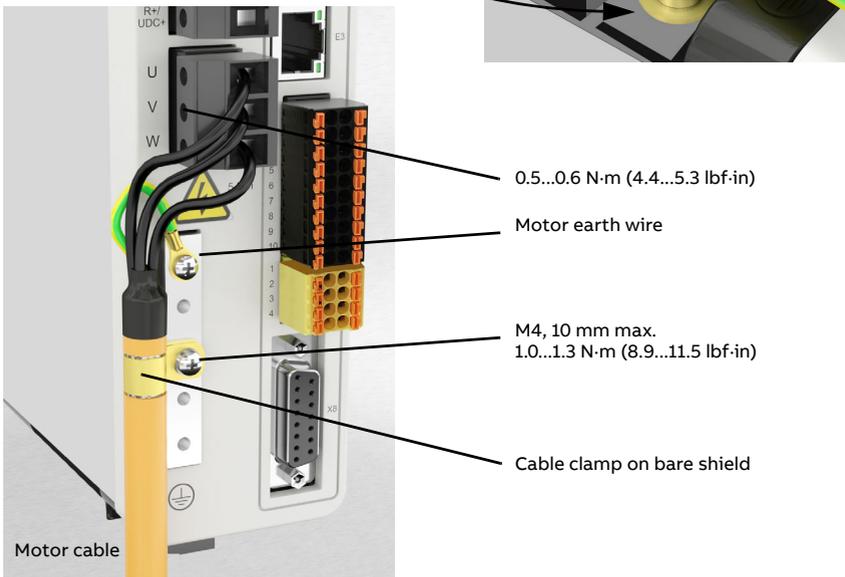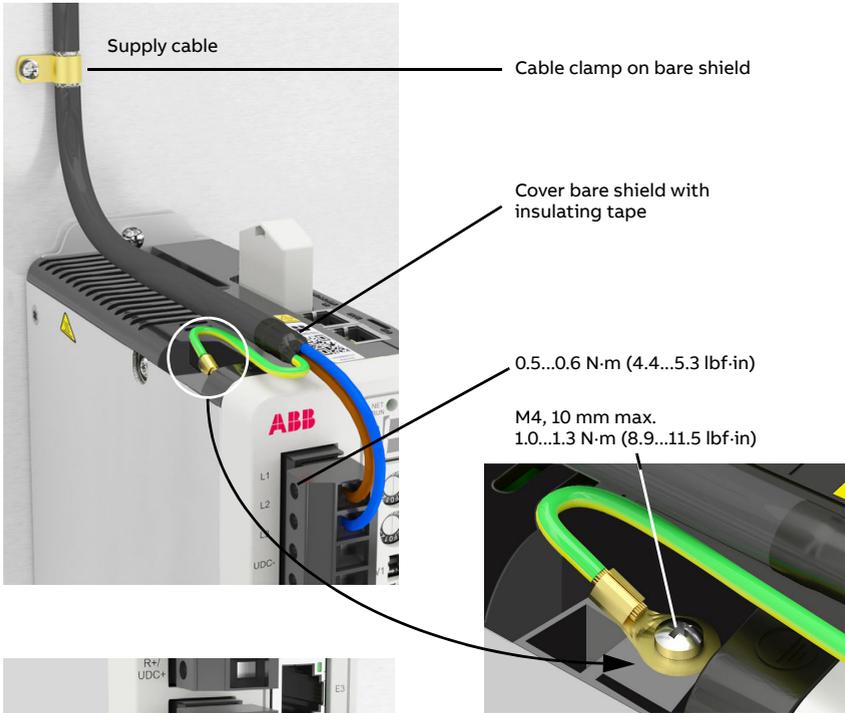
■ DC power cable connection diagram (optional)

The UDC+ and UDC- terminals are intended for common DC configurations of a number of MicroFlex e190 drives.

AC supply (DC sharing)

DC sharing allows regenerative energy from one drive to be utilized by other drives that are in motoring mode. Each drive is connected to the AC supply* and has its own brake resistor. The MicroFlex e190 drives' DC connections are linked as shown in the diagram below.
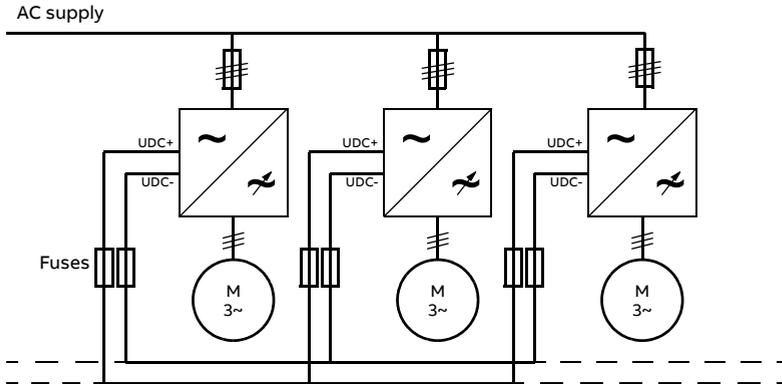
* The MicroFlex e190 DC connection is not designed to provide the primary power source to other drives.

DC supply

MicroFlex e190 can use a DC supply as the primary power source (see page). Each drive is powered from the DC supply and has its own brake resistor. There is no AC supply.
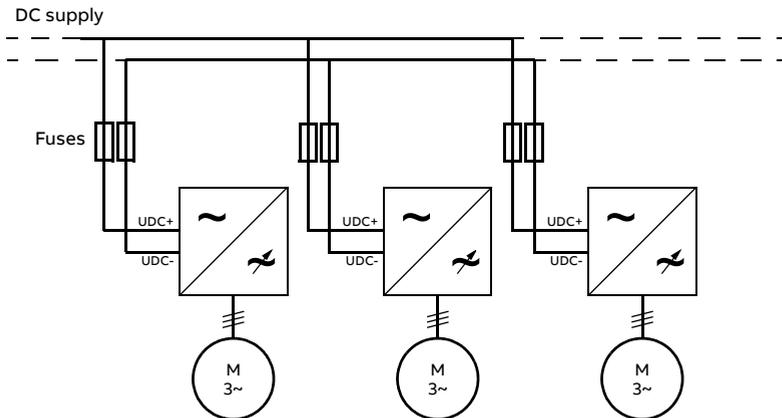
Each drive has an independent DC capacitor pre-charging circuit.

Pre-charging circuit
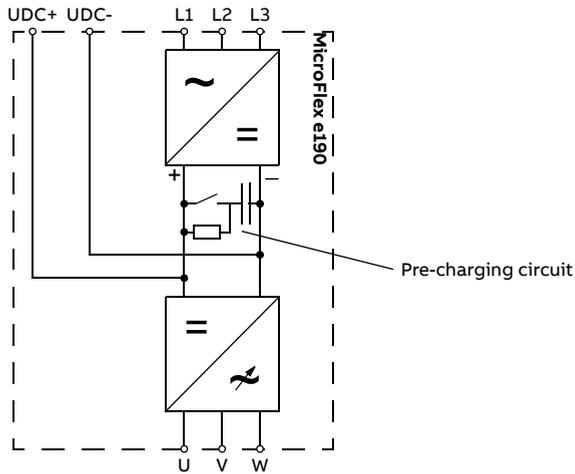
The ratings of the DC connection are given on page 165.

24 V control circuit supply (optional)

A 24 V DC supply can be provided to power the controlling electronics. This is useful for safety reasons where the main AC (or DC) power supply is removed from the power stage, but the controlling electronics must remain powered to retain position, I/O information and communications.

A separate fused 24 V supply should be provided for the MicroFlex e190.
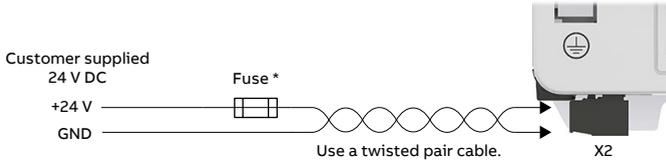
* Recommended fuse: Bussman S504 20 x 5 mm anti-surge 2 A.

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 a digital output on connector X3; see *Connecting the control cables* on page 64. This provides a way for the MicroFlex e190 to control the motor's brake. A typical circuit is shown in the following diagram:
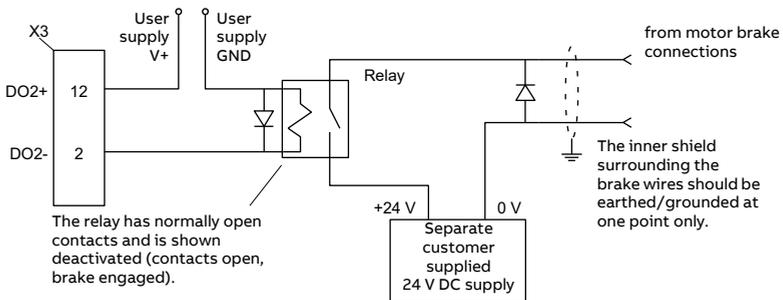
This circuit uses DO2 as a motor brake output. The output is configured using Mint keyword `MOTORBRAKEOUTPUT`; see the Mint help file for details. With this configuration, the following sequences can be used to control the brake. To engage the brake:

- 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 MicroFlex e190 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 (see below).

■ Thermal switch connection

You can use the motor's thermal switch contacts (normally closed), to control a relay connected to a digital input on connector X3. This allows the MicroFlex e190 to respond to motor over-temperature conditions. Using the Mint Workbench Digital I/O tool, the input can be configured to be the motor temperature input. The Mint keyword MOTORTEMPERATUREINPUT can also be used to configure a digital input for this purpose. A typical circuit, using DI2 as the input, is shown in the following diagram:
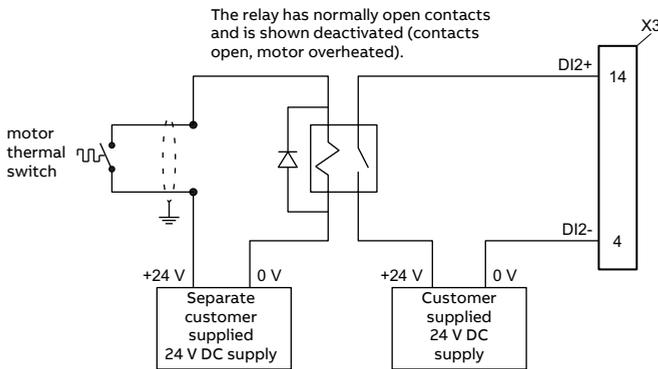
WARNING! The 24 V DC power supply connected to the thermal switch must be a separate supply as shown in the diagram. The thermal switch wires often carry noise that could cause erratic drive operation or damage. The thermal switch contacts must never be wired directly to a digital input. The separate 24 V DC supply used for the thermal switch can also be used for the motor brake circuit.

7

Electrical installation: input / output

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	Analog Input
AO	Analog 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.

Connecting the control cables
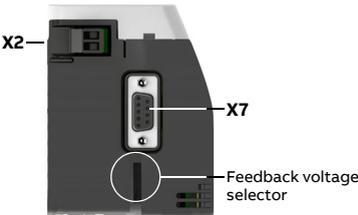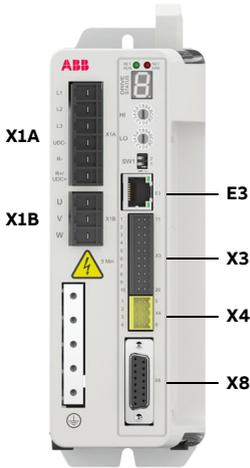
		E1/E2
Ethernet fieldbus	IN	E2
	OUT	E1

		X1A
AC input 200...240 V AC ±10%	L1	1
	L2	2
	L3	3
DC bus-	UDC-	4
Brake-	R-	5
DC bus+ / Brake+	R+/UDC+	6

		X1B
Motor output	U	1
	V	2
	W	3

		E3
Ethernet host (PC)		1

X3			X3
1	Status-/DO0-	Status-/DO0+	11
2	DO2-	DO2+	12
3	DO1-	DO1+	13
4	DI2-	DI2+	14
5	DI3-	DI3+	15
6	DI1-	DI1+	16
7	DI0-	DI0+	17
8	AGND	AO0	18
9	AI0-	AI0+	19
10	Shield	Shield	20

DO0-DO2: Maximum 100 mA per output, R_{load} > 250 Ω.
AI0: Differential and single-ended connections are possible.

X4			X4
1	STO1	STO1	5
2	STO2	STO2	6
3	SGND	SGND	7
4	24 V out	24 V out	8

Safe Torque Off: Both circuits must be closed for the drive to start.

		X2
(Optional) Control circuit supply input: 24 V, 1 A	0 V	1
	+24 V IN	2

Wire sizes and tightening torques:
X1A: Dinkle EC762V-B3253206P-BK
X1B: Dinkle EC762V-B3253203P-BK
0.2...6.0 mm^2 (30*...10 AWG)
* Minimum size for UL installations is 14 AWG.
Torque: 0.7 N·m (6.2 lbf·in)
X2: Phoenix Contact MVSTBR 2,5HC/ 2-ST-5,08
0.2...2.5 mm^2 (24...12 AWG)
Torque: 0.6 N·m (5.3 lbf·in)
X3, X4: Weidmüller B2L 3.50/20/180,
Weidmüller B2L 3.50/8/180
0.2...1.0 mm^2 (28...16 AWG)

Notes:
The wiring shown is for demonstrative purposes only. Complete information for all connectors, including X7 and X8, is provided in this chapter and the chapter *Technical data.*

E2
E1

X1A

X1B

E3

X3

X4

X8

X2

X7

Feedback voltage selector

Analog I/O

The MicroFlex e190 provides:

- One 12-bit resolution ±10 V analog input.
- One 12-bit resolution ±10 V analog output.

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

A additional analog input can be provided by the option card (see page).

■ X3: Analog input AI0

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

The analog input can be connected as either a differential or a single ended input as shown below. The analog 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 analog 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 MicroFlex e190 is connected to Mint Workbench, the analog 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 analog 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:
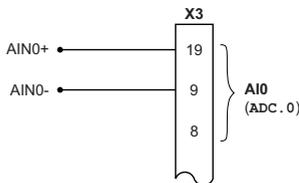
Differential connection
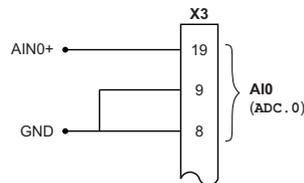
Single ended connection

Typical input circuit to provide 0-10 V (approx.) input from a 24 V source:
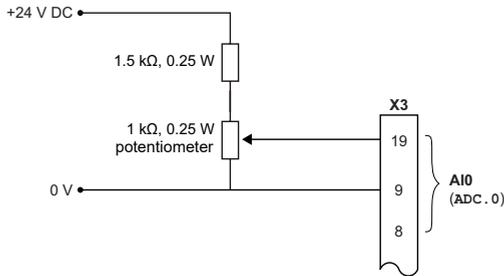
Analog input - typical connections from a PLC/controller:
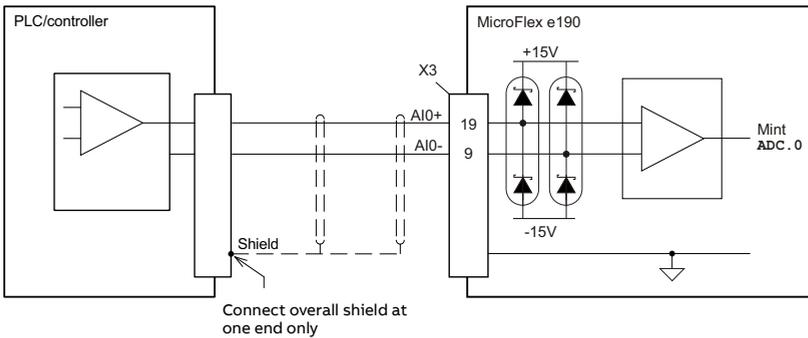
Analog input - typical connections from an ABB AO561:
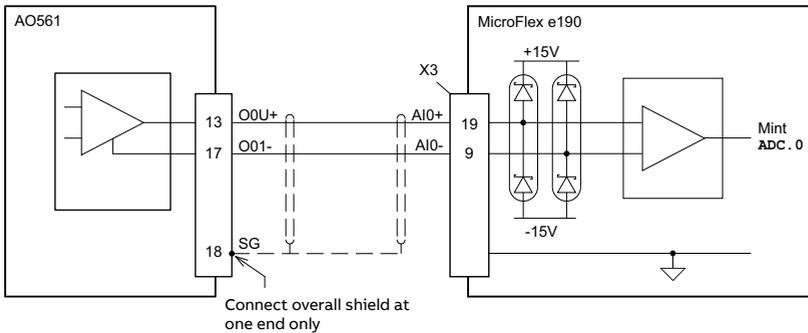
■ **X3: Analog output AO0**

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

Analog output - typical connections to a PLC/controller:

Connect overall shield at one end only

Analog output - typical connections to an ABB AI523:

Connect overall shield at one end only
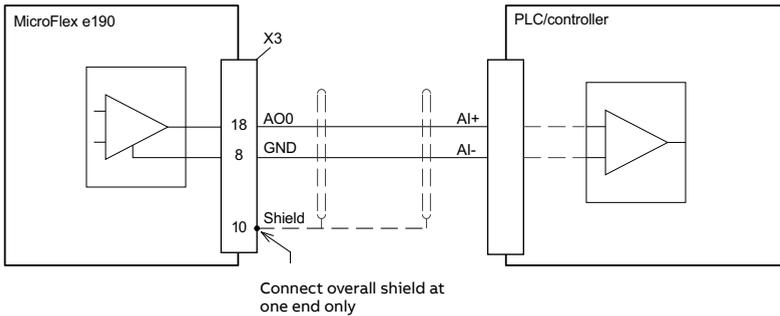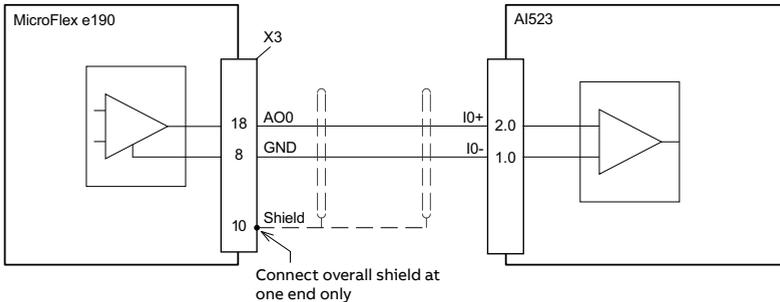
Digital I/O

The MicroFlex e190 provides:

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

6 additional general purpose digital inputs and 4 additional general purpose digital outputs can be provided by the option card (see page 197).

■ X4: 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 MicroFlex e190 to supply power to the motor. If an additional hardware drive enable input is used to control the MicroFlex e190, 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 or via the Mint `SAFETORQUEOFF` keyword. See the Mint help file for details. See *Appendix: The Safe Torque Off (STO) function* on page 203.

■ 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 MicroFlex e190 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`, `DRIVEENABLEINPUT`, `MOTORTEMPERATUREINPUT`, `PHASESEARCHINPUT` 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 a PLC/controller:
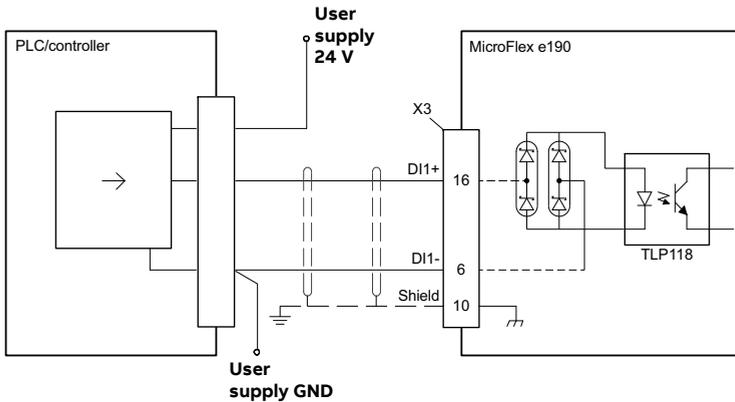
Digital input - typical connections from an ABB DO561 PLC output module:

■ **X3: Digital inputs - Special function DI1 & DI2**

DI1 and DI2 can be configured to perform special functions. The ENCODERMODE keyword controls the configuration. When operating as an encoder input or step and direction inputs, DI1 and DI2 can be used for a dual-loop feedback system or connected to a master encoder for position following applications (see the FOLLOW, FLY and CAM keywords in the Mint help file).

Fast latch input

(ENCODERMODE bit 2 = 0)
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 µs, 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 µs, although a width of 100 µs 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.

Encoder input

(`ENCODERMODE` bit 2 = 0)
Whilst operating as general purpose digital inputs, DI1 and DI2 are simultaneously interpreted by the drive as an additional quadrature (CHA, CHB) incremental encoder input. DI1 is CHA and DI2 is CHB. In Mint, the input formed by digital inputs DI1 and DI2 is encoder 1. The encoder value can be read using the `ENCODER` keyword.

Step (pulse) and Direction inputs

(`ENCODERMODE` bit 2 = 1)
If `ENCODERMODE` bit 2 is set, DI1 and DI2 are interpreted as step and direction inputs. In Mint, the input formed by digital inputs DI1 and DI2 is channel (encoder) 1.

- 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. The motor direction itself can be reversed if necessary via the `MOTORDIRECTION` Mint keyword.

The controller providing the step and direction signals may use current sourcing / open emitter outputs or it may use current sinking / open collector outputs. In both cases it is still vital to ensure twisted pairs are used for these signals (twist the signal for DIN1+ with the signal for DIN1- and twist the signal for DIN2+ with the signal for DIN2-).

Step and direction inputs - typical connections from a PLC/controller using open emitter outputs:
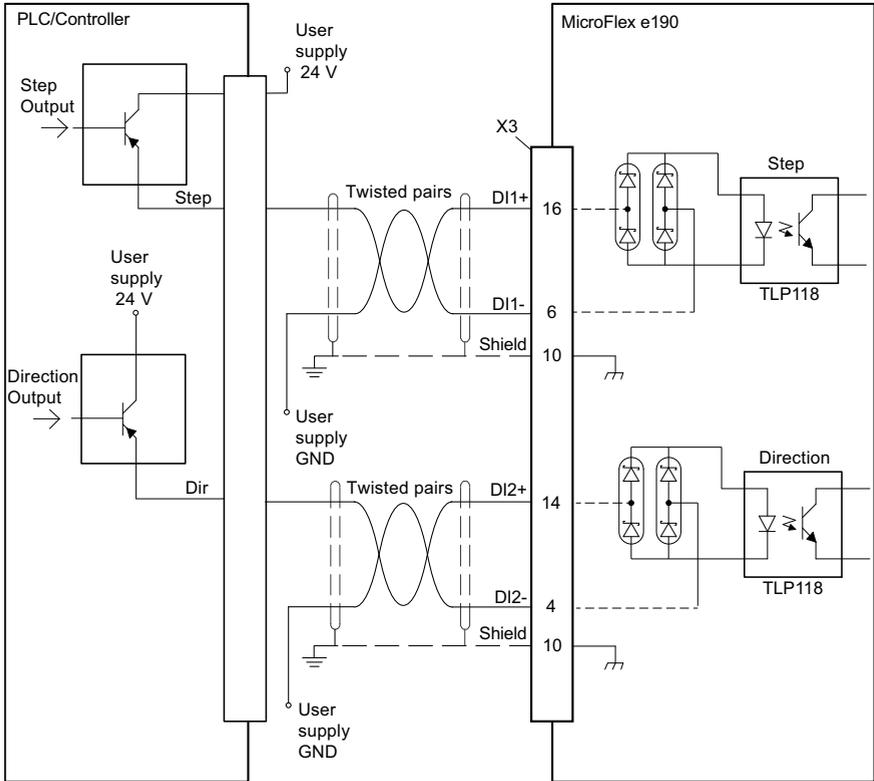
Step and direction inputs - typical connections from a PLC/controller using open collector outputs:
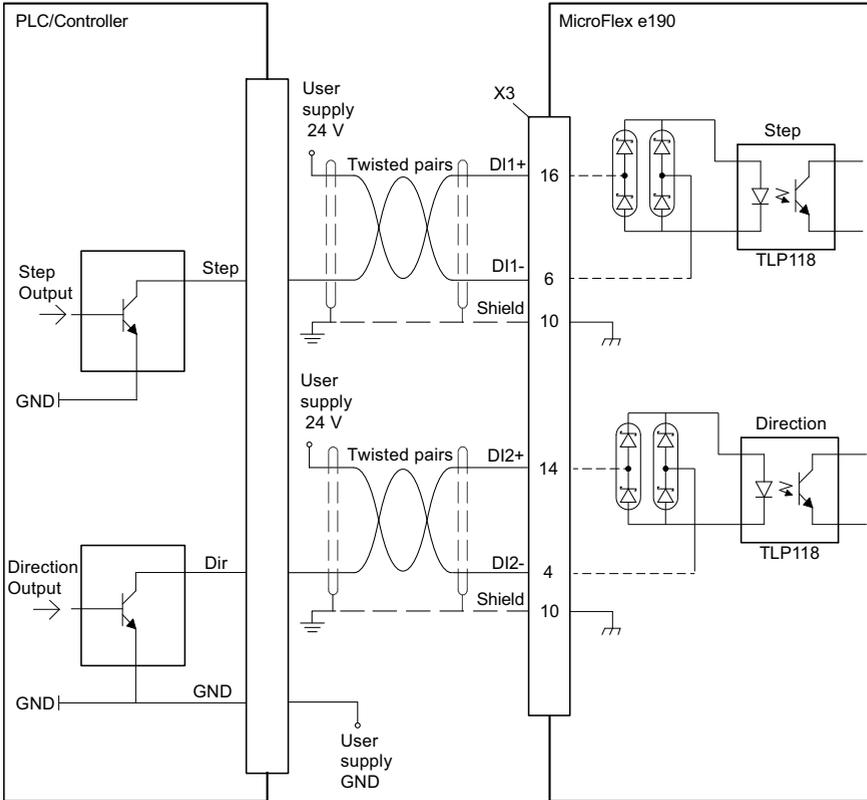
■ X3: Digital inputs - general purpose DI0 & DI3

These general purpose digital inputs are buffered by an opto-isolator, allowing the input signals to be connected with either polarity. When the MicroFlex e190 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, DRIVEENABLEINPUT, MOTORTEMPERATUREINPUT, PHASESEARCHINPUT 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 a PLC/controller:
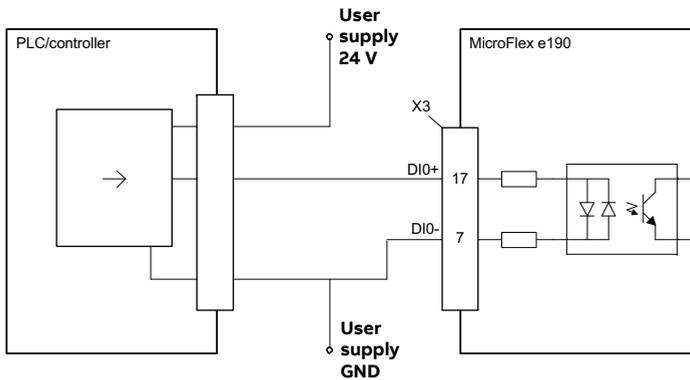
Digital input - typical connections from an ABB DO561 PLC output module:
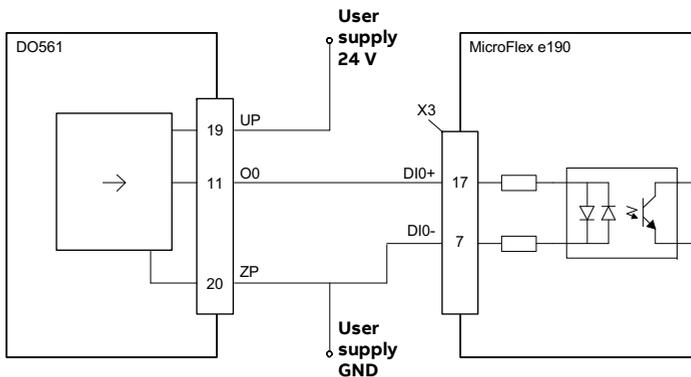
Digital input - typical current sourcing connections to a digital input:
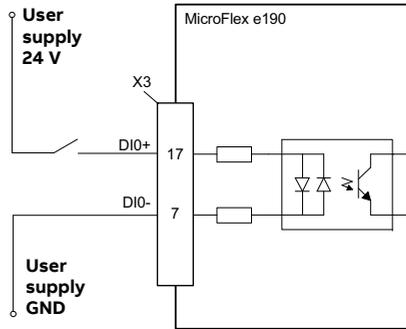
■ **X3: Digital inputs - special function DI0 & DI3**

Drive enable input

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) although it does not provide any of the formal safety features of the Safe Torque Off inputs (see page). The optional drive enable input is configured using the Digital I/O tool in Mint Workbench.

Home switch input

If homing is being handled locally by the MicroFlex e190, the axis home switch (if present) must be wired directly to the home input on the MicroFlex e190, 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 MicroFlex e190, 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 (or the manager node) enables the drive's touch probe function. See the Mint Workbench help file for details.

■ **X3: Digital outputs - general purpose DO0 - DO2**

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 or any other inductive load, a suitably rated diode must be fitted across the load, observing the correct polarity. This is to protect the output from the back-EMF generated by the load when it is de-energized.

When the MicroFlex e190 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.

Digital output - typical connections to a PLC/controller:
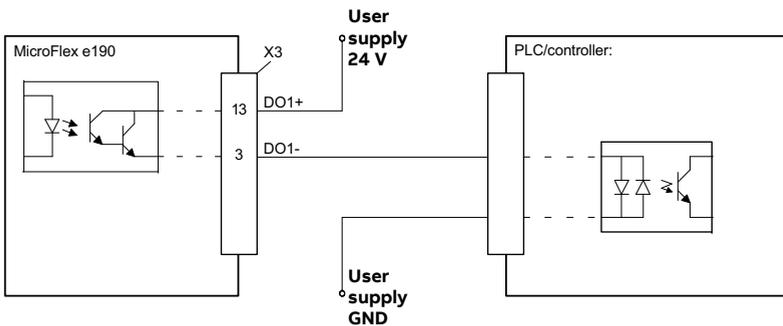
Digital output - typical connections to an ABB DI561 PLC input module:
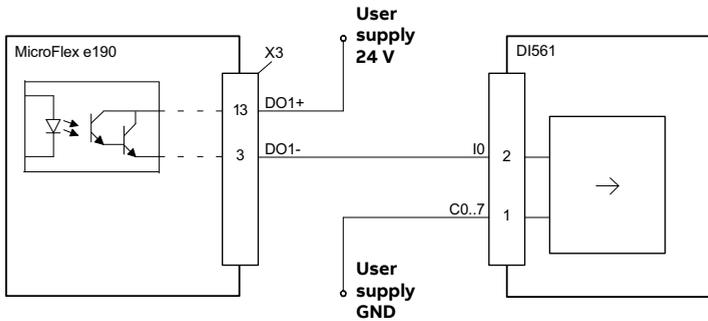
■ **X3: Digital outputs - special function DO0 - DO2**

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 sepcial 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 contrl 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

■ X2: External power supply for the control unit (optional)

An external +24 V, 1 A power supply for the control board can be connected to terminal block X2. 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.

■ SW1 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.
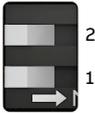
Software assigned IP address   Fixed IP address 192.168.0.1

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 ❙ symbol is displayed. Mint Workbench allows you to update firmware and view the file system.

Normal operation   Recovery mode

■ Control cable grounding

The shields of all control cables must be grounded at the earth bar. Use M4 screws to fasten cable clamps.

The shields should be continuous as close to the terminals 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 earth bar. 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.
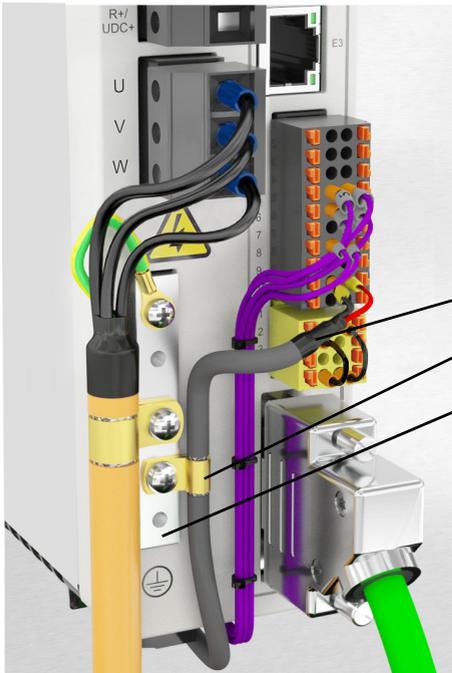
Use shrink tubing or tape to contain strands

Remove outer jacket of cable at clamp to expose cable shield

Earth bar
M4, 10 mm, 1.0...1.3 N·m (8.9...11.5 lbf·in)

Ethernet ports

■ E1 / E2: Real-time Ethernet port

1	TX+
2	TX-
3	RX+
4	(NC)
5	(NC)
6	RX-
7	(NC)
8	(NC)
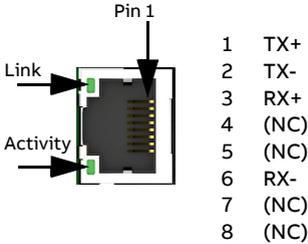
The E1 and E2 Ethernet ports on the top panel of the MicroFlex e190 are used for real-time Ethernet fieldbus connections such as EtherCAT®, Ethernet POWERLINK® and PROFINET®. For full details about the fieldbus connections, see the Mint Workbench help file.

In an EtherCAT network the E2 (IN) port must be connected to the master side of the network. The E1 (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 *MicroFlex e190 indicators* on page 117 for a description of the fieldbus status indicators.

EtherCAT connections:

EtherCAT master

■ E1 / E2: Ethernet port configuration

The rotary switches are read once at startup. The switches select the mode of operation for the E1 and E2 Ethernet fieldbus connectors on the top panel of the drive. See page 80.

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

HI

LO

■ E3: Ethernet host

The Ethernet host port is used to connect a PC for configuring the MicroFlex e190. See section *Start-up* on page 99 for details about configuring the PC's Ethernet adapter for communication with the MicroFlex e190.

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.

Motor feedback (X8)

MicroFlex e190 supports incremental encoder, EnDat 2.1, SinCos, BiSS-B (Bi-directional Synchronous Serial Interface), SSI (Synchronous Serial Interface), EnDat 2.2, Smart Abs absolute encoder or Hiperface feedback, for use with linear and rotary motors. Resolvers are supported by using the optional resolver adapter (see page 93). There are some important considerations when wiring the feedback device:

- The inputs are not isolated.
- The feedback device wiring must be separated from power wiring.
- Where feedback device wiring runs parallel to power cables, they must be separated by at least 76 mm (3 in).
- Feedback device wiring must cross power wires at right angles only.
- To prevent contact with other conductors or earths / grounds, unearthed / ungrounded ends of shields must often be insulated.
- Linear motors use two separate cables (encoder and Hall). The cores of these two cables will need to be wired to the appropriate pins of the 15-pin D-type mating connector or the encoder breakout option (see page 194) can be used to simplify linear feedback connections.
- A maximum combined total of 500 mA can be supplied by X8 pin 12 and X7 pin 9 to feedback devices. Self-resetting fuses protect the 5.5 / 8-12 V supply on X8 and the 5.5 V supply on X7.

Connection summary

Pin	Inc.encoder with Halls	EnDat 2.1	SinCos	BiSS-B, SSI	EnDat 2.2	Smart Abs	Hiperface
1	CHA+	Data+	(NC)	Data+	Data+	Data+	Data+
2	CHB+	Clock+	(NC)	Clock+	Clock+	(NC)	(NC)
3	CHZ+	(NC)	(NC)	(NC)	(NC)	(NC)	(NC)
4	(NC)	(NC)	(NC)	(NC)	(NC)	(NC)	(NC)
5	Hall U-	Sin-	Sin-	(NC)	(NC)	(NC)	Sin-
6	Hall U+	Sin+	Sin+	(NC)	(NC)	(NC)	Sin+
7	Hall V-	Cos-	Cos-	(NC)	(NC)	(NC)	Cos-
8	Hall V+	Cos+	Cos+	(NC)	(NC)	(NC)	Cos+
9	CHA-	Data-	(NC)	Data-	Data-	Data-	Data-
10	CHB-	Clock-	(NC)	Clock-	Clock-	(NC)	(NC)
11	CHZ-	(NC)	(NC)	(NC)	(NC)	(NC)	(NC)
12	+5.5 V out	+5.5 V out	+5.5 V out	+5.5 V out	+5.5 V out	+5.5 V out	+8 V out*
13	DGND	DGND	DGND	DGND	DGND	DGND	DGND
14	Hall W-	(NC)	(NC)	(NC)	(NC)	(NC)	(NC)
15	Hall W+	(NC)	(NC)	(NC)	(NC)	(NC)	(NC)

* The switch selects the voltage output on pin 12 (see page 84).

Twisted pairs must be used for each complementary signal pair e.g. CHA+ and CHA-or Data+ and Data-.

The overall cable shield (screen) must be connected to the metallic shell of the D-type connector.

In Mint Workbench, the primary motor feedback encoder on connector X8 is encoder 0. The extra incremental encoder input formed by digital inputs DI1 and DI2 is encoder 1 (see page 70). The other extra incremental encoder input on connector X7 is encoder 2 by default (see page 90), but alternatively connector X8 can be configured as encoder input 2 (see page 87).

■ **Incremental encoder with Halls**

The incremental encoder connections (ABZ channels and Hall signals) are made using the 15-pin D-type female connector X8. 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 typically provides 5.5 V to the encoder (500 mA maximum, less if other encoder inputs are in use; see page 82). Maximum cable length is 30 m.
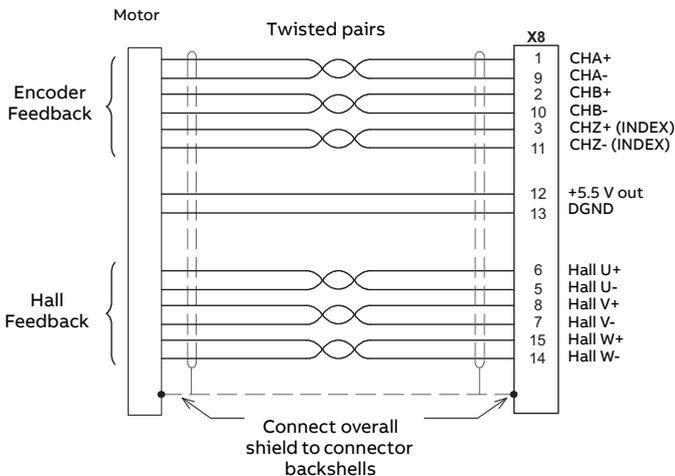
■ Serial interfaces & SinCos

The MicroFlex e190 supports the following feedback types, for use with linear and rotary motors:

- EnDat 2.1
- SinCos encoders (1 V pk-pk, 2.5 V reference)
- BiSS-B (Bi-directional Synchronous Serial Interface), SSI (Synchronous Serial Interface) or EnDat 2.2
- Smart Abs absolute encoders
- Hiperface

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 8-12 V to the encoder, selected using the switch behind connector X7 (500 mA maximum, less if other encoder outputs are in use; see page 82).

⚠ **WARNING!** Check the feedback device's power input specifications before using the 8 V position. Selecting the wrong voltage could damage your feedback device. Typically 8 V is only used when using a Hiperface encoder.

5 V
(Default)   8 V
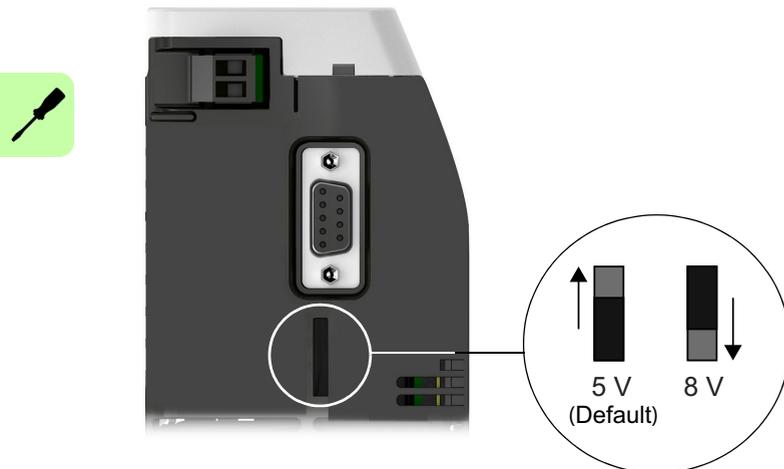
EnDat interface

Incremental and absolute (multi and single turn) devices are supported. It is possible to read and write information to the encoder. The Sin and Cos channels are not required when using a version 2.2 EnDat encoder.

EnDat 2.1 interface cable connections:
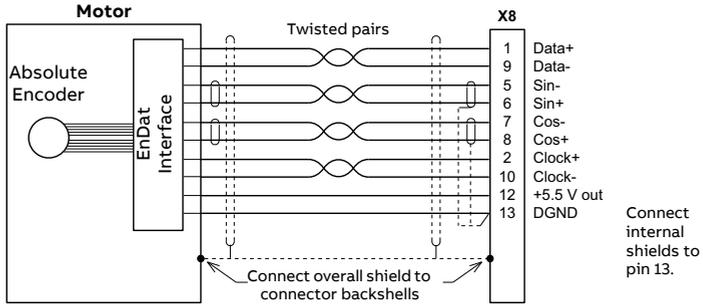
SinCos interface

SinCos interface cable connections:
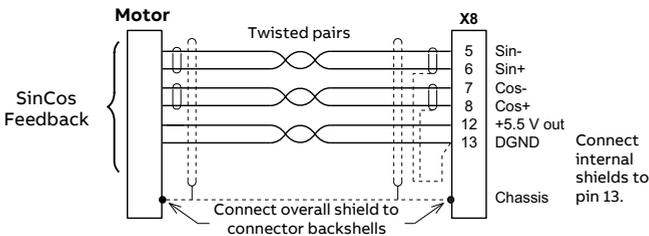
BiSS-B interface

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

BiSS-B interface cable connections:
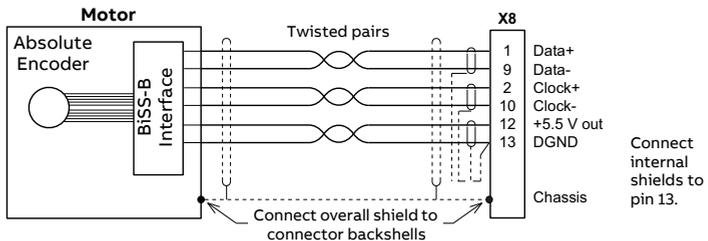
SSI encoders

SSI interface cable connections:
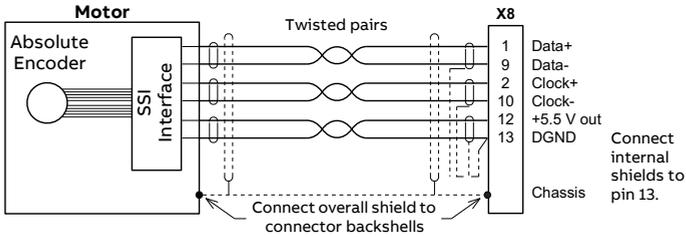
Smart Abs encoders

Smart Abs interface cable connections:
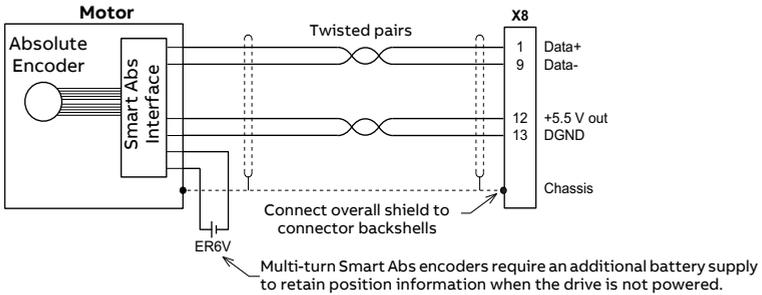
Hiperface interface

Hiperface interface cable connections:
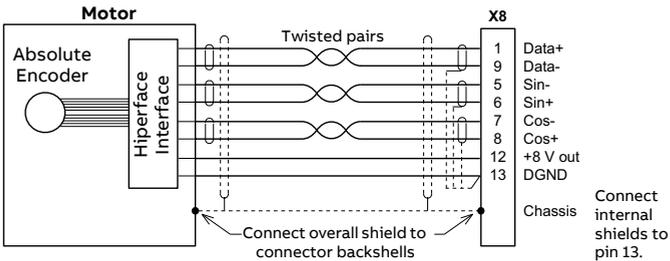
■ **Extra incremental encoder**

Some applications require the connection of multiple encoders typically when:

- A single axis has multiple encoders on the same motion system to eliminate mechanical errors (a dual encoder application).
- The drive is required to follow encoder signals given to it from a master encoder input.

In both cases the drive can support a connection to an extra incremental encoder by X7 (see page 90) or X8. The default extra incremental encoder input (encoder 2) is X7.If X7 is occupied as an encoder output and the primary feedback type is one that does not use the Hall/sin/cos inputs (Incremental encoder without Halls, BiSS-B, SSI, EnDat 2.2, Smart Abs or resolver), the extra incremental encoder also can be connected to X8.

Note: In Mint, this extra encoder input (encoder 2 on X8) is available only when connector X7 has been configured as an encoder output (see page 91).

Input mode: ABZ incremental encoder (default)

By default, connector X8 is configured as an ABZ incremental encoder input when operating as encoder 2.

Input mode: Step (Pulse) and Direction

Optionally, connector X8 can be configured as a step and direction input when operating as encoder 2. Use one of the following methods to select step and direction mode.

- In Mint Workbench, choose the Parameters tool and expand the Encoder family. Click the EncoderMode entry, then click the value next to EncoderMode (Encoder Channel 2). Check Bit 2: Step/Direction, then click OK. On the menu, choose Tools, Store Drive Parameters.
- In Mint Workbench, choose the Edit & Debug tool. In the Command window enter the command: ENCODERMODE(2)=4 (or other value where bit 2 is set). On the menu, choose Tools, Store Drive Parameters.

The step and direction inputs are both differential and must be controlled from a RS422 differential source. Single-ended connections cannot be used.

- The A channel pins (1 & 6) are used as the step input. The step frequency controls the speed of the motor.
- The B channel pins (2 & 7) are used as the direction input. The state of the direction input controls the direction of motion.
- The Z channel input is not used.

When connector X8 is specified as encode 2, an encoder breakout OPT-MF-200 need to be mounted to split one 15-pin connector X8 into one 15-pin connectors X8A and one 9-pin X8B. X8A is connected to motor feedback, while X8B is connected to an extra incremental encoder (see page 194).

X8A
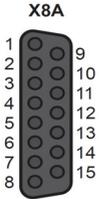
Pin	X8A (Primary encoder)				
	Inc. encoder without Halls	BiSS-B	SSI	EnDat 2.2	Smart Abs
1	CHA+	Data+	Data+	Data+	Data+
2	CHB+	Clock+	Clock+	Clock+	(NC)
3	CHZ+	(NC)	(NC)	(NC)	(NC)
4	(NC)	(NC)	(NC)	(NC)	(NC)
5	(NC)	(NC)	(NC)	(NC)	(NC)
6	(NC)	(NC)	(NC)	(NC)	(NC)
7	(NC)	(NC)	(NC)	(NC)	(NC)
8	(NC)	(NC)	(NC)	(NC)	(NC)
9	CHA-	Data-	Data-	Data-	Data-
10	CHB-	Clock-	Clock-	Clock-	(NC)
11	CHZ-	(NC)	(NC)	(NC)	(NC)
12	+5.5 V out	+5.5 V out	+5.5 V out	+5.5 V out	+5.5 V out
13	DGND	DGND	DGND	DGND	DGND
14	(NC)	(NC)	(NC)	(NC)	(NC)
15	(NC)	(NC)	(NC)	(NC)	(NC)

X8B
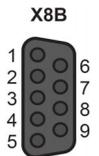
Pin	X8B (extra Inc. encoder without Halls/PTO)	Corresponding pin on X8
1	CHA+/Step+	6
2	CHB+/Dir+	8
3	CHZ+	15
4	(NC)	(NC)
5	DGND	13
6	CHA-/Step-	5
7	CHB-/Dir-	7
8	CHZ-	14
9	+5.5 V out	12

The inputs may be used as differential inputs (recommended for improved noise immunity) or single ended inputs. When used as single ended inputs, leave the CHA-, CHB- and CHZ- 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 (500 mA maximum, less if other encoder inputs are in use; see page 82). Maximum cable length is 30 m.

Extra incremental encoder cable connections:
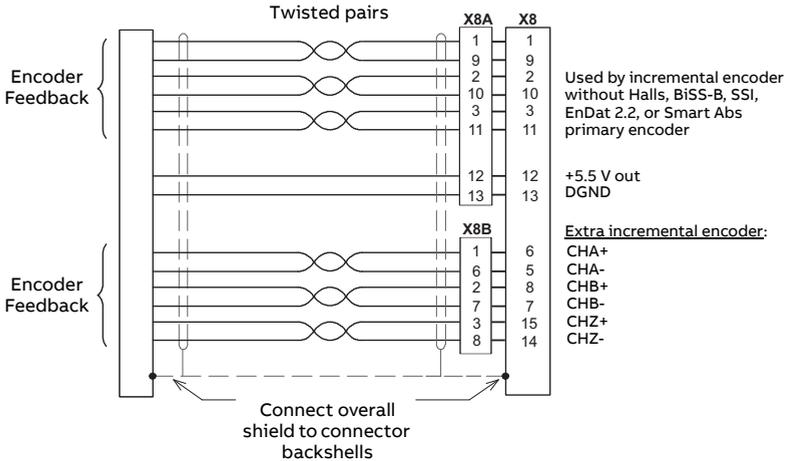
Extra Step and Direction inputs cable connections:
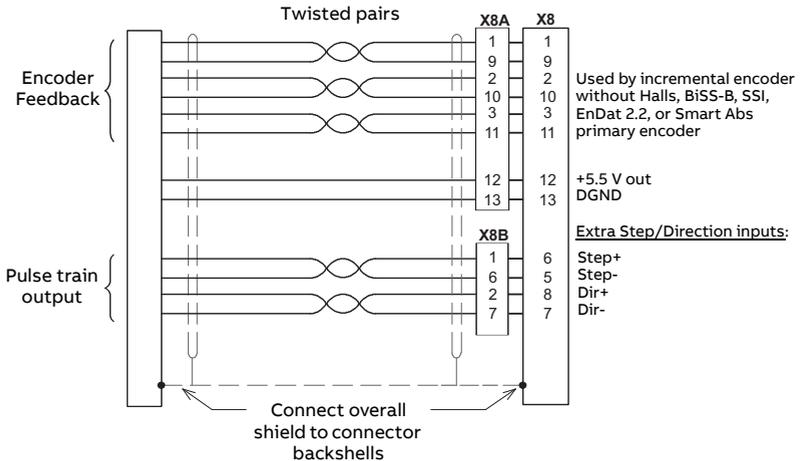
Incremental encoder input/output (X7)

The incremental encoder input/output connection provides A/B channels and a Z index channel. Twisted pairs must be used for each complementary signal pair e.g. CHA+ and CHA-. The Mint keyword ENCODEROUTCHANNEL is used to set the mode of operation for X7. When set to the default value of -1, X7 operates as an input.

Pin 1

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

Input mode: ABZ incremental encoder (default)

By default, X7 is configured as an extra ABZ incremental encoder input (encoder 2). When operating as an encoder input, X7 can be used for a dual-loop feedback system or connected to a master encoder for position following applications.

Incremental encoder cable connections:
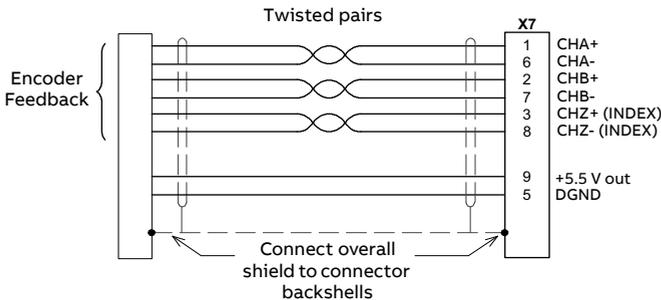
Twisted pairs

X7	
1	CHA+
6	CHA-
2	CHB+
7	CHB-
3	CHZ+ (INDEX)
8	CHZ- (INDEX)
9	+5.5 V out
5	DGND

Encoder Feedback

Connect overall shield to connector backshells

Input mode: Step (Pulse) and Direction

Optionally, connector X7 can be configured as a step and direction input. Use one of the following methods to select step and direction mode.

- In Mint Workbench, choose the Parameters tool and expand the Encoder family. Click the EncoderMode entry, then click the value next to

EncoderMode (Encoder Channel 2). Check Bit 2: Step/Direction, then click OK. On the menu, choose Tools, Store Drive Parameters.

- In Mint Workbench, choose the Edit & Debug tool. In the Command window enter the command: `ENCODERMODE(2)=4` (or other value where bit 2 is set). On the menu, choose Tools, Store Drive Parameters.

The step and direction inputs are both differential and must be controlled from a RS422 differential source. Single-ended connections cannot be used.

- The A channel pins (1 & 6) are used as the step input. The step frequency controls the speed of the motor.
- The B channel pins (2 & 7) are used as the direction input. The state of the direction input controls the direction of motion.
- The Z channel input is not used.

Step / Direction inputs - typical connections from a PLC/controller:
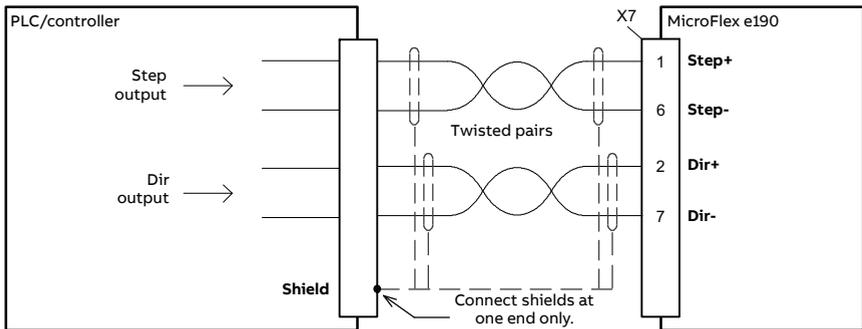
Note: The inputs should be use shielded twisted pair cable with an overall shield. Connect the input signals correctly according to the pin assignment for connector X7.

Encoder output mode

Optionally, connector X7 can be configured as an encoder output (encoder output 0). This automatically enables the extra incremental encoder input on connector X8, which then becomes encoder input 2 (see page 87). When operating as an encoder output, X7 can be connected to the encoder input of a motion controller 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 that will be output at X7:

- -1 = (Default) No encoder source assigned, X7 operates as an encoder input.
- 0 = Encoder 0, the primary encoder input on X8.
- 1 = Encoder 1, the encoder input formed by digital inputs DI1 and DI2 when they are set to behave as an encoder input (see).
- 2 = Encoder 2, the extra incremental encoder interface on X8.

The frequency of the A/B outputs is varied according to the source signal, and can be scaled using the `ENCODEROUTRESOLUTION` Mint keyword. The output at X7 is identical to the input at X8, with no propagation delay, provided the output resolution is set to match the input resolution. In all other cases there is a propagation delay of up to 125 µs.

Use one of the following methods to configure X7 as an encoder output:

- In Mint Workbench, choose the Drive Setup tool and proceed to the Motor Feedback page. In the Simulated Encoder Output 0 area, click in the Encoder source channel drop down and choose one of the encoder sources 0, 1, or 2 as described above. Proceed to the end of the wizard and follow the instructions to save the changed parameter.
- In Mint Workbench, choose the Parameters tool and expand the Encoder family. Click the EncoderOutChannel entry, then click the value next to EncoderOutChannel (Encoder Channel 0). Choose one of the encoder sources 0, 1, or 2 as described above. On the menu, choose Tools, Store Drive Parameters.
- In Mint Workbench, choose the Edit & Debug tool. In the Command window enter the command: `ENCODEROUTCHANNEL(0)=`n, where n is 0, 1, or 2, as described above. On the menu, choose Tools, Store Drive Parameters.

■ **OPT-MF-201 Resolver adapter**

The optional resolver adapter OPT-MF-201 allows a motor with resolver feedback to be connected to the MicroFlex e190. See page 195 for details.
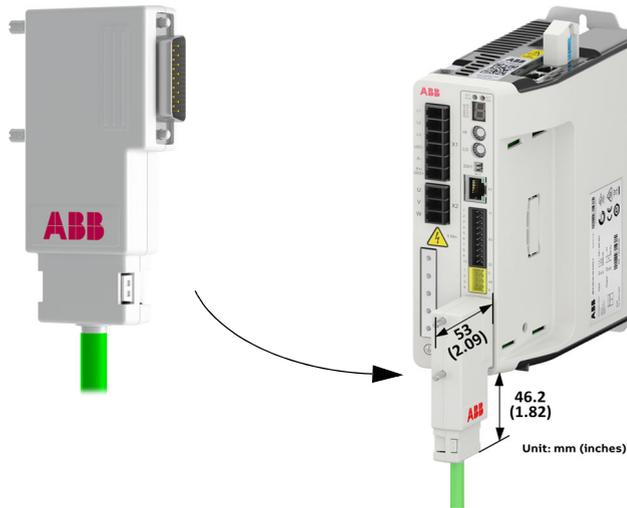
Supported feedback type

Various feedback types are offered as options on linear and rotary servo motors, the feedback types supported by MicroFlex e190 include the incremental encoder, EnDat 2.1, SinCos, BiSS-B, SSI, EnDat 2.2, Smart Abs absolute encoder, Hiperface encoder and resolvers (supported by using the optional resolver adapter, see page 195).

When selecting an encoder, you need to determine which type of encoder feedback is required in order to be compatible with the drive that will be receiving the encoder signals. Choosing the wrong encoder type will result in a non-functional system and possibly hardware damage.

The right feedback type for your application is automatically set when the motor is selected in Mint Workbench. The Mint keyword ENCODERTYPE can also

be used to define the feedback type of encoder input. Moreover, MicroFlex e190 supports two different types of incremental encoder signal inputs (primary encoder and optional inc. encoder), see more details below.

The MicroFlex e190 has 3 encoder input channels:
- Encoder 0: Primary encoder input on connector X8 (see page 82).
- Encoder 1: Extra optional incremental encoder input on connector X3 (see page 70).
- Encoder 2: Extra optional incremental encoder input/PTO on connector X7 (see page 90) or to X8 by using the OPT-MF-200 encoder breakout option (see page 87).
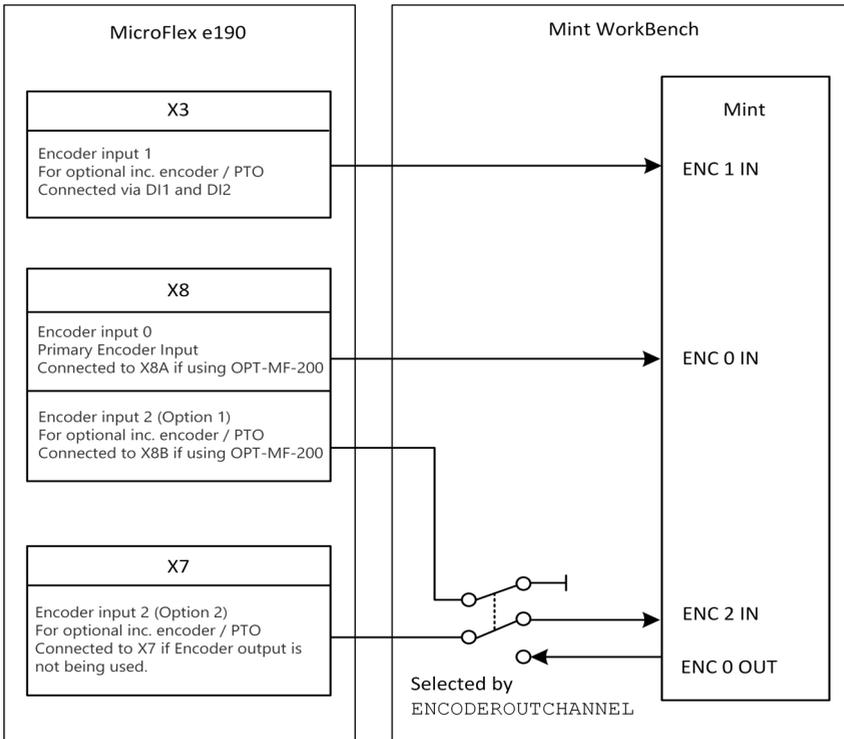
■ **Encoder 0 input**

Encoder 0 on connector X8 is the e190 drive's universal encoder input channel, supports a wide range of feedback types as follows.

No.	Feedback type		Parameter
1	Incremental encoder	Rotary incremental encoder without Halls	`ENCODERTYPE(0)=0`
2		Linear incremental encoder without Halls	`ENCODERTYPE(0)=1`
3		Rotary incremental encoder with Halls	`ENCODERTYPE(0)=2`
4		Linear incremental encoder with Halls	`ENCODERTYPE(0)=3`
5	Hall sensor	Rotary Hall sensors only without encoder	`ENCODERTYPE(0)=4`
6		Linear Hall sensors only without encoder	`ENCODERTYPE(0)=5`
7	SSI	Baumer SSI encoder of ABB motor	`ENCODERTYPE(0)=6`
8		Linear SSI encoder	`ENCODERTYPE(0)=19`
9		Generic SSI encoder	`ENCODERTYPE(0)=24`
10	Rotary EnDat v2.1		`ENCODERTYPE(0)=7`
11	EnDat v2.2	Rotary EnDat v2.2	`ENCODERTYPE(0)=9`
11		Linear EnDat v2.2	`ENCODERTYPE(0)=10`
13	SinCos	Rotary SinCos encoder	`ENCODERTYPE(0)=11`
14		Linear SinCos encoder	`ENCODERTYPE(0)=12`
15		Linear SinCos encoder with Halls	`ENCODERTYPE(0)=21`
16	Rotary Hiperface encoder		`ENCODERTYPE(0)=13`
17	Smart Abs absolute encoder		`ENCODERTYPE(0)=16`
18	BiSS-B	Rotary BiSS encoder	`ENCODERTYPE(0)=17`
19		Linear BiSS encoder	`ENCODERTYPE(0)=18`
20	Resolver (fitted with OPT-MF-201 resolver adapter)		`ENCODERTYPE(0)=25`

Note: When using the incremental without Halls, BiSS-B, SSI, EnDat 2.2, Smart Abs or resolver (via OPT-MF-201), an extra incremental encoder can be simultaneously connected to X8 (configured as encoder 2, via OPT-MF-200, see).

■ 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
- User power supply: 24 V DC

No.	Feedback type	Parameter
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 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: 5.5 V DC

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

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 disconnector of the drive and lock it to open position. Measure to ensure that the drive is not powered.

	Check
MECHANICAL INSTALLATION	
☐	The ambient operating conditions are allowable. (See *Mechanical installation*, *Technical data: Ratings, Ambient conditions*.)
☐	The unit is fastened properly to the cabinet. (See *Cabinet construction* and *Mechanical installation*.)
☐	The cooling air will flow freely.
☐	The motor and the driven equipment are ready for start. (See *Planning the electrical installation, Technical data: Motor connection*.)
ELECTRICAL INSTALLATION (See *Planning the electrical installation, Electrical installation: AC input / DC input, motor and brake*.)	
☐	The capacitors are reformed if stored over one year (ask local ABB representative for more information).
☐	The drive is grounded properly.

	Check
☐	The supply (input power) voltage matches the drive nominal input voltage.
☐	The supply (input power) is connected to L1/L2/L3 (UDC+/UDC- in case of a DC supply) and the terminals are tightened to specified torque.
☐	Appropriate supply (input power) fuses and disconnector are installed.
☐	The motor is connected to U/V/W, and the terminals are tightened to specified torque.
☐	The braking resistor (if present) is connected to R- and R+/UDC+, 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.

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 MicroFlex e190 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 MicroFlex e190.

Connect the MicroFlex e190 to the PC

Connect a CAT5e Ethernet cable between the PC and the MicroFlex e190 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 MicroFlex e190 without first altering the PC's Ethernet adapter configuration. See *Configure the PC Ethernet adapter* on page 100.

Install Mint Workbench

The Windows user account requires administrative user rights to install Mint Workbench. To install the software, download the application from new.abb.com/drives/low-voltage-ac/servo-products and run it.

Configure the PC Ethernet adapter

It is necessary to alter the PC's Ethernet adapter configuration to operate correctly with the MicroFlex e190. By default, the MicroFlex e190 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 MicroFlex e190 without first altering the PC's Ethernet adapter configuration. However, if you have installed a second Ethernet adapter dedicated for use with the MicroFlex e190, 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 MicroFlex e190, 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 Start menu, choose Control Panel, then Network and Sharing Center. (Windows 8.1: Apps screen, Control Panel, Network and Internet, Network and Sharing Center. Windows 10: Start, Settings, Network & Internet, Ethernet).

2. On the left of the window, click Change Adapter Settings (Windows 10: Change adapter options). 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 dialog.

9. Click Close to close the Local Area Connection Status dialog.

Enable the Ethernet adapter for Mint Workbench

Before Mint Workbench can use the Ethernet adapter to discover the MicroFlex e190, the adapter must be enabled in the Mint Sidebar.

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.

Note: If the Mint Sidebar cannot discover the drive then you may need to disable or modify your Firewall and/or Anti-virus settings.

Start the MicroFlex e190

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 MicroFlex e190.

■ Preliminary checks

Before you apply power for the first time, check all items in *Installation checklist*, starting on page 97.

■ Power on checks

See section *Drive status display* on page 120 for symbols that show if the drive has detected a fault.

1. Turn on the 24 V DC control circuit supply (if present).

2. Turn on the AC supply (or DC supply, page 58).

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 203) is not powered. Start-up can take more than 1 minute after downloading new firmware.

4. To allow the Commissioning Wizard to function, the Safe Torque Off inputs (page 203) must be powered to allow the MicroFlex e190 to be enabled.

Start Mint Workbench

Mint Workbench is a fully featured application for programming and controlling the MicroFlex e190. 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 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 dialog box, click Start Online Project...

3. Wait until the MicroFlex e190 is listed in the Controllers found box, e.g. "MicroFlex e190 on 192.168.0.1".

4. Select the MicroFlex e190 in the list, and check Launch Commissioning Wizard.

5. Click Select.

Note: If the MicroFlex e190 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 MicroFlex e190 is powered correctly and the start-up sequence (see *Power on checks*, above) has completed. Ensure you have enabled the Ethernet adapter for Mint Workbench (see page 101). Click Scan to re-scan the ports. It can take up to 5 seconds for Mint Workbench to detect the MicroFlex e190.

6. Mint Workbench connects to the MicroFlex e190 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 MicroFlex e190 can be used to control the motor accurately, the MicroFlex e190 must be 'tuned'. Tuning is the process where the MicroFlex e190 powers the motor in a series of tests. By monitoring the drive's output and the feedback from the motor's encoder, the MicroFlex e190 can make small adjustments to the way it controls the motor. This information is stored in the MicroFlex e190 and can be uploaded to a file if necessary.

The Commissioning Wizard provides a simple way to tune the MicroFlex e190 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 an ABB motor, the catalog number or spec. number can be found stamped on the motor's nameplate. If you are using a motor with EnDat feedback, are using a different manufacturer's motor, or need to enter the specification manually, select the 'Enter motor parameters manually' 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 'Enter motor parameters manually' 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 'Enter motor parameters manually' 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 the correct operating source ('Direct' or 'RT Ethernet') 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 MicroFlex e190 might eventually be controlled over EtherCAT (or Ethernet POWERLINK), the 'RT Ethernet' reference source should be selected only after the MicroFlex e190 has been commissioned and is ready to add to the EtherCAT (or Ethernet POWERLINK) network. This is selected by choosing the Operating Mode tool in the Toolbox.

Application Limits:

Application maximum speed (App. Max. Speed) defaults to zero and need to be entered the correct speed value. It is often not necessary to change other parameters on this screen. However, if you wish to adjust the application peak current (App. Peak Current) , then click in the appropriate box and enter a value.

Select Scale Factor:

It is often 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 often 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.

Analog input parameters:

It is not necessary to change anything on this screen. However, if you wish to adjust the analog 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 MicroFlex e190 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. Each Option shows settings relevant to the adjacent test.

⚠ **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 107.

Note: Even if you do not perform any further tuning or configuration, the STO function must be tested; see *Appendix: The Safe Torque Off (STO) function* on page 203.

■ **Further tuning - no load attached**

The Autotune Wizard calculates many parameters that allow the MicroFlex e190 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 Current tab to fine tuning the current loop.
    Click on the Velocity/ Position tab to fine tuning the velocity/position loop
    in velocity / torque servo configuration.

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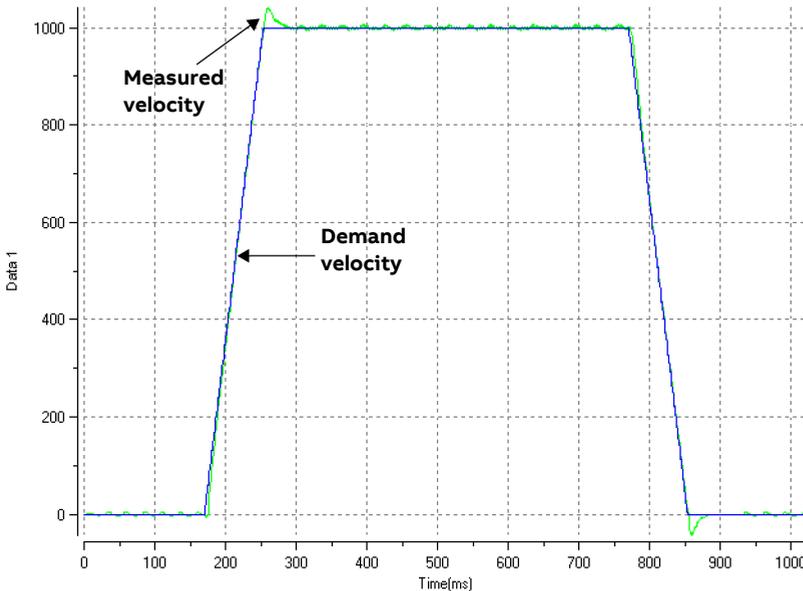
Note: The graph that you see will not look exactly the same as this one! Each motor has a different response.

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 107.

■ **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. Clear all of the check boxes. Only "Measure the inertia" and "Calculate speed and position loop gains" must be selected.
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.

Optimizing the velocity response

It can be desirable to optimize 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 dialog.

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

Velocity overshoots demand:
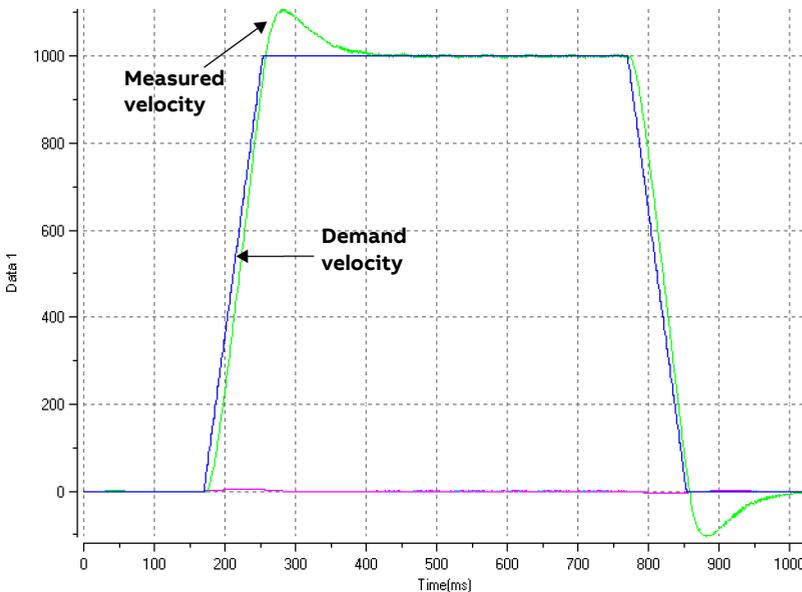
■ **Correcting zero-speed noise in the velocity response**

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 dialog.

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

Zero-speed noise:
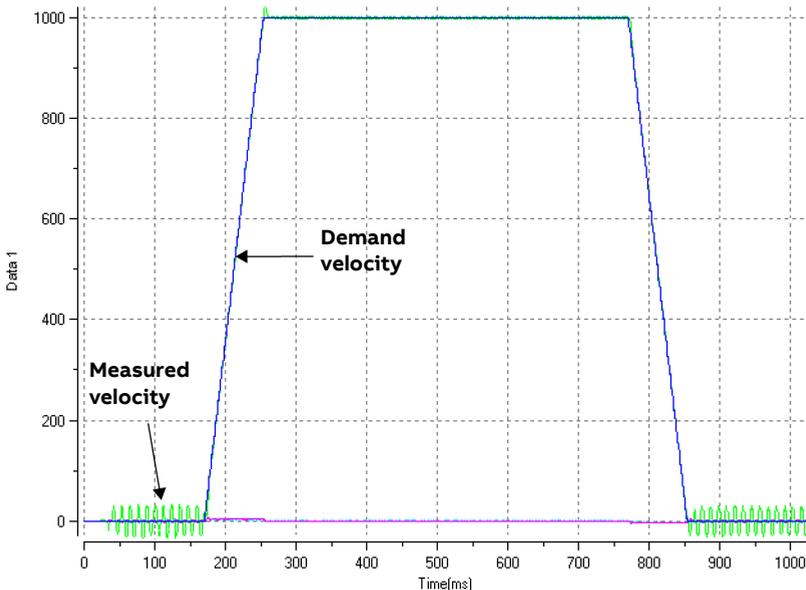
▪ Ideal velocity response

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:
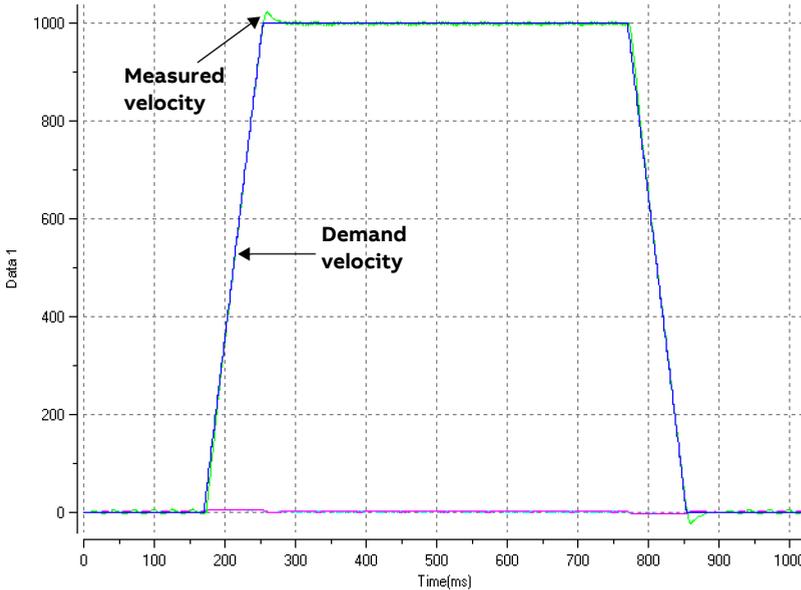
▪ Performing test moves - continuous jog

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 MicroFlex e190. 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 MicroFlex e190 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 MicroFlex e190.
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.
5. Click the "Save as..." button to export the ESI file.

■ Ethernet POWERLINK

The Ethernet POWERLINK tool shows all information relating to the Ethernet POWERLINK connection.

1. Click the Ethernet POWERLINK tool icon in the Toolbox on the left of the screen.
2. Wait until data is uploaded from the MicroFlex e190.
3. The Summary tab shows basic information about the Ethernet POWERLINK 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.

Click the "Save as…" button to export the XDD file.

■ **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 RO icon are read only so cannot be changed.
   Items listed with a green FD icon are currently set to their factory default value.
   Items listed with a yellow C 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 MicroFlex e190 until another value is defined or power is removed. The icon to the left of the item becomes yellow to indicate that the value has been changed. On the menu, choose Tools, Store Drive Parameters to ensure the value remains after a power cycle.

   Many of the MicroFlex e190'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 110 or *Performing test moves - relative positional move* on page 111 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 MicroFlex e190. If you tried the test moves in *Performing test moves - continuous jog* on page 110 or *Performing test moves - relative positional move* on page 111, then you have already used Edit & Debug mode. Press Ctrl+N to open a Mint programming window.

Note: Mint programming only supported if a Mint memory unit is installed.

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 68 to 73.

If a digital input is to be used as a home switch input, see *Home switch input* on page 74 for important details.

Safe Torque Off (STO) validation test

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

The validation 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: The Safe Torque Off (STO) function* on page 203.

10

Fault tracing

What this chapter contains

This section explains common problems and their solutions. The LED indicators are described in *MicroFlex e190 indicators* on page 117.

■ Problem diagnosis

If you have followed all the instructions in this manual in sequence, you should have few problems installing the MicroFlex e190. 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. Have the following information ready:

- The serial number of your MicroFlex e190 (if known).
- Open the Help, SupportMe menu item in Mint Workbench to view details about your system.
- The catalog 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 MicroFlex e190**

The term 'power-cycle the MicroFlex e190' is used in the Troubleshooting sections. If the mains AC supply (or DC supply) is removed, wait for 2 minutes before reapplying the supply.

MicroFlex e190 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)	
	Off: No errors or not powered.
	Blinking: 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.
	1 flash: Unspecific error. FreeRun needs 3 buffer mode. No memory. Background watchdog occurred. Invalid request state change. No valid inputs and outputs. Unknown requested state. Fatal sync error. Bootstrap not supported. No sync error. No valid firmware. PLL error. No valid inputs available. DC sync IO error. No valid output. DC sync time-out error. Synchronization error. Invalid DC Sync cycle time. Invalid Sync manager types. DC Sync0 cycle time. Slave needs cold start. DC Sync1 cycle time. Slave needs INIT. Message box EoE error. Slave needs PREOP. Message box CoE error. Slave needs SAFEOP. Message box FoE error. Invalid input mapping. Message box SoE error. Invalid output mapping. Message box VoE error. Inconsistent settings. EEPROM no access. FreeRun not supported. EEPROM error. SyncMode not supported. Slave restarted locally.
	2 flashes: Sync manager watchdog.

NET RUN (Green)	
	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.

Green (status)	
	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:

Off	(Not illuminated)
1 flash	← 1 s → ← 1 s →
2 flashes	← 1 s →
Inverted 2 flashes	← 1 s →
3 flashes, etc.	← 1 s →
Blinking	
Flickering	
On	(Continuously illuminated)
	← 200 ms →
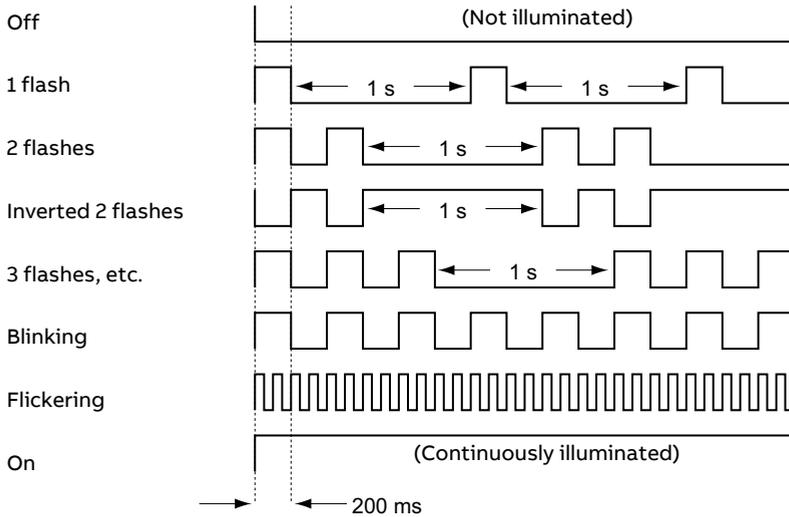
■ Drive status display

The drive status display indicates errors and general
MicroFlex e190 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:
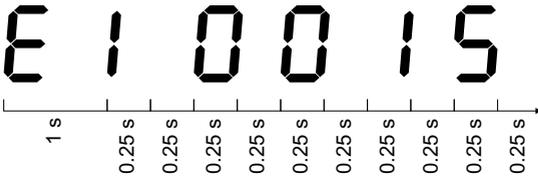
STO error

The decimal point to the right of the number also illuminates to indicate STO
errors. If a ƃ symbol appears followed by an error code, please contact ABB
technical support. 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
MicroFlex e190* on page 101.

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.
▮	Initialization error / recovery mode. If this is the only symbol shown after powering the drive, remove all power, check the memory unit is inserted correctly, then reapply power. This symbol is also displayed during recovery mode (see page 78).
▬	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 SUSPEND 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.
A	Hold to Analog (HTA) mode. The axis is in Hold To Analog mode. See the Mint keyword HTA.

Symbol	Description
8	Drive enabled, but idle.
c	Cam move. A cam profile is in progress. See the Mint keyword CAM.
d	Dwell. A dwell (wait) 'move' is in progress. See the Mint keyword MOVEDWELL.
F	Flying shear. A flying shear is in progress. See the Mint keyword FLY.
ꓱ	Follow move. The drive is in follow mode. See the Mint keyword FOLLOW.
h	Homing. The drive is currently homing. See the Mint keyword HOME.
l	Incremental move. An incremental linear move is in progress. See the Mint keywords INCA and INCR.
u	Jog. The drive is jogging. See the Mint keywords JOG, JOGCOMMAND and related topics.
o	Offset move. An offset move is in progress. See the Mint keyword OFFSET.
P	Position move. A linear move is in progress. See the Mint keywords MOVEA and MOVER.
q	Torque move. The drive is in torque mode. See the Mint keywords TORQUEREF, TORQUEREFSOURCE and related commands.
ı	Firmware recovery mode in operation; see *SW1 linear switches - startup functions* on page 78.
S	Stop input active. A Mint STOP command has been issued or an optional stop input is active.
ꭒ	Velocity reference move. The drive is under velocity control. See the Mint keywords VELREF and related keywords.
ᴎ	Spline. A spline move is in progress. See the Mint keyword SPLINE and related keyword.

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

■ 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 X2, and is switched on. If a 24 V DC supply is not provided, an AC supply (or DC supply, page 58) must be present at X1 to allow communication.

Drive status display shows 'I':

- The MicroFlex e190 is in firmware recovery mode. This means that it does not boot fully, and allows Mint Workbench to download firmware from the Choose Firmware dialog. See *SW1 linear switches - startup functions* on page 78.

Mint Workbench fails to detect the MicroFlex e190:

- Ensure that the MicroFlex e190 is powered and the drive status display is illuminated (page 120).
- Check that the Ethernet cable is connected between the PC and MicroFlex e190. 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 100).
- 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 MicroFlex e190.
- 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 MicroFlex e190.

■ **Tuning**

Cannot enable the MicroFlex e190 because there is an error 10010:

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

Cannot enable the MicroFlex e190 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 MicroFlex e190 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 re-tune 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.

■ **Brake chopper short circuit detection at startup**

The brake chopper short circuit detection checks whether an external brake resistor has failed in a short circuit state or not. This check is done at start up and as such can make the time between power on and drive ready state take longer than before.

If a quicker start up is desired the setting of the `BrakeChopperCheck` parameter can be changed at the users risk.

When the `BrakeChopperCheck` parameter is:

• set to 1, the brake chopper short circuit detection is enabled, and if there is a short circuit for brake resister connection at power-on, error 10046 will be reported.

• set to 0, the brake chopper short circuit detection is disabled, and error 10046 will not be reported.

The default value is 1(enabled). It can be disabled only when the customer needs to speed up the startup time.

■ **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 100.

How do I configure my EtherCAT manager to operate with the MicroFlex e190?

• 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 MicroFlex e190 from my EtherCAT or Ethernet POWERLINK manager

The drive reference source must be set to allow the EtherCAT or Ethernet POWERLINK manager to take control of the MicroFlex e190. There are several ways to do this:

• Set the CONTROLREFSOURCESTARTUP parameter to '1' using the Mint Workbench Parameter viewer or Command window, save the parameters and restart the drive. This gives control to the manager each time the MicroFlex e190 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 real time Ethernet in the Mint Workbench Operating Mode Wizard, and that the master has been configured correctly.

■ Dual encoder

In dual encoder application, a feedback deviation error (*10045*) will occur if the axis exceeds its maximum deviation error limit. For 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'.

Set POSVELENCODERDEVIATIONERRORMODE(0)=1 to select **crash stop and disable mode**, when a deviation error occurs, the drive will:
- · Perform crash stop.
- · Call the error event and the error 10045 is generated.
- · Be disabled.

Set POSVELENCODERDEVIATIONERRORMODE(0)=10 to select **error decel as velocity mode**, 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.
- · Keep enabled (if no other error occurs) and 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 multi-turn) 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.

■ 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 handing.

Error messages generated by the drive

■ Autotuning errors

Code	Error	Cause	What to do
4000	No autotuning error (_ecAUTOTUNE_SUCCESS)	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 auoDESIGN_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 (_ecPOSSIBLE_SHORT_CIRCUIT)	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 (_ecUNSUPPORTED_FEEDBACK_TYPE)	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. Ie the combination of Motor and Feedback device is not supported by Mint Workbench.
4012	Encoder resolver rotation sense is wrong (_ecFEEDBACK_SENSE_WRONG)	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).	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. 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. 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.

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.	The error can occur for a number of reasons, so try the following tests: • 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 • 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. • 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. 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.
4015	Position control update rate invalid	Position loop control rate (ControlRate(0, 1)) < 1.	Change control rate to expected value (normally 4000).

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Code	Error	Cause	What to do
4016	Mathematic error in gain calculations (_ecGAIN_CALCS_FAILED)	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 (MOTORRS and MOTORLS) when it occurs during current loop gain calculations, or with the values of inertia and damping (LOADINERTIA and LOADDAMPING) 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 (_ecCANNOT_FIT_RESISTANCE_MODEL)	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 (_ecCANNOT_FIT_INDUCTANCE_MODEL)	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 require 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_T IMEOUT)	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_STATOR_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_STATOR_INDUCTANCE)	Can't set stator leakage inductance.	
4030	Motor pole pitch invalid	Calculated motor pole pitch <= 0.	
4031	Motor pole number invalid	Calcualted motor poles < 2.	
4032	Load inertia is not set	Calcaulted load inertia <= 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.	
4043	Can't set position integral gain (_ecCANNOT_SET_GAIN_KINT)	Can't set position integral gain.	

Code	Error	Cause	What to do
4044	Can't set velocity feedforward gain (_ecCANNOT_SET_GAIN_ KVELFF)	Can't set velocity feedforward gain.	
4045	Can't set velocity feedback gain (_ecCANNOT_SET_GAIN_ KVEL)	Can't set velocity feedback gain.	
4046	Can't set acceleration feedforward gain (_ecCANNOT_SET_GAIN_ KACCEL)	Can't set acceleration feedforward gain.	
4047	Inertia test failed (_ecINERTIA_TEST_FAILE D)	Inertia measurement failed	
4048	Voltage constant test failed (_ecVOLTAGE_CONSTA NT_TEST_FAILED)	Voltage constant measurement failed	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.
4049	Can't set offset angle (_ecCANNOT_SET_ANG LE_OFFSET)	Can't set motor feedback offset angle (Possible encoder fault or wrong config)	
4050	Can't set observer gain K1 (_ecCANNOT_SET_OBS ERVER_GAIN_K1	Can't set observer gain K1.	
4051	Can't set observer gain K2 (_ecCANNOT_SET_OBS ERVER_GAIN_K2)	Can't set observer gain K2.	
4052	Can't set observer gain KJ (_ecCANNOT_SET_OBS ERVER_GAIN_KJ)	Can't set observer gain KJ.	
4053	Can't enable integral position control (_ecCANNOT_SET_KINT _MODE)	Can't enable integral position control.	
4054	Can't set integral term limit (_ecCANNOT_SET_KINT _LIMIT)	Can't set integral term limit.	

Code	Error	Cause	What to do
4055	Invalid autotuning operation number (_ecINVALID_OPERATION)	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 (_ecCANNOT_ENABLE_DRIVE)	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 (_ecDRIVE_COMMS_ERROR)	Communication between the host PC and the controller has failed.	Check the serial or USB cable.
4063	Encoder fault (_ecPOSSIBLE_ENCODER_FAULT)	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
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 (_ecPARAM_VALUE_OUT_OF_RANGE)	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 (_ecPARAM_DEFINITION_ERROR)	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 (_ecETHERCAT_AL_STATUS 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 (_ecCIP_CFG_ERROR)	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 (_ecPOWERLINK_ERROR)	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 (ecPROFINET_CFG_ERROR)	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 anamolus 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 DRIVEENABLEREADY.
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. **over current, earth fault, over temperature on power board**	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_VOLT AGE)	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_VOL TAGE)	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^2.T exceeded limit (_ecMOTOR_OVERLO AD)	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_INPUT)	#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 been 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. 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.
10040	Hiperface DSL encoder error (_ecHIPERFACE_DSL_ENCODER_ERROR	An error has occurred when reading the position over Hiperface DSL.	
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 POSVELENCODERDEVIATIONERRORMODE.	1 Check the motor, the encoders, other equipments and connections. 2 Check the value of the keyword POSVELENCODERDEVIATIONFATAL is not too low.
10046	Brake chopper short circuit	An error has occurred when the drive detected that the brake chopper is short-connected at power-on.	Check the wiring to the brake chopper. The error could not be reset until the system is restart.

■ **Controller errors**

Code	Error	Cause	What to do
30001	Controller over-temperature (_ecOVER_TEMPERATURE)	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 each drive is; e190 3A is 80°C, e190 6A and 9A is 75°C
30003	Controller reset on watchdog time-out (_ecCPU_WATCHDOG_RRESET)	-	Please ensure you are using the latest firmware and if problem persists please contact ABB technical support.
30005	FPGA failed to initialise (_ecFPGA_INITIALISATION_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 Error Log 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.
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.

Code	Error	Cause	What to do
30030	All controller errors cleared (_ecCONTROLLER_ERRORS_CLEARED)	This information message can appear in the error log 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.

See *AN00267 ABB Motion Drives Error trouble shooting manual* for more details on error handing.

11

Maintenance

What this chapter contains

This chapter contains preventive maintenance instructions.

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.

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 *Reforming the capacitors*.
Heat sink temperature check and cleaning	Depends on the dustiness of the environment (every 6 to 12 months)	See *Heat sink*.

Cooling fan change	**Every 6 years** if the ambient temperature does not exceed 45 °C (113 °F). **Every 3 years** if the ambient temperature is higher than 45 °C (113 °F).	See *Cooling fan*.

Heat sink

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

⚠ **WARNING!** Obey the instructions in *Safety* on page 13. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

⚠ **WARNING!** Use a vacuum cleaner with an anti-static hose and nozzle. A normal vacuum cleaner can cause static discharges which can cause damage to circuit boards:

Clean the heat sink as follows (when necessary):

1. Stop the drive and disconnect it from input power.
2. Wait for 5 minutes and measure to make sure that there is no voltage. Refer to *Electrical safety* on page 15.
3. Remove the cooling fan (see section *Cooling fan* on page 151).
4. Blow clean, dry, and oil free compressed air from the bottom of the heat sink to the top. Use a vacuum cleaner at the air outlet to trap the dust. If there is a risk that dust can go into other equipment, clean the heat sink in another room.
5. Install 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 heat sink temperature in spite of heat sink 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.

■ Removing the fan

Place the drive on its side as shown. Push in the two retaining clips (1) at the back of the drive. Remove the base (2) by pulling on the top edge first. Disconnect the fan cable (3). Carefully bend the clips on the fan holder (4) to release the fan.
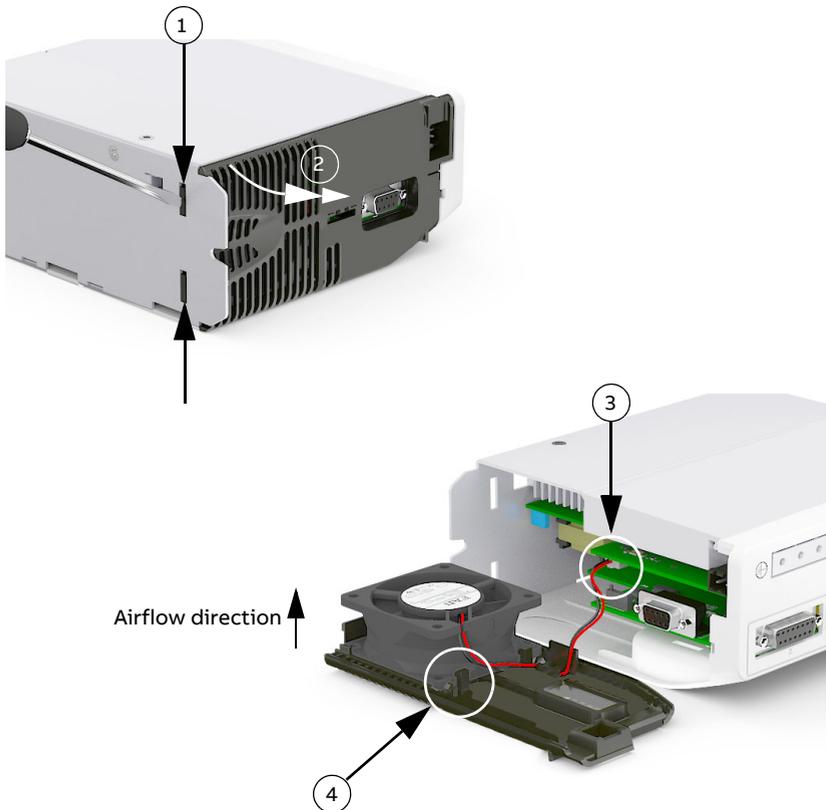
Airflow direction

■ Replacing the fan

Insert the new fan (1) ensuring the airflow direction is bottom-to-top. Route the wire through the retaining clip and connect the cable to the circuit board (2). Insert the front edge of the base into the front panel (3). Apply outward pressure at the centre of the base and simultaneously push the fan into the drive (4). Check that the plastic lug fits into the recess in the heat sink (5). Check that the fan cable has not moved or obstructed the encoder voltage switch (6, see page 84 to check the correct position). Check that the retaining clips are fitted into the mounting plate (7).
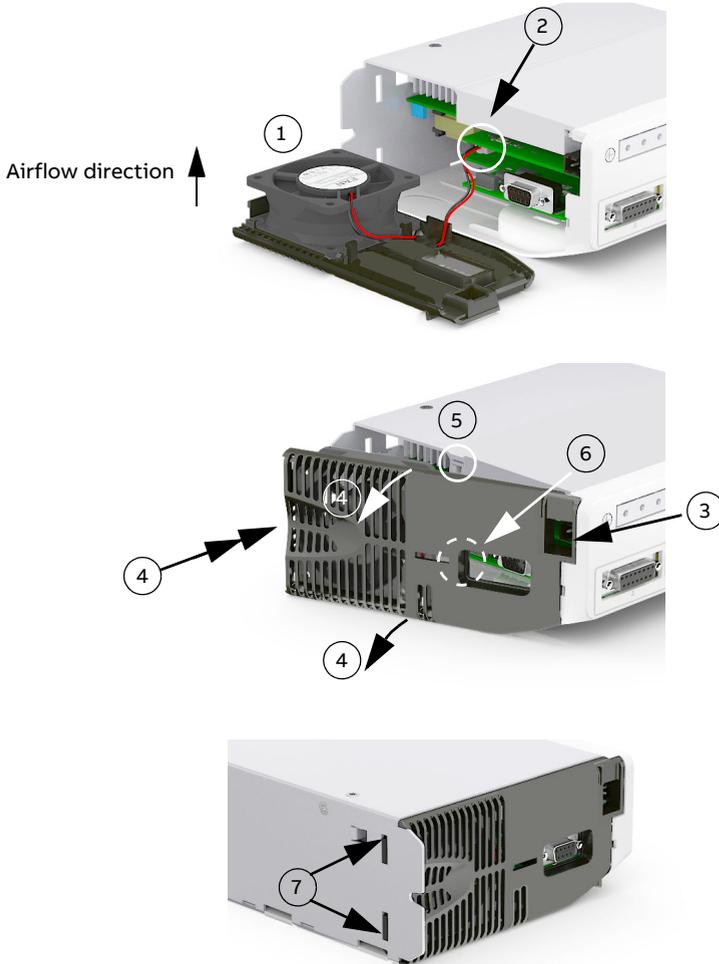
Reforming the capacitors

■ 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 154.
- 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 154 or *Reforming with another e190 drive* on page 156.
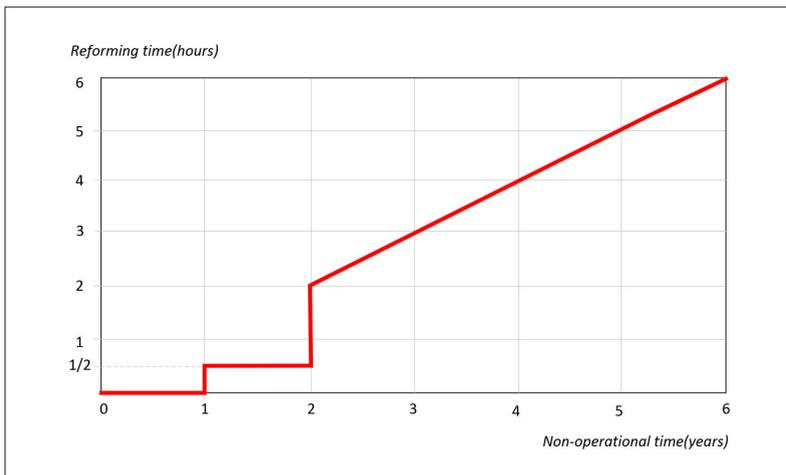
■ Checking the drive age

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 33 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) <u>for one to two years</u>.

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) <u>for two years or longer</u>.

⚠ **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 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.

4. Switch on the reforming circuit for the time defined in section *Reforming time* on page 153.
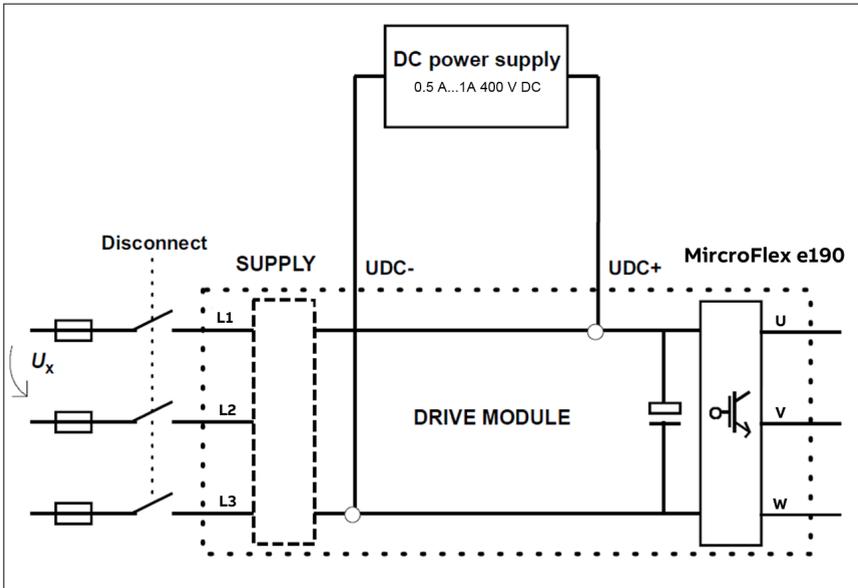
Note: Limit the reforming current to max. 200 mA. If the DC power supply does not have an adjustable current limiter, increase the voltage gradually from 0 V to 400 V.

⚠ **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 e190 drive

This method can be used for capacitor reforming if the drive has been stocked (non-operational) <u>for two years or longer</u> 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 disconnector (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 e190 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.
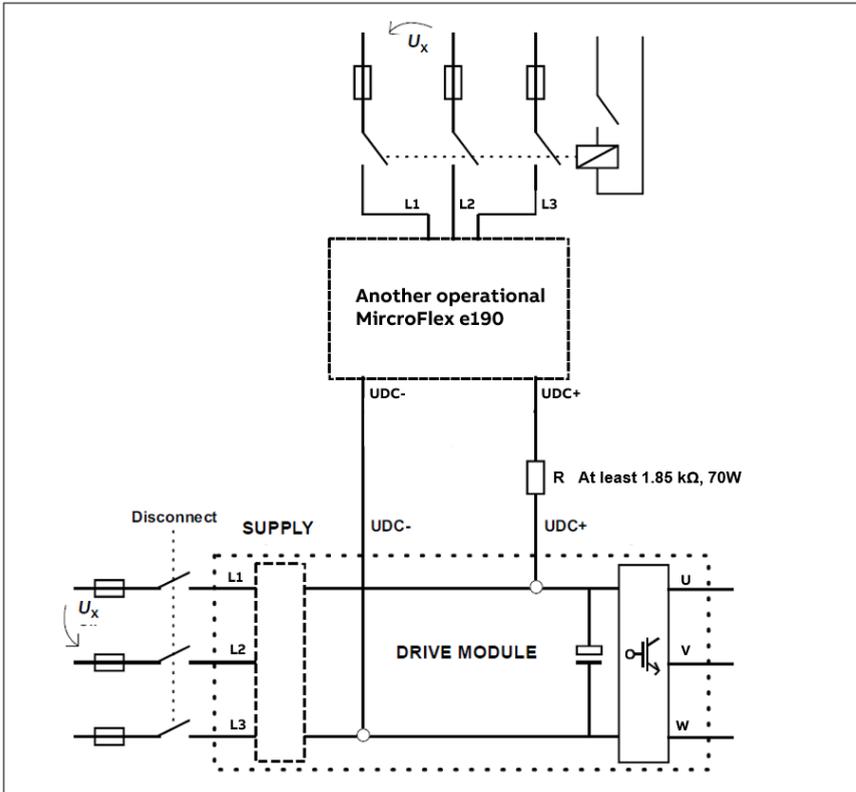
4. Switch on the AC power supply of the reforming circuit for the time defined in section *Reforming time* on page 153.

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.

8. 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.

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

12

Technical data

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 MicroFlex e190 with 200…240 V AC supply are given below. For example, if a 3 A model is required to provide brief 300% overloads, assume its rated current is only 2.5 A.

Drive type MFE190-04UD…	PWM switching frequency (Hz)	300% 3 s overload (A_{rms})	200% 3 s overload (A_{rms})	Low speed output* (< 2 Hz) (A_{rms})	Stationary: DC output, any phase (A)
-03A0-2	8000	2.5	3.0	3.0	4.2

Drive type MFE190-04UD…	PWM switching frequency (Hz)	300% 3 s overload (A_{rms})	200% 3 s overload (A_{rms})	Low speed output* (< 2 Hz) (A_{rms})	Stationary: DC output, any phase (A)
-06A0-2	8000	5.25	6.0	6.0	8.5

Drive type MFE190-04UD…	PWM switching frequency (Hz)	300% 3 s overload (A_{rms})	200% 3 s overload (A_{rms})	Low speed output* (< 2 Hz) (A_{rms})	Stationary: DC output, any phase (A)
-09A0-2	8000	7.5	9.0	9.0	12.7

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

* The maximum overload current between 0 Hz and 2 Hz is 150% of rated current.

■ 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 DriveSize PC tool.

Cooling

Method	Internal fan, flow from bottom to top, air-cooled heat sink.
Free space around the unit	See *Cooling and degrees of protection* on page 38.

Cooling characteristics, noise levels

Drive type MFE190-04UD...	Max. power loss W	Air flow m³/h	Noise level dBA
-03A0-2	60	56.4	45
-06A0-2	130	56.4	45
-09A0-2	135	56.4	45

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.

1Φ AC supply

Drive type MFE190-04UD...	Input current (A)	IEC fuse Bussmann series:C10G20			UL fuse Bussmann Class CC KTK-R-20			Cross-sectional area of cable	
		Rated current (A)	Voltage (V)	Class	Rated current (A)	Voltage (V)	UL Class	mm^2	AWG
-03A0-2	7	20	500	gG	20	600	CC	1.5...4	16…12
-06A0-2	14		500	gG		600		1.5...4	16…12
-09A0-2	20		500	gG		600		1.5...6	16…10

3Φ AC supply

Drive type MFE190-04UD...	Input current (A)	IEC fuse Bussmann series:C10G20			UL fuse Bussmann Class CC KTK-R-20			Cross-sectional area of cable	
		Rated current (A)	Voltage (V)	Class	Rated current (A)	Voltage (V)	UL Class	mm^2	AWG
-03A0-2	4	20	500	gG	20	600	CC	1.5...4	16…12
-06A0-2	8		500	gG		600		1.5...4	16…12
-09A0-2	12		500	gG		600		1.5...6	16…10

AC input (supply) connection

	1Φ	3Φ
Voltage (U_1)	200…240 V AC ±10%	200…240 V AC ±10%
Frequency	50…60 Hz ±5%	
Network type	Grounded (TN, TT). Corner grounded TN, and IT (ungrounded) systems not allowed.	
Imbalance		Max. ±3% of nominal phase to phase input voltage
Fundamental power factor (cos phi₁)	0.98 (at nominal load)	
Terminals	Detachable screw terminal block for 0.20..6 mm² wire.	
Short circuit current protection (UL 61800-5-1)	The drive is suitable for use on a circuit capable of delivering not more than 5000 A rms symmetrical amperes, 264 V maximum, when protected by fuses given in the fuse table on page 162.	

■ **Effect of AC power supply voltage on DC-bus voltage**
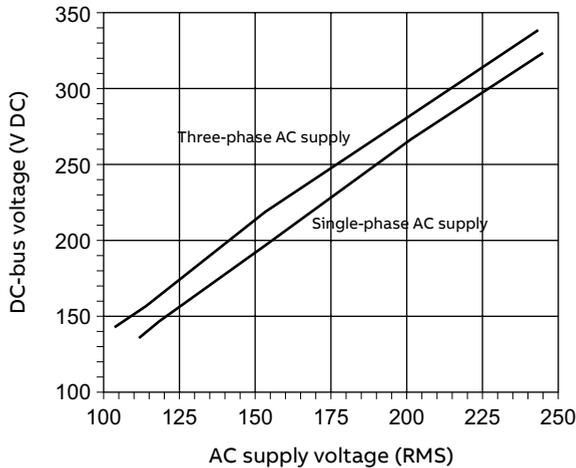
■ **Effect of AC power supply voltage on DC-bus ripple voltage**
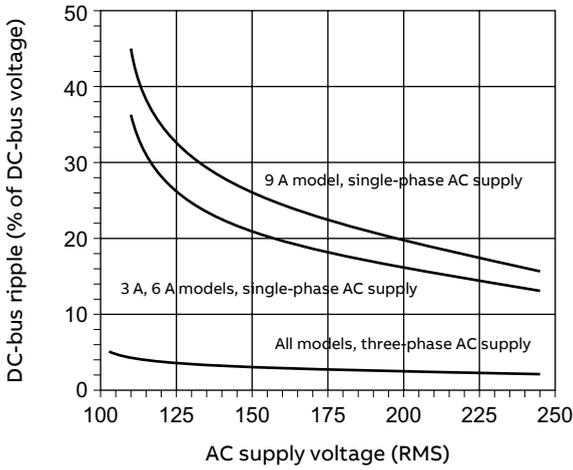
■ **Effect of output current on DC-bus ripple voltage**
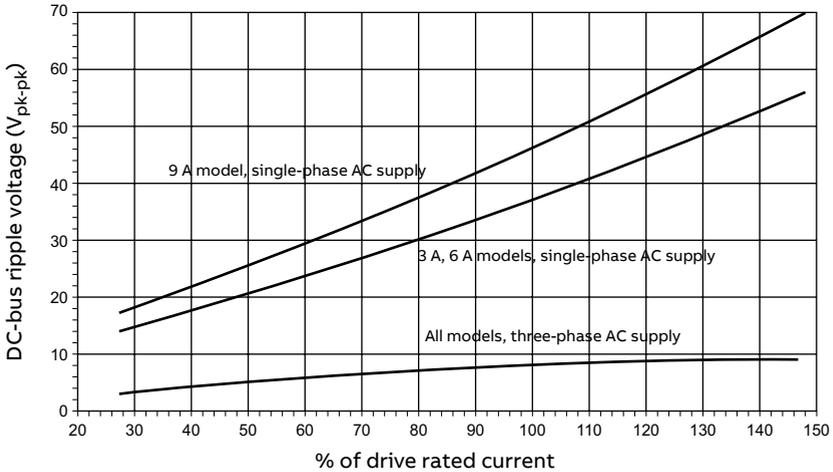
DC input (supply) connection

Voltage	270...340 V DC ±10%		
Ratings	**Drive type MFE190-04UD...**	**I_{dcN} (A)**	**C (µF)**
	-03A0-2	3.67	560
	-06A0-2	7.35	1120
	-09A0-2	11.02	1120
	I_{dcN} is the average DC input current requirement.		
Terminals	Detachable screw terminal block for 0.20...6 mm^2 wire.		

Motor connection

Motor types	Asynchronous induction motors, asynchronous servo motors, synchronous permanent magnet motors
Frequency	0...550 Hz
Current	See section *Ratings.*
Switching frequency	8 kHz
Maximum motor cable length	30 m (98 ft) with screened cable
Terminals	Detachable screw terminal block for 0.20...6 mm^2 wire.

Brake resistor connection

Description	Unit	All models
Nominal switching threshold	V DC	on: 388, off: 376
Nominal power (10% peak power, r = 57 Ω	kW	0.25
Peak power (10% peak power, r = 57 Ω	kW	2.7
Maximum brake switching current	A_{pk}	10
Minimum load resistance	Ω	39
Maximum load inductance	µH	100

Circuit breaker connection

Recommended circuit breaker 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 breaker.

1-phase 220Vac power supply

DRIVE		MCB (S 200 series)			MCB (S 200 series)		
TYPE	MFE190-04UD-xxxx-2	S 202 Dxx*			S 202 M- Dxx*		
	I_{2n} [A]	I_n [A]	U_e [V_{AC}]	I_{cu} [kA]	I_n [A]	U_e [V_{AC}]	I_{cu} [kA]
	03A0	10	400	6	10	400	10
	06A0	20	400	6	20	400	10
	09A0	25	400	6	25	400	10

3-phase 220Vac power supply

DRIVE		MCB (S 200 series)			MCB (S 200 series)		
TYPE	MFE190-04UD-xxxx-2	S 203 Dxx*			S 203 M- Dxx*		
	I_{2n} [A]	I_n [A]	U_e [V_{AC}]	I_{cu} [kA]	I_n [A]	U_e [V_{AC}]	I_{cu} [kA]
	03A0	10	400	6	10	400	10
	06A0	20	400	6	20	400	10
	09A0	25	400	6	25	400	10

Nomenclature:

I_{2n} = nominal output current of the drive

I_n = nominal current of the circuit breaker (or limiter)

U_e = rate supply voltage

I_{cu} = breaking capacity of the circuit breaker

xx* = I_n

Control unit

X2: Control circuit supply input	24 V (±10%) DC, 1 A Optional external power supply through connector X2 (pitch 5.08 mm, wire size 2.5 mm^2).
X3: Analog input AI0	Connector pitch 3.5 mm, wire size 1.0 mm^2 Voltage input: –10…10 V, R_{in}: 120 kΩ Differential inputs, common mode ±10 V Sampling interval per channel: 0.25 ms Filtering: Adjustable using `ADCTIMECONSTANT` keyword (see Mint Workbench help file) Resolution: 11 bit + sign bit (±4.9 mV)
X3: Analog output AO0	Connector pitch 3.5 mm, wire size 1.0 mm^2 AO0 (voltage): –10…10 V, R_{load} > 1 kΩ Update interval: 1 kHz Resolution: 11 bit + sign bit (±4.9 mV)

X3: Digital inputs DI1…DI2	Connector pitch 3.5 mm, wire size 1.0 mm^2
	Logic levels: "0" < 5 V, "1" > 15 V
	R_{in}: 2 kΩ
	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, PTO maximum 500 kHz
	Sampling interval: 1 kHz
	Filtering: Adjustable using `INPUTDEBOUNCE` keyword (see Mint Workbench help file)

X3: Digital inputs DI0, DI3	Connector pitch 3.5 mm, wire size 1.0 mm^2 Logic levels: "0" < 5 V, "1" > 15 V R_{in}: 2 kΩ Minimum pulse width: 5 µs Filtering: Adjustable using `INPUTDEBOUNCE` keyword (see Mint Workbench help file)
X3: Digital outputs DO0…DO2	User supply: 24 V DC Output current: 100 mA max. per output, R_{load} > 250 Ω
X4: Safe Torque Off (STO)	Connector pitch 3.5 mm, wire size 1.0 mm^2 Output supply: STO power, 30 mA per input Pulse tolerance: < 1 ms For the drive to start, both connections STO1 and STO2 must be powered.
E1: Ethernet host PC connection	Connector: RJ-45 Cable length < 3 m
Memory capacity	256 KB program / variables; 1 KB non-volatile data

Feedback

■ X7 Incremental encoder without Halls

Encoder interface	RS422 A/B differential, Z index, RS422 Pulse+Direction differential
Max. input frequency A / B	2 MHz (8 MHz quadrature counts)
Output power supply to encoder	5.5 V DC (±7%) 350 mA max.*
Maximum recommended cable length	30 m

* Total combined current for this encoder and X8 primary encoder, which may be connected simultaneously (see page 82).

■ X8 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 DC (±7%) 350 mA max.* or 8 V DC set by switch
Maximum recommended cable length	30 m

* Total combined current for this encoder and the X7 encoder input, which may be connected simultaneously (see page 82).

■ X8 Serial interfaces + SinCos

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

Signals	Differential input pairs for Data, Clock, Sin, Cos.

Device types:
  BiSS-B, Smart Abs
  SSI
  EnDat, SinCos
  Hiperface
	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 8-12 V set by switch, 350 mA max.*
Maximum recommended cable length	30 m

* Total combined current for this encoder and either the X8 extra incremental encoder or X7 encoder, which may be connected simultaneously (see page 82).

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

*as of Firmware 5905.

■ **X8 Resolver**

Supports resolver by using the optional resolver adapter (page 195).

Resolver interface	Sin/Cos pairs
Maximum input speed	60000 rpm(2 pole resolver)
Resolver winding ratio	0.5±10%
Excitation supply load	100 mA max
Typical accuracy	±11 arc minutes
Maximum recommended cable length	30 m
Resolution	12 bit
Excitation frequency	12 kHz
Resolver voltage	5 Vrms(and above)

Dimensions and weights

For basic weights and dimensions, see *Main dimensions* on page 37.

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
Installation site altitude	0 to 2000 m (6560 ft) above sea level. [See also section *Derating* on page 160.]	-	-
Air temperature	0 to +55 °C (32 to 131 °F). No frost allowed. See section *Derating* on page 160.	-40 to +70 °C (-40 to +158 °F)	-40 to +70 °C (-40 to +158 °F)
Relative humidity	0 to 95%	Max. 95%	Max. 95%
	No condensation allowed. Maximum allowed relative humidity is 60% in the presence of corrosive gases.		
Contamination levels	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.		
Sinusoidal vibration: EN 60068-2-6: 2008	Tested according to, mechanical conditions: 2…9 Hz: 3.0 mm (0.12") 9…200 Hz: 1g	–	–
Shock: EN 60068-2-27: 2009 IEC 60068-2-27:2008	–	Max. 10g, 11 ms	Max. 10g, 11 ms
Free fall	Not allowed	76 cm (30")	76 cm (30")

Degrees of protection

MicroFlex e190 complies with EN 60529, IP20.

For UL purposes the MicroFlex e190 is defined as an open-type, three phase single axis servo amplifier.

The drive must be installed in a cabinet to fulfill 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

Drive enclosure	PC/ABS, color NCS 1502-Y (RAL 9002 / PMS 1C Cool Grey) and RAL 9017 (Traffic black). Hot-dip zinc coated steel sheet extruded aluminum AlSi.
Packaging	Corrugated cardboard, PP bands.
Disposal	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.

■ WEEE notice

According to the requirements of the Waste Electrical and Electronic Equipment Directive (WEEE) the following information is provided.

This symbol indicates that the product must not be disposed of with other general waste. It is your responsibility to dispose of your waste electrical equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment. The separate collection and recycling of your waste equipment at the time of disposal will help conserve natural resources and ensure that it is recycled in a

manner that protects human health and the environment. For more information about where you can recycle your waste, please contact your local authority.

■ RoHS compliance

MicroFlex e190 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 3AXD10000540158 is available on new.abb.com/drives.

■ China RoHS marking

The People's Republic of China Electronic Industry Standard (SJ/T 11364-2014) specifies the marking requirements for hazardous substances in electronic and electrical products. The green mark is attached to the drive to verify that it does not contain toxic and hazardous substances or elements above the maximum concentration values, and that it is an environmentally-friendly product which can be recycled and reused.

Part	Hazardous substances					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent chromium (Cr(VI))	Polybrominated biphenyls (PBB)	Polybrominated diphenyl ethers (PBDE)
PCB	O	O	O	O	O	O
Metal parts	O	O	O	O	O	O
Plastic parts	O	O	O	O	O	O
O: Indicates that said hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572.						
X: Indicates that said hazardous substance contained in at least one of the homogeneous materials used for this part is above the limit requirement of GB/T 26572. The limits are:						
Pb: 1000 ppm (0.1%) Hg: 1000 ppm (0.1%) Cd: 100 ppm (0.01%) Cr6+: 1000 ppm (0.1%) PBB: 1000 ppm (0.1%) PBDE: 1000 ppm (0.1%)						

Applicable standards

MicroFlex e190 complies with the following standards.

■ Design and test standards

UL 61800-5-1:2018	Power Conversion Equipment.
EN 61800-5-1:2007	Adjustable speed electrical power drive systems. Safety requirements. Electrical, thermal and energy.
EN 60529:1991 + A2:2013	Degrees of protection provided by enclosures.
EN 61800-3:2004 + A1:2012	Adjustable speed electrical power drive systems. Electromagnetic compatibility. Conducted emissions: When installed as directed in this manual, MicroFlex e190 conforms to Category C2 conducted limits. Radiated emissions: When installed as directed in this manual, MicroFlex e190 conforms to Category C2 radiated limits. All frame sizes conform to the 'second environment' immunity requirements defined by this standard.
EN 61800-9-2:2017	Adjustable speed electrical power drive systems. Ecodesign for power drive systems, motor starters, power electronics and their driven applications.

See also the CE Declaration of Conformity available on the Internet, see *Document library on the Internet* on page .

■ Environmental test standards:

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

■ **Functional safety standards**

EN 61508:2010, Parts 1, 2	Functional safety of electrical/electronic/programmable electronic safety-related systems
EN 61800-5-2:2007 IEC 61800-5-2:2016	Adjustable speed electrical power drive systems: Safety requirements, Functional
EN ISO 13849-1:2015	Safety of machinery: Safety-related parts of control systems. Part 1: General Principles for Design
EN ISO 13849-2:2012	Safety of Machinery: Safety-related parts of control systems. Part 2: Validation
EN 62061:2005 + A1: 2013 + A2: 2015	Safety of machinery: Functional safety of safety-related electrical, electronic and programmable electronic control systems

Note: For more functional safety standards compliance, see *Appendix: The Safe Torque Off (STO) function* on page 203.

RCM marking

RCM marking is required in Australia and New Zealand. A RCM 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*).

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.

Declaration of Conformity

The EU declaration (3AXD10001229164) is available on the Internet. See *Document library on the Internet* on page 231.

Compliance with the European Low Voltage Directive

The compliance with the European Low Voltage Directive has been verified according to standard EN 61800-5-1:2007. Declaration is available on the Internet.

Compliance with the European RoHS Directive

The RoHS Directive defines the restriction of the use of certain hazardous substances in electrical and electronic equipment. The declaration is available on the Internet.

Compliance with the European WEEE Directive

The WEEE Directive defines the regulated disposal and recycling of electric and electronic equipment.

Compliance with the European EMC Directive

The cabinet builder is in 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 C2 & 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 C2 & C3

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

1. The drive is equipped with optional mains filter (see page 179).

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.

Motor cable length does not exceed 30 metres (98.4 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.
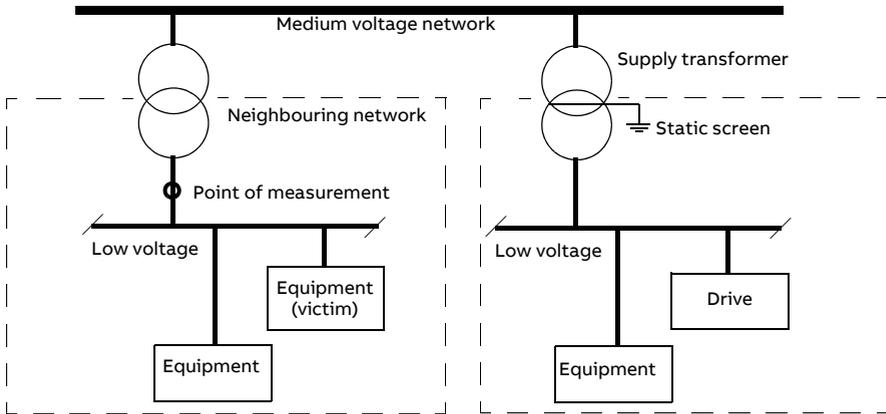
2. An EMC plan for preventing disturbances is drawn up for the installation. A template is available from the local ABB representative.

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.

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 (3AXD10001398251) is available on the Internet. See *Document library on the Internet* on page 231.

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 163.

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 170 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 162.

For installation in Canada, branch circuit protection must be provided in accordance with the Canadian Electrical Code and any applicable provincial codes. To fulfill this requirement, use the UL classified fuses given in section *Supply cable fuses* on page 162.

Power cable selection – See section *Selecting the power cables* on page 47.

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 64.

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

Braking – The MicroFlex e190 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 185.

UL standards – See section *Applicable standards* on page 173.

13

Mains filters

What this chapter contains

This chapter describes how to select and install mains filters for the MicroFlex e190. 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 MicroFlex e190 to meet the category C2 level, using a motor with a max. 30 m cable. This level corresponds to the A limits for Group 1 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 Ω] power system).

■ Footprint filter (single phase only)

The single-phase footprint AC power filter, part OFI-01, provides mounting holes for the MicroFlex e190. This allows the filter and MicroFlex e190 to use minimal panel mounting space.

Protective Earth (PE)
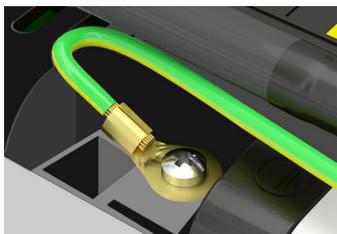
Installation guidelines

• 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.
• Connect the filter grounding cable to the protective earth (PE) point of the drive. The PE point is located on the top panel of the drive.

■ **Connection diagram**
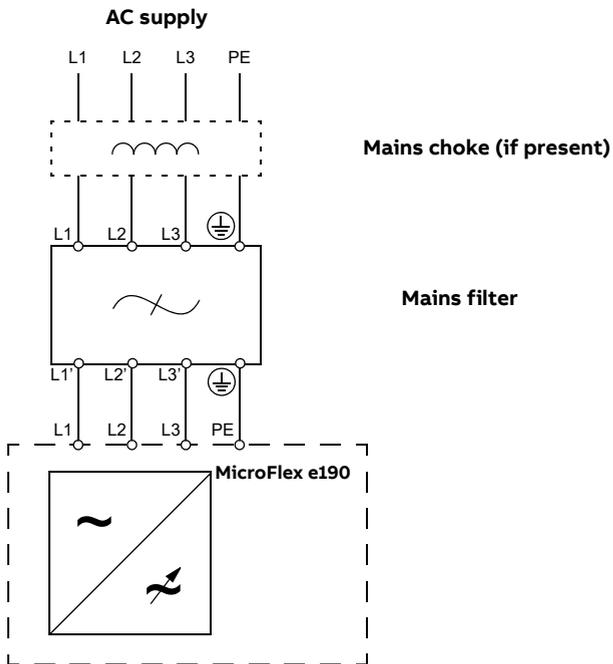
■ **Selection table**

Drive type MFE190-04UD...	230VAC 1Ø Meets EN 61800-3, category C2 with motor cable <30 m	230VAC 3Ø Meets EN 61800-3, category C2 with motor cable <30 m
-03A0-2	OFI-02 or OFI-01	OFI-03
-06A0-2	OFI-01	JFI-02
-09A0-2		

The mains filters are protected to IP20.

Specifications and dimensions

Part	Rated volts	Rated amps @ 40°C	Leakage current (mA)	Weight kg (lbs)
OFI-02	250	8	0.7	0.33 (0.73)
OFI-03	480	7	33	0.5 (1.1)
JFI-02	480	16	33	0.8 (1.76)
OFI-01	250	20	12	0.72 (1.59)

Dimensions, type OFI-01:

Mounting slot detail

G 5.3 mm
H 10.25 mm
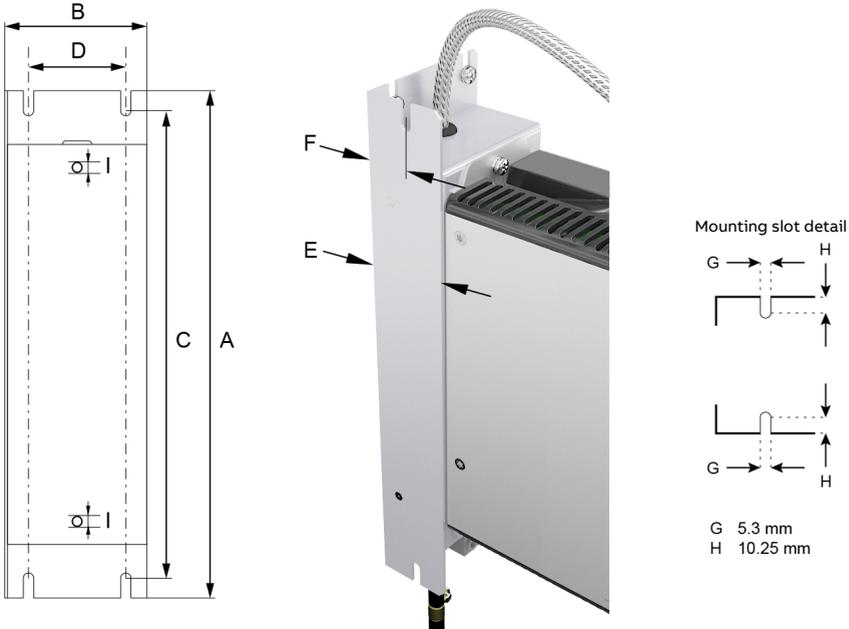
Dimension	OFI-01 Dimensions: mm (inches)
A	260 (10.23)
B	73 (2.87)
C	239.5 (9.43)
D	50 (1.97)
E	40 (1.57)
F	21.5 (0.87)
I	M5×10 (0.39) max. depth

Dimensions, type OFI-02:
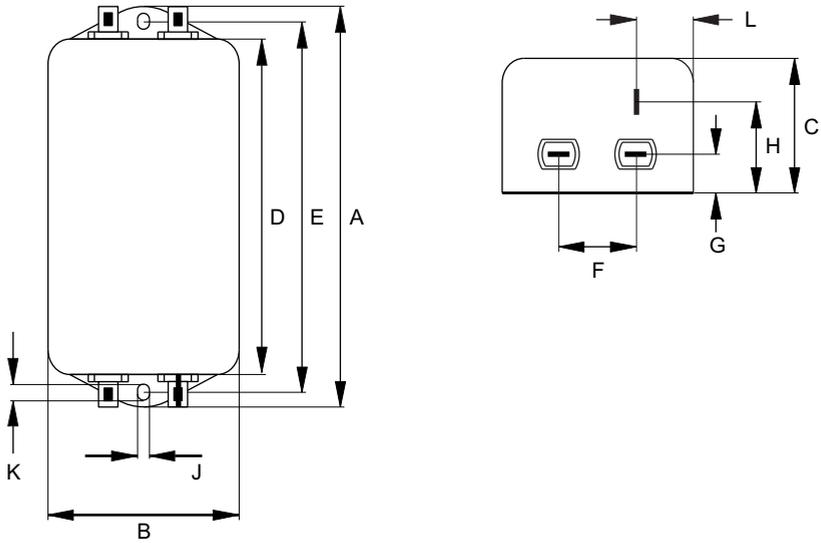
Dimension	OFI-02 Dimensions: mm (inches)
A	113.5 (4.47)
B	57.5 (2.26)
C	45.4 (1.79)
D	94 (3.7)
E	103 (4.06)
F	25(0.98)
G	12.4 (0.49)
H	32.4 (1.28)
J	4.4 (0.17)
K	6 (0.24)
L	15.5 (0.61)

Dimensions, types OFI-03 / JFI-02:
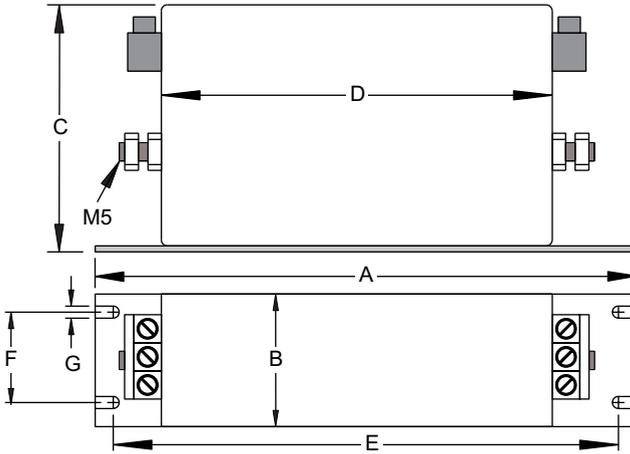
Dimension	Dimensions: mm (inches)	
	OFI-03	**JFI-02**
A	190 (7.48)	250 (9.84)
B	40 (1.57)	45 (1.77)
C	70 (2.76)	70 (2.76)
D	160 (6.30)	220 (8.66)
E	180 (7.09)	235 (9.25)
F	20 (0.79)	25 (0.98)
G	4.5 (0.18)	5.4 (0.21)

EMC screw disconnection

This operation is applicable only to special application that the filter is not suitable for, such as the leakage current sensitive environment.

Please contact ABB technical support for more information.

14

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.

⚠ **WARNING!** Electrical shock hazard. DC-bus voltages can be present at the brake resistor terminals. Use a suitable heat sink (with fan if necessary) to cool the brake resistor. The brake resistor and heat sink (if present) can reach temperatures in excess of 80 °C (176 °F).

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 over-voltage 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 brake resistor (also known as a regeneration or 'regen' resistor) to be dissipated as heat. The brake 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 brake resistor.

System braking capacity

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

$$B_{dc} = 0.5 \text{ x } \textit{DC bus capacitance} \text{ x } \left((\textit{Brake switching threshold})^2 - (\sqrt{2} \text{ x } \textit{Supply voltage})^2 \right)$$

where the *Brake switching threshold* is 388 V. This gives the following typical values:

MicroFlex e190			Braking capacity, B_{dc} (J)
Model	Frame	DC bus capacitance (µF)	240 V AC supply
03A0-2	A	560	12.5
06A0-2	A	1120	25
09A0-2	A		

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. *Multiply RPM by 0.1047 to give radians per second.*	**Initial motor speed, U =** _____ **rad/s**
b) Final motor speed after deceleration is complete, in radians per second. *Multiply RPM by 0.1047 to get radians per second. This value will be zero if the load is going to be stopped.*	**Final motor speed, V =** _____ **rad/s**
c) The deceleration time from initial speed to final speed, in seconds.	**Decel time, D** **=** _____ **s**
d) The total cycle time (i.e. how frequently the process is repeated), in seconds.	**Cycle time, C** **=** _____ **s**
e) Total inertia. *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 kg·m^2 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.* *Multiply kg·cm^2 by 0.0001 to give kg·m^2.* *Multiply lb-ft^2 by 0.04214 to give kg·m^2.* *Multiply lb-in-s^2 by 0.113 to give kg·m^2.*	**Total inertia, J** **=** _____ **kg·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 ω is the angular velocity.

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

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

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

$$= \underline{\hspace{3cm}} \text{ J (joules)}$$

Calculate the braking energy for the motor. If the value is less than the system braking capacity B_{dc}, calculated on page 186, a brake resistor will not be required.

■ Braking power and average power

The braking power, $P_{gen,max}$, is the *rate* at which the braking energy is dissipated. This rate is defined by the deceleration period, D (see page 186). The shorter the deceleration period, the greater the braking power.

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

$$P_{gen,max} = \underline{\hspace{3cm}} \text{ W (watts)}$$

The brake resistors shown in the table on page 189 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 187):

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

$$= \underline{\hspace{3cm}} \text{ W (watts)}$$

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

■ Resistor choice

$P_{gen,ave}$ 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[1], so:

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

$$\underline{\hspace{3cm}} \text{ W (watts)}$$

The range of suitable brake resistors is shown in the following table. Choose the resistor that has a power rating equal to or greater than the value calculated above.

Part	Resistance	Power rating
RGJ139	39 Ω	100 W
RGJ160	60 Ω	100 W
RGJ260	60 Ω	200 W
RGJ360	60 Ω	300 W

⚠ **WARNING!** The brake resistance must be 39 Ω or greater to ensure the drive's maximum regeneration switching current (10 A) is not exceeded. Failure to observe the minimum resistance could result in damage to the drive. See *Brake resistor connection* on page 165.

1. *The brake resistors listed in the following table can withstand a brief overload of 10 times the rated power for 5 seconds. Please contact ABB if larger power ratings are required.*

■ Resistor derating

The brake resistors shown in the previous table can achieve their stated power rating only when mounted on a heat sink. In free air a derating must be applied. Furthermore, in ambient temperatures greater than 25 °C (77 °F), a temperature derating must be applied.

Resistor part number	Nominal power rating (W)	In free air	On heat sink
RGJ139 RGJ160	100	Derate power linearly from: 80% @ 25 °C (77 °F) to 70% @ 55 °C (113 °F)	Derate power linearly from: 100% @ 25 °C (77 °F) to 88% @ 55 °C (113 °F) Typical heat sink: 200 mm x 200 mm x 3 mm
RGJ260 RGJ360	200 300	Derate power linearly from: 70% @ 25 °C (77 °F) to 62% @ 55 °C (113 °F)	Derate power linearly from: 100% @ 25 °C (77 °F) to 88% @ 55 °C (113 °F) Typical heat sink: 400 mm x 400 mm x 3 mm

■ 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):
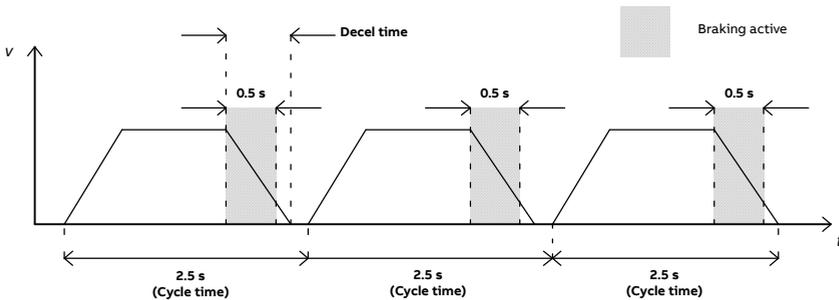
■ Dimensions
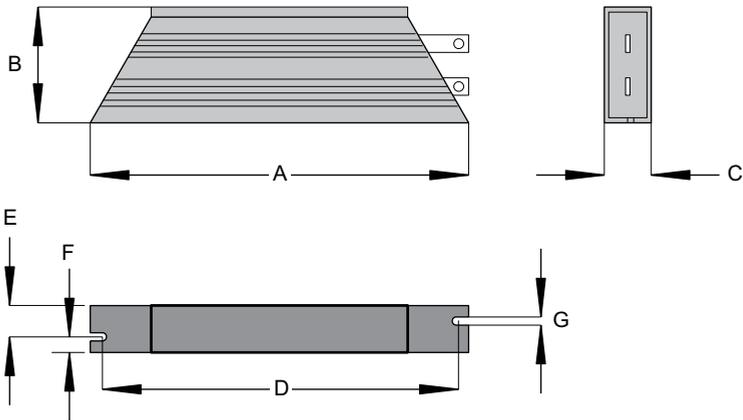
Part	Power W	Res. Ω	Dimensions mm (inches)						
			A	**B**	**C**	**D**	**E**	**F**	**G**
RGJ139	100	39	165 (6.49)	41 (1.61)	22 (0.87)	152 (5.98)	12 (0.47)	10 (0.39)	4.3 (0.17)
RGJ160	100	60	165 (6.49)	41 (1.61)	22 (0.87)	152 (5.98)	12 (0.47)	10 (0.39)	4.3 (0.17)
RGJ260	200	60	165 (6.49)	60 (2.36)	30 (1.18)	146 (5.75)	17 (0.67)	13 (0.51)	5.3 (0.21)
RGJ360	300	60	215 (8.46)	60 (2.36)	30 (1.18)	196 (7.72)	17 (0.67)	13 (0.51)	5.3 (0.21)

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Accessories

What this chapter contains

This section describes accessories and options that you might need to use with your MicroFlex e190. Shielded (screened) cables provide EMI / RFI shielding and are required for compliance with CE regulations. All connectors and other components must be compatible with the shielded cable.

■ 24 V power supplies

A range of compact 24 V DIN rail mounting power supplies are available. The supplies include short circuit, overload, over-voltage and thermal protection.

Part	Input voltage	Output voltage	Output rating
CP-E 24/0.75	100-240 V AC	24 V DC	0.75 A
CP-E 24/1.25	100-240 V AC	24 V DC	1.25 A
CP-E 24/2.5	100-240 V AC	24 V DC	2.5 A
CP-E 24/5.0	115/230 V AC	24 V DC	5 A
CP-E 24/10.0	115/230 V AC	24 V DC	10 A
CP-E 24/20.0	115/230 V AC	24 V DC	20 A

Encoder breakout OPT-MF-200

The encoder breakout (part OPT-MF-200) can be used to connect motor feedback and an extra incremental encoder (see page). Alternatively, the connectors can be used together to connect a single motor that has separate cables for encoder and Halls (e.g. a linear motor).

OPT-MF-200

MicroFlex e190

OPT-MF-200

Motor feedback   Incremental encoder

Resolver adapter OPT-MF-201

The resolver adapter (OPT-MF-201) allows a motor with resolver feedback to be connected to the MicroFlex e190. The MicroFlex e190 must be power-cycled after connecting the resolver adapter. The resolver adapter sends an absolute position to the MicroFlex e190 at startup, so a phase search is not required. In Mint Workbench, select a resolver motor in the Drive Setup Wizard. The wizard's *Feedback* page will show the feedback type as Resolver Adapter. The resolver adapter can be used in conjunction with the encoder breakout (OPT-MF-200).
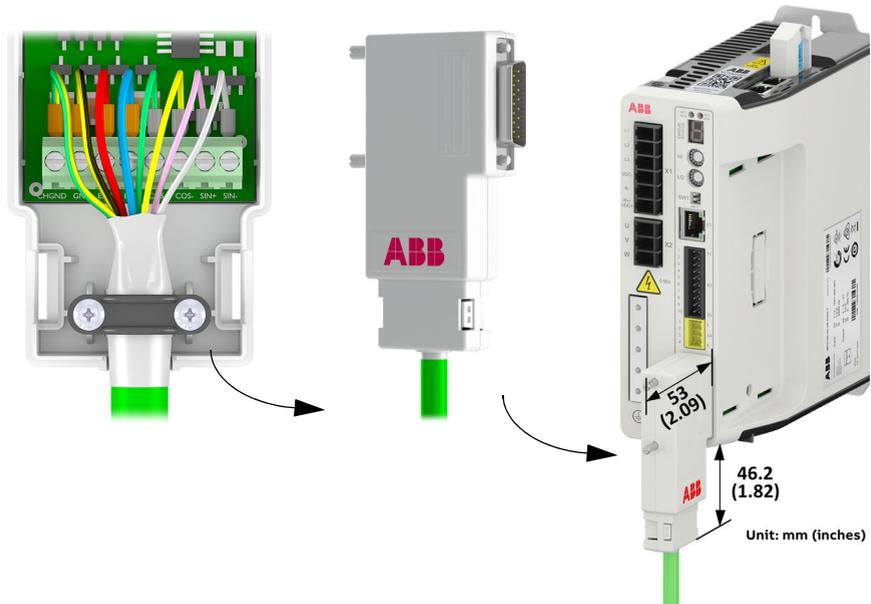
Resolver adapter specifications

- Excitation frequency: 10 kHz
- Maximum input speed: 60000 rpm (2 pole resolver)
- Output resolution: 12-bit
- Accuracy: +/-11 arc minutes

Resolver requirements

When selecting the resolver, you must connect it to the OPT-MF-201 adapter (see Quick installation guide for more detail). The specification of this allows for a resolver which satisfies the following criteria:

- 2 x Sin / Cos pairs (2 pole resolver)
- Winding ratio 0.5

Note: These are the key characteristics to be used when deciding if the resolver is compatible or not.

Further information on the resolver, see *X8 Resolver* on page*169*.

Option card OPT-SIO-1

The option card can provides:

1 general purpose analog input

6 general purpose digital inputs

4 general purpose digital outputs

1 RS485/ RS422 serial port

One analog input with a 12-bit resolution receives a wide range from -10V to +10V.

Six digital input channels are divided into 2 groups. Each group is powered by separate external power supply and allows the input signal to be connected with either polarity. All digital outputs share one common external power supply and the maximum voltage across the outputs when active is 30VDC. Serial port supports 4-wire or 2-wire connections. DIP switch SW2 is used for connecting terminal resistor.

See OPT-SIO-1 option card user's manual (code:3AXD50000351336) for details.

Note: The firmware build version that supports the option card is MicroFlex e190 Build 5900.4.0 and later.
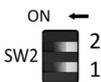
Switch	Purpose	OFF	ON
2	RS422 RX terminator	NO	120Ω
1	RS422 TX terminator or RS485 terminator	NO	120Ω

X9

Pin 1   Pin 8

1	TX+/ A	8	TX+/ A
2	TX-/ B	9	TX-/ B
3	Shield	10	Shield
4	RX+	11	RX+
5	RX-	12	RX-
6	Shield	13	Shield
7	AIN1-	14	AIN1+

X10

Pin 14   Pin 7

14	Shield	7	DIN4
13	CREF1	6	DIN5
12	DIN8	5	DIN6
11	DIN9	4	DIN7
10	USRV+	3	CREF0
9	DOUT5	2	DOUT3
8	DOUT6	1	DOUT4

Cables

A wide range of motor and feedback cables are available.

■ Motor power cables

For easier installation, it is recommended that a color-coded motor power cable is used. The part number for a BSM rotary motor power cable is derived as follows:

CBL   025   SP   -12   S

m	ft			Current (Amps)		
1.5	5*	**SP**	BSM style threaded motor connector (motor end only)		**-**	Standard connector
2.5	8.2					
3.0	10*			**6**	**S**	Stainless connector
5.0	16.4	**WP**	SDM style threaded motor connector (motor end only)	**12**		
6.1	20*			**20**		
7.5	24.6			**35**		
9.1	30*	**RP**	Raw cable (no connector)	**50**		
10	32.8			**90**		
15	49.2					
15.2	50*					
20	65.6					
22.9	75*					
30.5	100*					

* North America only

Larger motors requiring 35 A cable or greater normally use terminal box connections, so a motor power connector is not required. For this reason connectors are not available on 35 A - 90 A cable.

Examples:
A 6.1 m cable, with a CE threaded standard connector, rated for 12 A has part number **CBL061SP-12**.

A 30.5 m cable, with a CE threaded stainless steel connector, rated for 20 A has part number **CBL305SP-20S**.

A 50 ft cable, with no connector, rated for 50 A has part number **CBL152RP-50**.

■ Feedback cables

The part number for a feedback cable is derived as follows:

CBL   020   SF   -E   1   S

m	ft					
		SF BSM servo motor feedback cable with at least 1 connector	**B** BiSS	**-** Raw cable	**-** Standard connector	
2.5	8.2		**D** EnDat SinCos	**1** Legacy controllers		
5.0	16.4	**WF** SDM servo motor feedback cable with at least 1 connector			**S** Stainless steel connector	
7.5	24.6		**E** Incremental encoder	**2** e100 / e150 e180 / e190		
10	32.8					
15	49.2	**DF** Servo motor feedback cable with drive connector only	**S** SSI			
20	65.6					
30	98.4		**A** Smart Abs			
		RF Raw cable (no connector)				

Other lengths available on request

R Resolver

Example:
A 2 m encoder feedback cable for a MicroFlex e190 drive, with required connectors at both ends, has part number **CBL020SF-E2.**

These feedback cables have the outer shield tied to the connector housing(s). If you are using an alternative cable with your chosen feedback device, be sure to obtain a cable that is a shielded twisted pair 0.34 mm^2 (22 AWG) wire minimum, with an overall shield. Ideally, the cable should not exceed 30.5 m (100 ft). Maximum wire-to-wire or wire-to-shield capacitance is 50 pF per 300 mm (1 ft) length, to a maximum of 5000 pF for 30.5 m (100 ft).

■ Ethernet cables

The cables listed in this table connect MicroFlex e190 to other Ethernet nodes such as the controller, additional MicroFlex e190s, or other Ethernet compatible hardware. The cables are standard CAT5e shielded twisted pair 'crossover' Ethernet cables:

Cable description	Part	Length	
		m	**ft**
CAT5e Ethernet cable	CBL002CM-EXS	0.2	0.65
	CBL005CM-EXS	0.5	1.6
	CBL010CM-EXS	1.0	3.3
	CBL020CM-EXS	2.0	6.6
	CBL050CM-EXS	5.0	16.4
	CBL100CM-EXS	10.0	32.8
	CBL200CM-EXS	20.0	65.6

Connectors

The MFE190 DRIVE CONNECTOR KIT (order code: 3AXD50000038521) containing terminal blocks for the e190 drive can be provided separately if necessary.

The connector pack contains:

No.	Connector	Description	Quantity
1	X1A		1
2	X1B		1
3	X2		1
4	X3		1
5	X4		1

Note: The pictures are for reference only. Actual connectors are subject to change without notice.

Screws and clamps

The MFE190 DRIVE INSTALLATION KIT (order code: 3AXD50000447121) containing memory unit (MU) fixing screw, grounding screws and cable shield clamps for the e190 drive can be provided separately if necessary.

The installation pack contains:

No.	Name	Description	Quantity
1	Cable shield clamp	P-CLIP, AL5	3
2	Grounding screw	M4x8	5
3	MU fixing screw	M3x8	1

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Appendix: The Safe Torque Off (STO) function

Contents of this chapter

The appendix describes the Safe torque off (STO) function for the servo drive and gives instructions for its use. In addition, application features and technical data for the safety system calculation are presented.

Description

The STO function disables the control voltage of the power semiconductors of the drive output stage, which prevents the drive generating the voltage required to rotate the motor (see diagrams in section *Wiring*). 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.

The STO function has a redundant architecture, that is, both channels must be used in the safety function implementation. The safety data given in this manual is calculated for redundant use, and does not apply if both channels are not used.

The STO function complies with these standards:

Standard	Name
IEC 60204-1:2016 EN 60204-1:2018	Safety of machinery – Electrical equipment of machines – Part 1: General requirements
EN 61000-6-7:2015	Electromagnetic compatibility (EMC) – Part 6-7: Generic standards – Immunity requirements for equipment intended to perform functions in a safety-related system (functional safety) in industrial locations

Standard	Name
EN 61326-3-1:2017	Electrical equipment for measurement, control and laboratory use – EMC requirements – Part 3-1: Immunity requirements for safety-related systems and for equipment intended to perform safety-related functions (functional safety) – General industrial applications
EN 61508-1:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements
EN 61508-2:2010	Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related systems
EN 61511-1:2016	Functional safety – Safety instrumented systems for the process industry sector
EN 61800-5-2:2007 IEC 61800-5-2:2016	Adjustable speed electrical power drive systems – Part 5-2: Safety requirements – Functional
EN 62061:2005 + AC:2010 + A1:2013 + A2:2015	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
EN ISO 13849-1:2015	Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design
EN ISO 13849-2:2012	Safety of machinery – Safety-related parts of control systems – Part 2: Validation

The function also corresponds to Prevention of unexpected start-up as specified by EN ISO 14118:2018 (ISO 14118:2017), and Uncontrolled stop (stop category 0) as specified in EN/IEC 60204-1.

■ Compliance with the European Machinery Directive

See section *Compliance with the European Machinery Directive* on page .

The Declaration of Conformity is shown at the end of this chapter.

Wiring

For information on the specifications of the STO input, see section *Safety data* (page 225).

■ Activation switch

In the wiring diagrams below, the activation switch represents a component such as a manually operated switch, an emergency stop push button switch, or the contacts of a safety relay or safety PLC.

• If a manually operated activation switch is used, the switch must be of a type that can be locked out to the open position.

• The STO inputs must be switched on/off within 200 ms of each other.

■ Cable types and lengths

• Double-shielded twisted-pair cable is recommended.

• Maximum cable length 30 m (98 ft) between activation switch and the drive.

Note: A short-circuit in the wiring between the switch and an STO terminal causes a dangerous fault. Therefore, it is recommended to use a safety relay (including wiring diagnostics), or a wiring method (shield grounding, channel separation) which reduces or eliminates the risk caused by the short-circuit.

Note: The voltage at each channel of STO input terminal X4 must be at least 13 V DC to be interpreted as "1". The pulse tolerance of the input channels is 1 ms.

■ Grounding of protective shields

• Ground the shield in the cabling between the activation switch and the control unit at the control unit only.

• Ground the shield in the cabling between two control units at one control unit only.

■ Connection principle

Single MicroFlex e190 drive, internal power supply
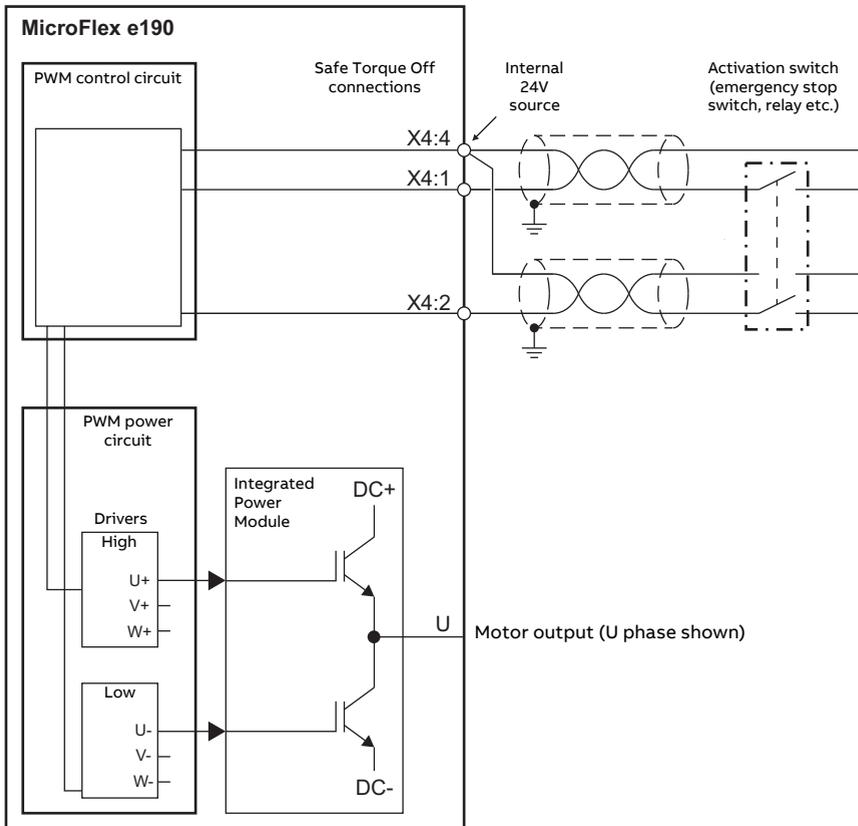
Single MicroFlex e190 drive, external power supply
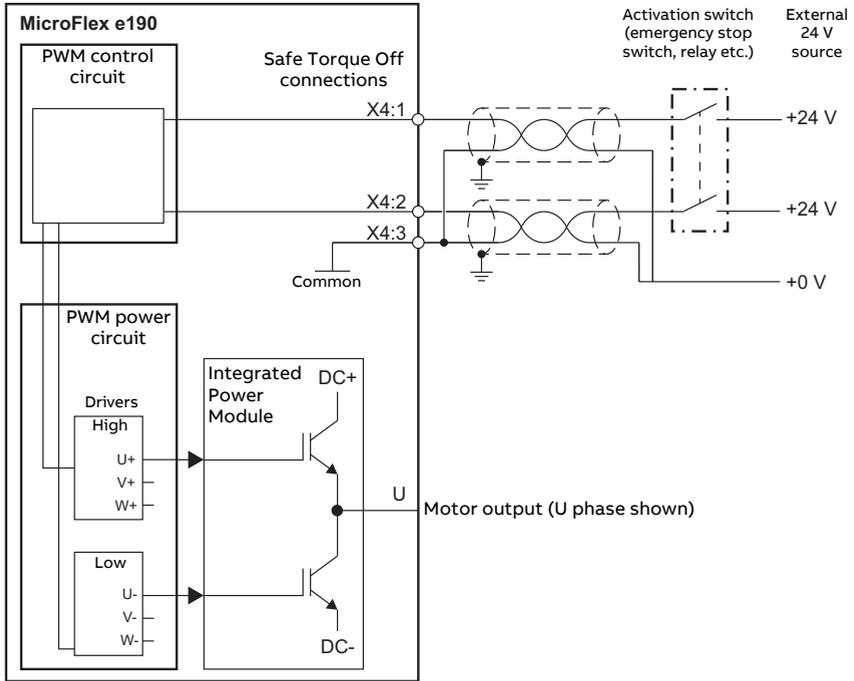
Notes:
* The STO function is activated when one or both of the safety circuit contacts open. If the period between both contacts opening or closing exceeds a predefined value, a fault in the safety circuit or wiring is assumed and an error is reported.
* The maximum cable length between drive and the safety switch is 30 m (98 ft).

■ Wiring examples

Single drive module: internal power supply
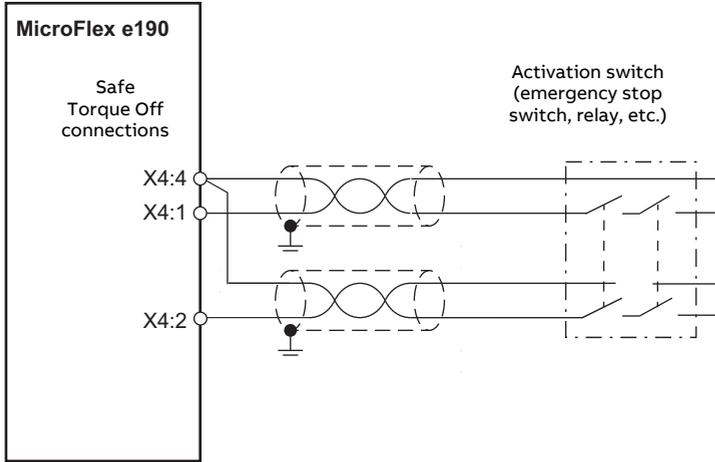
Single drive module: external power supply
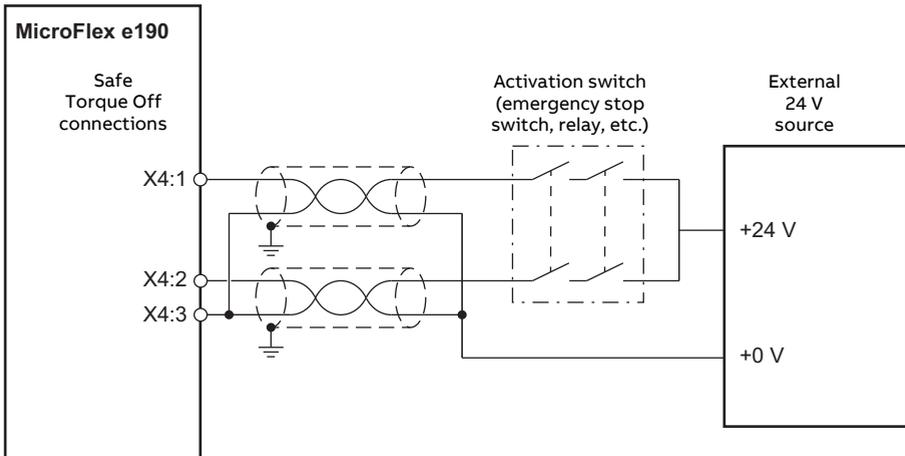
Multiple drive modules: internal power supply

MicroFlex e190
Safe
Torque Off
connections

Activation switch
(emergency stop
switch, relay, etc.)

X4:4
X4:1
X4:2
X4:3

MicroFlex e190
Safe
Torque Off
connections

X4:1
X4:2
X4:3

MicroFlex e190
Safe
Torque Off
connections

X4:1
X4:2
X4:3

Note: The maximum number of drives is 16.

Multiple drive modules: external power supply

MicroFlex e190
Safe
Torque Off
connections

Activation switch
(emergency stop
switch, relay, etc.)

24 V External
Supply

+24 V

+0 V

X4:1
X4:2
X4:3

MicroFlex e190
Safe
Torque Off
connections

X4:1
X4:2
X4:3

MicroFlex e190
Safe
Torque Off
connections

X4:1
X4:2
X4:3

Note: The maximum number of drives is 16.

Operation principle

The Safe Torque Off connector is X4 on MicroFlex e190 drives.

Connection principles are shown in the diagrams in section *Wiring* on page 205. See section *STO technical data* on page 228 for the cable specification and possible safety relay types.

1. The wiring to each STO input must be routed separately.

2. Wiring the STO inputs in accordance with the 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.

3. The Safe Torque Off (STO) function provides a stop function equivalent to 'stop category 0' according to EN 60204-1.

4. 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 recognized by the MicroFlex e190, 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 4 of connector X4. This supply is derived from the bus voltage (if present) or from the optional 24 V logic supply on connector X2 (if present).

If an external 24 V DC power supply is connected to X4 it must fulfill 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 <u>not</u> be wired as part of the STO input circuit.

Start-up including validation test

To ensure the safe operation of a safety function, validation is required. The final assembler of the machine must validate the function by performing a validation test. The validation 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
• after a drive firmware update
• at the proof test interval, T_1

◼ Competence

The validation test of the safety function must be carried out by a competent person with adequate expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6. The test procedures and report must be documented and signed by this person.

◼ Validation test reports

Signed validation 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 validation 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.

■ Validation test procedure

After wiring the Safe torque off function, validate its operation as follows.

	Action
☐	⚠ **WARNING!** Obey the safety instructions. If you ignore them, injury or death, or damage to the equipment can occur.
☐	Ensure that the drive can be run and stopped freely during the commissioning.
☐	Stop the drive (if running), switch off the input power and isolate the drive from the power line by a disconnector.
☐	Check the STO circuit connections against the circuit diagram.
☐	Check that the shield of the STO input cable is grounded to the drive frame.
☐	Close the disconnector and switch on the power.
☐	Test the operation of the STO function when the motor is stopped: • Disable the drive and ensure the motor shaft is not rotating. • Activate the STO function (remove power from the STO inputs) and attempt to enable the drive. • Ensure that the drive can not be enabled (see section *Use* on page 216.) • Deactivate the STO function (apply power to the STO inputs).
☐	Test the operation of the STO function when the motor is running: • Enable the drive and start motion. Ensure the motor is rotating. • Activate the STO function (remove power from the STO inputs). • Ensure that the drive disables and the motor stops rotating. • Attempt to enable the drive. • Ensure that the drive can not be enabled (see section *Use* on page 216.) • Deactivate the STO circuit (apply power to the STO inputs).
☐	Document and sign the validation 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
Deactivate the STO circuit (apply power to the STO inputs).
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: • Activate the additional drive enable input (if present). • In Mint Workbench (if connected), click the Clear errors button on the System toolbar, followed by the Drive Enable button on the Motion toolbar. • Enable the drive from the Ethernet master device (if connected).

Use

1. Open the activation switch, or activate the safety functionality that is wired to the STO connection.

2. The STO inputs on the drive control unit de-energize, and the control unit cuts off the control voltage from the output IGBTs.

3.The control program generates an indication, see section *STO status indications* (page 218).

4. The motor coasts to a stop (if running). The drive will not restart while the activation switch or safety relay contacts are open.

5. Deactivate the STO by closing the activation switch, or resetting the safety functionality that is wired to the STO connection.

6. Reset any faults before restarting.

WARNING! The 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 from the supply and all other voltage sources. If the drive was connected to the input power, wait for 5 minutes after disconnecting the input power.

■ 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 all the faults have been cleared.

■ Firmware monitoring of the STO function

STO function activation

The firmware detects when the STO function is activated and will generates the 'STO active' error (10033) if the drive is enabled. The drive can be enabled again only after all the faults have 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 (the default value is 100ms). If the inputs are in different states

after the specified period has elapsed, the 'STO input mismatch' error (10035) is generated.

⚠ **WARNING!** The drive cannot detect or memorize any changes in the STO circuitry when the drive control unit is not powered. If both STO circuits are closed and a level-type start signal is active when the power is restored, it is possible that the drive starts without a fresh start command. Take this into account in the risk assessment of the system.

◾ 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 STO channel 1 and STO channel 2, the internal STO status output and the internal STO fault latch. This array is described in the following table:

Parameter	Meaning
SAFETORQUEOFF(0)	The combined state of the two STO inputs: STO1 = bit 0, STO2 = bit 1 0 = not powered, 1 = powered
SAFETORQUEOFF(1)	The state of STO1 input: 0 = not powered, 1 = powered
SAFETORQUEOFF(2)	The state of STO2 input: 0 = not powered, 1 = powered
SAFETORQUEOFF(6)	The state of the internal STO status output: 0 = fault, 1 = no fault
SAFETORQUEOFF(7)	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 218 for a complete listing of SAFETORQUEOFF values.

See *Error messages generated by the drive* on page 222, 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 217).
- 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$_{STO1}$ present	FAULT$_{STO2}$ present	FAULT$_{STO1}$ FAULT$_{STO2}$ both present
STO1 & STO2 powered	**STO in standby.** **Motor output enabled.** `SAFETORQUEOFF(0)=3` `SAFETORQUEOFF(1)=1` `SAFETORQUEOFF(2)=1` `SAFETORQUEOFF(6)=1`	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=3` `SAFETORQUEOFF(1)=1` `SAFETORQUEOFF(2)=1` `SAFETORQUEOFF(6)=0`	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=3` `SAFETORQUEOFF(1)=1` `SAFETORQUEOFF(2)=1` `SAFETORQUEOFF(6)=0`	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=3` `SAFETORQUEOFF(1)=1` `SAFETORQUEOFF(2)=1` `SAFETORQUEOFF(6)=0`
STO1 not powered	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=2` `SAFETORQUEOFF(1)=0` `SAFETORQUEOFF(2)=1` `SAFETORQUEOFF(6)=0`	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=2` `SAFETORQUEOFF(1)=0` `SAFETORQUEOFF(2)=1` `SAFETORQUEOFF(6)=0`	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=2` `SAFETORQUEOFF(1)=0` `SAFETORQUEOFF(2)=1` `SAFETORQUEOFF(6)=0`	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=2` `SAFETORQUEOFF(1)=0` `SAFETORQUEOFF(2)=1` `SAFETORQUEOFF(6)=0`
STO2 not powered	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=1` `SAFETORQUEOFF(1)=1` `SAFETORQUEOFF(2)=0` `SAFETORQUEOFF(6)=0`	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=1` `SAFETORQUEOFF(1)=1` `SAFETORQUEOFF(2)=0` `SAFETORQUEOFF(6)=0`	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=1` `SAFETORQUEOFF(1)=1` `SAFETORQUEOFF(2)=0` `SAFETORQUEOFF(6)=0`	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=1` `SAFETORQUEOFF(1)=1` `SAFETORQUEOFF(2)=0` `SAFETORQUEOFF(6)=0`
STO1 STO2 both not powered	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=0` `SAFETORQUEOFF(1)=0` `SAFETORQUEOFF(2)=0` `SAFETORQUEOFF(6)=0`	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=0` `SAFETORQUEOFF(1)=0` `SAFETORQUEOFF(2)=0` `SAFETORQUEOFF(6)=0`	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=0` `SAFETORQUEOFF(1)=0` `SAFETORQUEOFF(2)=0` `SAFETORQUEOFF(6)=0`	**STO activated.** **Motor output disabled.** `SAFETORQUEOFF(0)=0` `SAFETORQUEOFF(1)=0` `SAFETORQUEOFF(2)=0` `SAFETORQUEOFF(6)=0`

STO software functional diagram
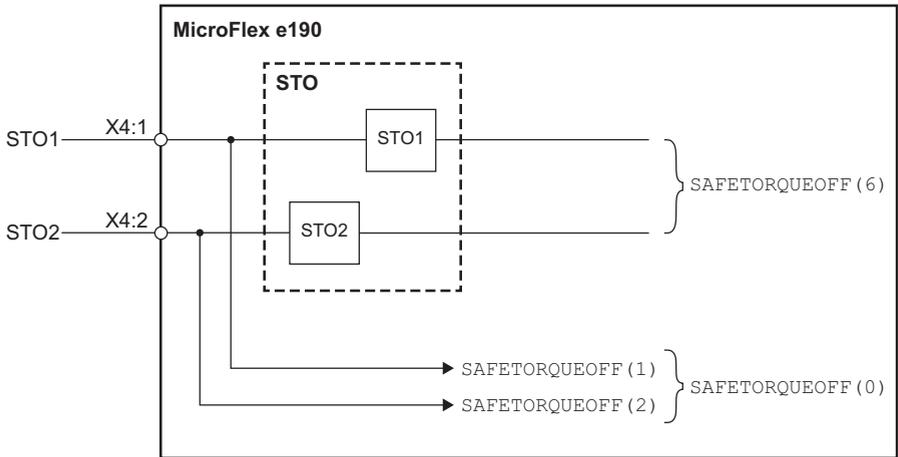
■ Monitoring the delay between the STO inputs

The STO function monitors the switching time difference between the STO inputs. See *Use* on page 216.

■ 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.

■ Special considerations for using the STO function

Drive location

The MicroFlex e190 and all associated STO wiring must be installed in an indoor location. The MicroFlex e190 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 170 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.

Maintenance

After the operation of the circuit is validated at start-up, the STO function shall be maintained by periodic proof testing. In high demand mode of operation, the maximum proof test interval is 20 years. In low demand mode of operation, the maximum proof test interval is 5 or 2 years; see section *Safety data* (page 225). It is assumed that all dangerous failures of the STO circuit are detected by the proof test. To perform the proof test, do the *Validation test procedure* (page 214).

Note: See also the Recommendation of Use CNB/M/11.050 (published by the European co-ordination of Notified Bodies) concerning dual-channel safety-related systems with electromechanical outputs:

• When the safety integrity requirement for the safety function is SIL 3 or PL e (cat. 3 or 4), the proof test for the function must be performed at least every month.

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 STO function does not contain any electromechanical components.

In addition to proof testing, it is a good practice to check the operation of the function when other maintenance procedures are carried out on the machinery.

Include the STO operation tests described in *Special considerations for using the STO function* on page 219 in the routine maintenance program of the machinery to which the drive is connected.

If any wiring or component change is needed after start up, or the parameters are restored, do the test given in section *Validation test procedure* (page 214).

Use only spare parts approved by ABB.

Record all maintenance and proof test activities in the machine logbook.

■ Competence

The maintenance and proof test activities of the safety function must be carried out by a competent person with adequate expertise and knowledge of the safety function as well as functional safety, as required by IEC 61508-1 clause 6.

Fault tracing

The diagnostics of the STO function cross-compare the status of the two STO channels. In case the channels are not in the same state, a fault reaction function is performed and the drive trips on an "STO hardware failure" fault. An attempt to use the STO in a non-redundant manner, for example activating only one channel, will trigger the same reaction.

Any failure of the STO function must be reported to ABB.

■ 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..0..3..3.

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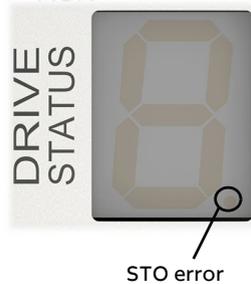
STO error

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
10033 STO active ecSTO_ACTIVE	Either one or both of the STO inputs is not powered. This error is detected when the drive is enabled, or when attempting to enable the drive in software.	
	- safe switch or relay has dropped an output that controls the STO input.	Use a test meter to check that the device controlling the STO input is providing the required output.
	- emergency stop switch has been operated.	Check the operation of the emergency stop switch. Check that the contacts close correctly when the switch is reset.
	- faulty safety relay	Check the operation of the safety relay.
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.	Check the operation of the emergency stop switch. Check that the contacts close correctly when the switch is reset.
	This error can occur while the drive is enabled or disabled.	Check that the period defined by STOINPUTMISMATCHTIME is long enough to allow both STO inputs to settle.
	- emergency stop switch fault	Check the operation of the emergency stop switch. Check that the contacts close correctly when the switch is reset.
	- wiring fault	Check all wiring for the STO inputs.

■ 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.

Safety data

The safety data for the STO function and failure rates are given below.

Note: The safety data is calculated for redundant use, and does not apply if both STO channels are not used.

Drive	SIL / SILCL	PL	SFF (%)	PFH (T_1=20a) (1/h)	PFD_{avg} (T_1=2a)	PFD_{avg} (T_1=5a)	$MTTF_D$ (a)	DC (%)	SC	Cat.	HFT	CCF	T_M (a)
e190	3	e	>99	1.84E-09	1.61E-05	4.03E-05	41836	≥90	3	3	1	80	20

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- The following temperature profile is used in safety value calculations:
  - 670 on/off cycles per year with ΔT = 71.66 °C
  - 1340 on/off cycles per year with ΔT = 61.66 °C
  - 30 on/off cycles per year with ΔT = 10.0 °C
  - 32 °C board temperature at 2.0% of time
  - 60 °C board temperature at 1.5% of time
  - 85 °C board temperature at 2.3% of time.
- The STO is a type A safety component as defined in IEC 61508-2.
- Relevant failure modes:
  - The STO trips spuriously (safe failure)
  - The STO does not activate when requested

  A fault exclusion on the failure mode "short circuit on printed circuit board" has been made (EN 13849-2, table D.5). The analysis is based on an assumption that one failure occurs at one time. No accumulated failures have been analyzed.
- STO reaction time (shortest detectable break): 1 ms
- STO response time: 5 ms (typical), 10 ms (maximum)
- Fault detection time: Channels in different states for longer than 200 ms
- Fault reaction time: Fault detection time + 10 ms
- STO fault indication delay: < 500 ms
- STO warning indication delay: < 1000 ms

■ **Abbreviations**

Abbreviation	Reference	Description
Cat.	EN ISO 13849-1	Classification of the safety-related parts of a control system in respect of their resistance to faults and their subsequent behavior in the fault condition, and which is achieved by the structural arrangement of the parts, fault detection and/or by their reliability. The categories are: B, 1, 2, 3 and 4.
CCF	EN ISO 13849-1	Common Cause Failure (%)
DC	EN ISO 13849-1	Diagnostic Coverage
HFT	EN 61508	Hardware Fault Tolerance
IGBT		Insulated-gate bipolar transistor: The electrical components that drive the motor power outputs
$MTTF_D$	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_{avg}	EN 61508	Average probability of dangerous failure on demand, that is, mean unavailability of a safety-related system to perform the specified safety function when a demand occurs.
PFH	IEC 61508	Average frequency of dangerous failures per hour, that is, average frequency of a dangerous failure of a safety related system to perform the specified safety function over a given period of time.
PL	EN ISO 13849-1	Performance level. Levels a…e correspond to SIL.
SC	EN 61508	Systematic capability
SFF	EN 61508	Safe failure fraction (%)
SIL	EN 61508	Safety integrity level (1…3)
SILCL	IEC/EN 62061	Maximum SIL (level 1…3) that can be claimed for a safety function or subsystem.
STO	IEC/EN 61800-5-2	Safe Torque Off
T_1	IEC 61508-6	Proof test interval. T_1 is a parameter used to define the probabilistic failure rate (PFH or PFD) for the safety function or subsystem. Performing a proof test at a maximum interval of T_1 is required to keep the SIL capability valid. The same interval must be followed to keep the PL capability (EN ISO 13849) valid. See also section *Maintenance* (page 221).

T_M	EN ISO 13849-1	Mission time: the period of time covering the intended use of the safety function/device. After the mission time elapses, the safety device must be replaced. Note that any T_M values given cannot be regarded as a guarantee or warranty.

■ Declaration of Conformity

The EU declaration (3AXD10001229164) and UK declaration (3AXD10001398251) are available on the Internet. See *Document library on the Internet* on page 231.

■ TüV Certificate

The TüV Certificate (3AXD10001229165) is available on the Internet. See *Document library on the Internet* on page 231.

STO 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 ±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 mm^2 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^2 shielded twisted pair cable by HELUKABEL or CEAM

■ **Ambient conditions**

Description	Unit	All models
Operating temperature range		
Minimum	°C	0
	°F	+32
Maximum	°C	+55
	°F	+131
Storage temperature range	°C	-40 to +85
	°F	-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	6560
Shock		10 G
Vibration		1 G, 2-200 Hz

— 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*.

Providing feedback on ABB Drives manuals

Your comments on our manuals are welcome. Navigate to *new.abb.com/drives/manuals-feedback-form*.

Document library on the Internet

You can find manuals and other product documents in PDF format on the Internet at *new.abb.com/drives*.

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