ABB motion control

User's manual
MicroFlex e150 servo drive

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List of related manuals

Drive hardware manuals and guides	Code (English)
MicroFlex e150 Quick Installation Guide	*LT0307*
Safety Manual: Safe Torque Off (STO) function for MicroFlex e150 drives	*LT0313*
MicroFlex e150 wall chart	*LT0296*
MicroFlex e150 flyer	*3AUA0000097609*
MicroFlex e150 CE certificate	*3AXD10000409551*

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

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User’s manual

MicroFlex e150

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4. Mechanical installation

6. Electrical installation:
AC input, motor and brake

9. Start-up

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1

Safety

Safety in installation and maintenance

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

Electrical safety

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

Only qualified electricians are allowed to install and maintain the drive!

- Be sure the system is properly earthed/grounded before applying power. Do not apply AC power before earths/grounds are connected.
- Never work on the drive, motor cable or motor when input power is applied. After disconnecting the input power, always wait for 5 minutes to let the intermediate circuit capacitors discharge before you start working on the drive, motor or motor cable. Always ensure by measuring with a multimeter (impedance at least 1 Mohm) that there is no voltage between the drive input phases L1, L2 and L3 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 can carry dangerous voltage even when the input power of the drive is switched off.
- Do not make any insulation or voltage withstand tests on the drive.
- 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.

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- Even when the motor is stopped, dangerous voltage is present at the power circuit terminals L1, L2, L3, U, V, W, R1, R2 (connector X1).
- If a motor is driven mechanically, it can generate hazardous voltages that are conducted to its power terminals. The enclosure must be earthed/grounded to prevent possible shock hazard.
- To prevent equipment damage, be certain that the input power has correctly sized protective devices installed.
- 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 2004/108/EC an appropriate AC filter must be installed.
- Motor overtemperature sensing is required to satisfy UL 508C. The drive has no provisions for motor overtemperature protection, so external provisions are required.
- Both the AC supply and the 24 V DC 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.

Permanent magnet motor drives

These are additional warnings concerning permanent magnet motor drives. Ignoring the instructions can cause physical injury or death, or damage to the equipment.

WARNING! 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:

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- Stop the motor.
- Ensure that there is no voltage on the drive power terminals according to step 1 or 2, or if possible, according to the both of the following steps:

  1. Disconnect the motor from the drive with a safety switch or by other means. Measure that there is no voltage present on the drive input (L1, L2, L3), motor output (U, V, W), or brake terminals (R1, R2).

  2. Ensure that the motor cannot rotate during work. Make sure that no other system, like a hydraulic crawling drive, is able to rotate the motor directly or through any mechanical connection like felt, nip, rope, etc. Measure that there is no voltage present on the drive input (L1, L2, L3), output (U, V, W), or brake / regeneration terminals (R1, R2). Ground the drive output terminals temporarily by connecting them together as well as to the PE.

General safety

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

- 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 e150 in torque mode with no load attached to the motor can cause the motor to accelerate rapidly to excessive speed.
- Make sure that dust from drilling does not enter the drive during the installation. Electrically conductive dust inside the drive can cause damage or lead to 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. Failure to meet cooling air flow requirements will result in reduced product lifetime and/or drive overtemperature trips.
- The metal heat sink on the left side of the MicroFlex e150 can become very hot during normal operation.

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Safe start-up and operation

These warnings are intended for all who plan to start-up or operate the drive.

General safety

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

- 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.
- Improper operation or programming of the drive can 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.
- Do not activate automatic fault reset functions 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); use instead external commands (I/O or fieldbus).
- If a drive enable signal is already present when power is applied to the MicroFlex e150, the motor could begin to move immediately.
- The metal heat sink on the left side of the MicroFlex e150 can become very hot during normal operation.
- 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.
- 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.
- 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.

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2

Introduction to the manual

What this chapter contains

The chapter describes applicability, target audience and purpose of this manual. It describes the contents of this manual and refers to a list of related manuals for more information. The chapter also contains a flowchart of steps for checking the delivery and installing and commissioning the drive. The flowchart refers to chapters/sections in this manual.

Applicability

The manual is applicable to the MicroFlex e150 drive.

Target audience

The reader is 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.

Purpose of the manual

This manual provides information needed for planning the installation, installing, commissioning, using and servicing the drive.

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Contents of this manual

The manual consists of the following chapters:

- *Safety* (page *11*) gives safety instructions you must follow when installing, commissioning, operating and servicing the drive.
- *Introduction to the manual* (this chapter, page *15*) describes applicability, target audience, purpose and contents of this manual. It also contains a quick installation and commissioning flowchart.
- *Hardware description* (page *21*) describes the operation principle, connector layout, type designation label and type designation information in short.
- *Mechanical installation* (page *27*) describes how to check the installation site, unpack, check the delivery and install the drive mechanically.
- *Planning the electrical installation* (page *33*) describes the requirements for the AC supply, cabling and RCDs.
- *Electrical installation: AC input, motor and brake* (page *43*) describes the installation of high power connections including the AC supply, motor output, and brake resistor.
- *Electrical installation: input / output* (page *59*) describes the installation of low power connections, including analog and digital input/outputs (including Safe Torque Off), motor feedback and Ethernet.
- *Installation checklist* (page *87*) provides a list of checks to confirm that the physical installation has been completed correctly.
- *Start-up* (page *89*) describes the steps for applying power to the drive, installing the Mint Machine Center software, and tuning and optimizing the motor/drive combination.
- *Fault tracing* (page *117*) describes the drive's LED indicators and provides solution to common problems encountered during installation.
- *Technical data* (page *127*) contains the technical specifications of the drive, e.g. the dimensions, ratings, technical specifications, and provisions for fulfilling the requirements for CE and other markings.
- *Appendix: Safe Torque Off (STO)* (page *173*) describes STO features, installation, and technical data.
- *Accessories* (page *161*) describes optional accessories.

Related documents

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

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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*) *Technical data* (page *119*)
Check the installation site.	*Requirements for the installation site* (page *27*)
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.	*Checking the delivery* (page *28*). *Mounting and cooling* (page *29*).
Route the cables.	*Routing the cables* (page *39*)
Check the insulation of the supply cable, the motor and the motor cable.	*Checking the insulation of the assembly* (page *44*)
Connect the power cable. Connect the motor cable. Connect the control cables.	*Connecting the power cables* (page *45*). *Motor connections* (page *52*). *Electrical installation: input / output* (page *59*).
Check the installation.	*Installation checklist* (page *87*).
Start the drive.	*Start-up* (page *89*)

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Terms and abbreviations

The following units and abbreviations might appear in this manual.

General terms

Unit / term / abbreviation	Description
W	Watt
A	Ampere
Ω	Ohm
µF	microfarad
pF	picofarad
mH	millihenry
Φ	phase
ms	millisecond
µs	microsecond
ns	nanosecond
mm	millimeter
m	meter
in	inch
ft	feet
cu.ft	cubic feet
lbf-in	pound force inch (torque)
N·m	Newton meter (torque)
ADC	Analog to Digital Converter
ASCII	American Standard Code for Information Interchange
AWG	American Wire Gauge
CDROM	Compact Disc Read Only Memory
CiA	CAN in Automation International Users and Manufacturers Group e.V.
CTRL+E	on the PC keyboard, press Ctrl and E at the same time.
DAC	Digital to Analog Converter
DS402	CiA Device Profile for Drives and Motion Control
EDS	Electronic Data Sheet
EMC	Electromagnetic Compatibility
HMI	Human Machine Interface
ISO	International Standards Organization
Kbit/s	kilobits per second
LCD	Liquid Crystal Display
Mbit/s	megabits per second
MB	megabytes
MMC	Mint Machine Center

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Unit / term / abbreviation	Description
(NC)	Not Connected
RF	Radio Frequency
SSI	Synchronous Serial Interface
TCP/IP	Transmission Control Protocol / Internet Protocol
UDP	User Datagram Protocol

See also page *177* for safety related abbreviations.

Trademarks

EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

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3

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.

Features

The MicroFlex e150 is a versatile servo drive, providing a flexible and powerful motion control solution for rotary and linear motors. Standard features include:

- Single axis drive for AC brushless servo motors. Can also control induction motors.
- Range of models with continuous current ratings of 3 A, 6 A or 9 A.
- Direct connection to 115 V AC or 230 V AC single-phase, or 230 V AC three-phase supplies.
- Universal feedback interface supporting incremental encoder, BiSS, SSI, EnDat, SinCos or Smart Abs feedback.
- Position, velocity and current control.
- 10 optically isolated general purpose digital inputs. Two inputs have ‘fast input' capability, providing real-time position capture.
- 2 dedicated Safe Torque Off (STO) digital inputs.
- 7 optically isolated general purpose digital outputs.
- 2 analog inputs (±10 V) and 1 analog output (±10 V).
- USB serial port (compatible with USB 2.0 and USB 3.0).
- EtherCAT support.
- Programmable in Mint (except models E152AxxE**IN**A).

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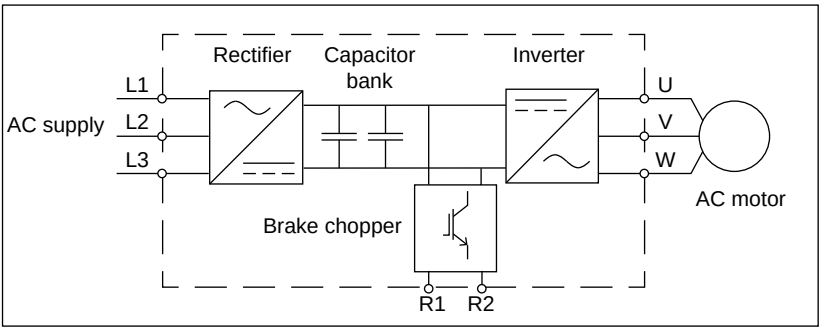
Operating principle

The figure below shows the simplified main circuit diagram of the drive. The rectifier converts three-phase AC voltage to DC voltage. The capacitor bank of the intermediate circuit stabilizes the DC voltage. The inverter converts the DC voltage back to AC voltage for the AC motor. The brake chopper connects the external brake resistor to the intermediate DC circuit when the voltage in the circuit exceeds its maximum limit.



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Product overview

Connections - front panel

X1 Power

⏚	Earth/Ground
⏚	Earth/Ground
	(NC)
L1	AC Phase 1/L
L2	AC Phase 2 / N
L3	AC Phase 3
U	Motor U
V	Motor V
W	Motor W
R1	Brake
R2	Brake

LEDs

The seven-segment display and the two EtherCAT LEDs are described in *MicroFlex e150 indicators* on page *119*.

DIP switches

These switches select the Ethernet mode and RS485 settings. See *DIP switches* on page *79*.

U1 USB

1	+5 V
2	Data-
3	Data+
4	GND

X6 RS485 serial port

	2-wire	4-wire
1	TXA(+)/RXA(+)	TXA(+)
2	TXB(-)/RXB(-)	TXB(-)
3	GND	GND
4	7 V out	7 V out
5	(NC)	RXA(+)
6	(NC)	RXB(-)

X3 Input / Output

1	Status-	11	Status+
2	DOUT2-	12	DOUT2+
3	DOUT1-	13	DOUT1+
4	DIN2-	14	DIN2+
5	DIN3-	15	DIN3+
6	DIN1-	16	DIN1+
7	DIN0-	17	DIN0+
8	SREF	18	STO1
9	SREF	19	STO2
10	Shield	20	Shield

X4 Input / Output

1	AOUT0	5	AGND
2	AIN1+	6	AIN1-
3	AIN0+	7	AIN0-
4	Shield	8	Shield

X8 Feedback in

Pin	Incremental	BiSS/SSI/ EnDat 2.2	Smart Abs	EnDat 2.1	SinCos
1	CHA+	Data+	Data+	Data+	(NC)
2	CHB+	Clock+	(NC)	Clock+	(NC)
3	CHZ+	(NC)	(NC)	(NC)	(NC)
4	(NC)	(NC)	(NC)	(NC)	(NC)
5	Hall U-	(NC)	(NC)	Sin-*	Sin-
6	Hall U+	(NC)	(NC)	Sin+*	Sin+
7	Hall V-	(NC)	(NC)	Cos-*	Cos-
8	Hall V+	(NC)	(NC)	Cos+*	Cos+
9	CHA-	Data-	Data-	Data-	(NC)
10	CHB-	Clock-	(NC)	Clock-	(NC)
11	CHZ-	(NC)	(NC)	(NC)	(NC)
12	+5 V out	+5 V out	+5 V out	+5 V out	+5 V out
13	DGND	DGND	DGND	DGND	DGND
14	Hall W-	(NC)	(NC)	(NC)	(NC)
15	Hall W+	(NC)	(NC)	(NC)	(NC)
Shell	Shield	Shield	Shield	Shield	Shield

X2 Control circuit power

0 V
+24V

(NC) = Not Connected. Do not make a connection to this pin.

* EnDat v2.1 only. EnDat v2.2 does not use the Sin and Cos signals.
Tightening torque for terminal block connections X1 & X2 is 0.5-0.6 N·m (4.4-5.3 lb-in).
Maximum wire sizes: X1: 2.5 mm^2; X3: 0.5 mm^2.
Connector X3 is designed to accept bare wires only; do not use ferrules.

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Connections - top panel

OPT1: Input / Output

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

E1 / E2 EtherCAT®

E2

E1

EtherCAT IN

EtherCAT OUT

1	TX+
2	TX-
3	RX+
4	(NC)
5	(NC)
6	RX-
7	(NC)
8	(NC)

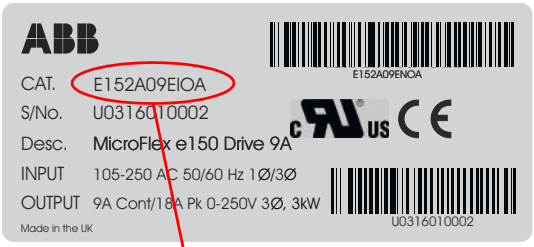
Both connectors have identical pinouts.

E1 is also used for standard Ethernet if DIP switch 4 is in the ON position (see page 79).

See chapter *Electrical installation: AC input, motor and brake* on page *43* for installation in general.

Type designation label

A description of the product's catalog numbering system is shown below:



Typical label shown.
Actual appearance may differ.

E 1 5 2 A 0 9 E I O A *x x x*

E15	MicroFlex e150.
2A	115 - 230 V AC supply input.
09	Rated amps: 03 = 3 A, 06 = 6 A, 09 = 9 A.
E	Feedback: E = Universal Encoder (connector X8, see page *23*).
I	Extra digital inputs / outputs present (connector OPT1).
O	Build option: O = Programmable, N = Not programmable.*
A	Hardware revision.
XXX	(Optional) Custom variant.

*** Note:** Model ..EI**N**A.. cannot store or run a Mint program, but it does support individual Mint commands entered in the Mint WorkBench Command window. Commands received from a host application using the Mint ActiveX control are also supported, although the application cannot be used to download a program file to the drive.

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4

Mechanical installation

What this chapter contains

The chapter describes the mechanical installation procedure of the drive.

Requirements for the installation site

The safe operation of this equipment depends upon its use in the appropriate environment. The following points must be considered:

- The MicroFlex e150 must be installed indoors, permanently fixed and located so that it can only be accessed by service personnel using tools. When installed in a cabinet, the cabinet must have a volume of at least 0.19 m^3 (6.84 cu.ft). If not installed in a cabinet, barriers around the equipment are required.
- The MicroFlex e150 must be secured by the slots in the flange. The protective earth/ground (the threaded hole on the top of the MicroFlex e150) must be bonded to a safety earth/ground using either a 25 A conductor or a conductor of three times the peak current rating - whichever is the greater.
- Avoid locating the MicroFlex e150 immediately above or beside heat generating equipment, or directly below water steam pipes.
- Avoid locating the MicroFlex e150 in the vicinity of corrosive substances or vapors, metal particles and dust.
- Failure to meet cooling air flow requirements will result in reduced product lifetime and/or drive overtemperature trips.
- The maximum suggested operating altitude is 1000 m (3300 ft).
- The MicroFlex e150 must be installed where the pollution degree according to EN 60664 shall not exceed 2.
- The atmosphere must not contain flammable gases or vapors.
- There must not be abnormal levels of nuclear radiation or X-rays.

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- The threaded holes in the top and bottom of the case are for cable clamps. The holes are threaded for M4 bolts no longer than 11 mm (0.43 in).
- The D-type connectors on the front panel of the MicroFlex e150 are secured using two hexagonal jack screws (sometimes known as “screwlocks”). If a jack screw is removed accidentally or lost it must be replaced with a #4-40 UNC jack screw with an external male threaded section no longer than 10 mm (0.4 in).

Required tools

- A small slot screwdriver(s) with a blade width of 3 mm or less for connector X1, and 2 mm (1/10 in) or less for connectors X3 and X4.
- A drill, and M5 screws or bolts for mounting the MicroFlex e150.
- 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.

Checking the delivery

Check that there are no signs of damage. Notify the shipper immediately if damaged components are found.

If MicroFlex e150 is to be stored for several weeks before use, be sure that it is stored in a location that conforms to the storage humidity and temperature specifications shown in *Ambient conditions* on page *150*.

Before attempting installation and operation, check the information on the type designation label of the drive to verify that the drive is of the correct type. See section *Type designation label* on page *25*.

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Mounting and cooling

Ensure you have read and understood *Requirements for the installation site* on page *27*. Mount the MicroFlex e150 vertically on its rear side, the side opposite the front panel. M5 bolts or screws should be used to mount the MicroFlex e150. Detailed dimensions are shown in *Dimension drawing (all models)* on page *128*.

For effective cooling, the MicroFlex e150 must be mounted upright on a smooth vertical metal surface. The MicroFlex e150 is designed to operate in an ambient temperature of 0 °C to 45 °C (32 °F to 113 °F). Output current must be derated between 45 °C (113 °F) and the absolute maximum ambient temperature of 55 °C (131 °F). Within the ambient temperature range:

- The 3 A model is designed to operate without any additional cooling methods.
- The 6 A and 9 A models require a forced air flow, passing vertically from the bottom to the top of the MicroFlex e150 case, to allow full rated current at 45 °C (113 °F).

Temperature derating characteristics are shown in *Temperature derating* on page *132*.

Failure to meet cooling air flow requirements will result in reduced product lifetime and/or drive overtemperature trips. It is recommended to check periodically the operation of the cooling equipment. Optional fan tray FAN001-024, mounted exactly as shown in *Fan tray* on page *162*, ensures that correct cooling is provided and allows the MicroFlex e150 to be UL listed.

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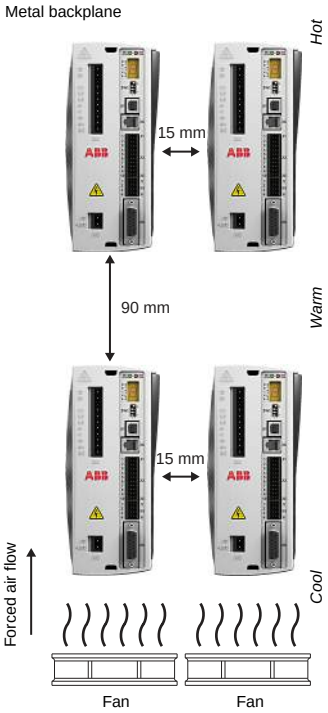
Effects of mounting surface and proximity

The proximity of the MicroFlex e150 to other components could affect cooling efficiency. If the MicroFlex e150 is mounted beside another MicroFlex e150 (or other obstruction), there should be a minimum space of 15 mm (0.6 in) to maintain effective cooling.

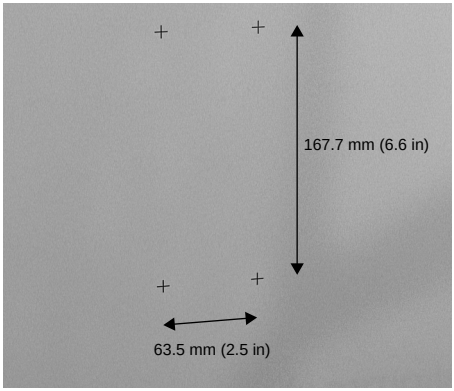
If the MicroFlex e150 is mounted above or below another MicroFlex e150 (or other obstruction), there should be a minimum space of 90 mm (3.5 in) to maintain effective cooling. Remember that a MicroFlex e150 will be receiving air that has been already heated if it is mounted above another MicroFlex e150 or heat source. Multiple MicroFlex e150 units mounted above each other should be aligned, not offset, to promote air flow across the heat sinks.

It is recommended to allow approximately 60 mm (2.4 in) at the front to accommodate wiring and connectors.



Installing

1. Mark the hole locations. See *Dimension drawing (all models)* on page *128* for complete dimensions.



2. Position the drive and check the hole positions are correct.

3. Drill the holes, mount the drive and tighten all four screws until the drive is secure.

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5

Planning the electrical installation

What this chapter contains

The chapter contains the instructions that you must follow when checking the compatibility of the motor and drive, selecting cables, protective devices, and cable routing.

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

The installation methods described in this chapter will improve the reliability of the system, reduce troubleshooting time, and optimize the EMC (electromagnetic compatibility) behavior of the control system.

Checking the compatibility of the motor and drive

Check that the 3-phase AC motor and the drive are compatible according to the *Motor output power (X1)* on page *139*.

Selecting the supply disconnecting device

Install a hand-operated supply 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.

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European Union

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

Other regions

The disconnecting device must conform to the applicable safety regulations.

Emergency stop devices

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

Implementing the STO function

See *Appendix: Safe Torque Off (STO)* on page *173*.

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Thermal overload and short circuit protection

Thermal overload protection

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

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

Protection against short circuit in motor cable

The drive protects the motor and motor cable 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. 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. The motor outputs are fully short circuit proof according to EN 61800-5-1.

Protecting against short circuit in the supply cable or drive

Protect the supply cable with fuses or circuit breakers. Size the fuses according to instructions given in *Technical data* on page *136*. The fuses 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.

Fuses

Recommended fuses are listed in *Recommended fuses, circuit breakers and wire sizes* on page *136*. Alternative fuses must be compatible fast acting types.

Circuit breakers

It is highly recommended that fuses are used instead of circuit breakers. Circuit breakers should only be used when absolutely necessary. UL compliance can only be achieved when using the recommended fuses.The use of circuit breakers does not guarantee UL compliance and provides protection for the wiring only, not the MicroFlex e150. Your local ABB representative can help you in selecting the breaker type when the supply network characteristics are known.

Motor thermal protection

According to regulations, the motor must be protected against thermal overload and the current must be switched off when overload 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 *57*, and the Mint keyword `MOTORTEMPERATUREINPUT` in the Mint WorkBench help file.

Brake output short circuit protection

The brake resistor output is fully short circuit proof according to EN 61800-5-1.

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Selecting the power cables

General rules

Dimension the input power and motor cables according to local regulations.

- The input power and the motor cables must be able to carry the corresponding load currents. See *Electrical power network specification* on page *129* and *Motor output power (X1)* on page *139* for the rated currents.
- The cable must be rated for at least 70 °C (US: 75 °C / 167 °F) maximum permissible temperature of the conductor in continuous use.
- The conductivity of the PE conductor must be equal to that of the phase conductor (same cross-sectional area).
- 600 V AC cable is accepted for up to 500 V AC.
- Refer to *Technical data* on page *154* for the EMC requirements.

A symmetrical shielded motor cable must be used to meet the EMC requirements of the CE and C-Tick marks; see the following diagrams.

A four-conductor system is allowed for input cabling, but a shielded symmetrical cable is recommended. Compared to a four-conductor system, the use of a 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) should be kept as short as possible in order to reduce electromagnetic emission.

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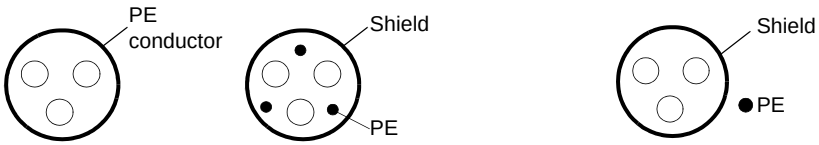
Alternative power cable types

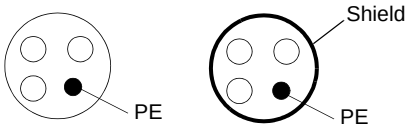
Motor cables (also recommended for supply cabling):

Symmetrical shielded cable: three phase conductors and a concentric or otherwise constructed PE conductor, and a shield. Check with local / state / country electrical codes for allowance.	Note: A separate PE conductor is required if the conductivity of the cable shield is not sufficient for the purpose.



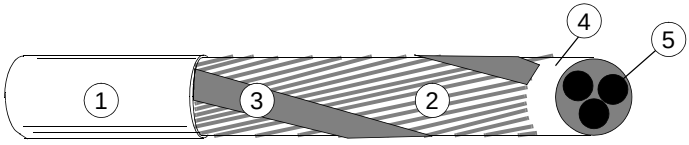
Allowed for AC power cabling

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



Motor cable shield

To function as a protective conductor, the shield must have the same cross-sectional area as the phase conductors when they are made of the same metal. To effectively suppress radiated and conducted radio-frequency emissions, the shield conductivity must be at least 1/10 of the phase conductor conductivity. The requirements are easily met with a copper or aluminium shield. The minimum requirement of the motor cable shield of the drive is shown below. It consists of a concentric layer of copper wires. The better and tighter the shield, the lower the emission level and bearing currents.



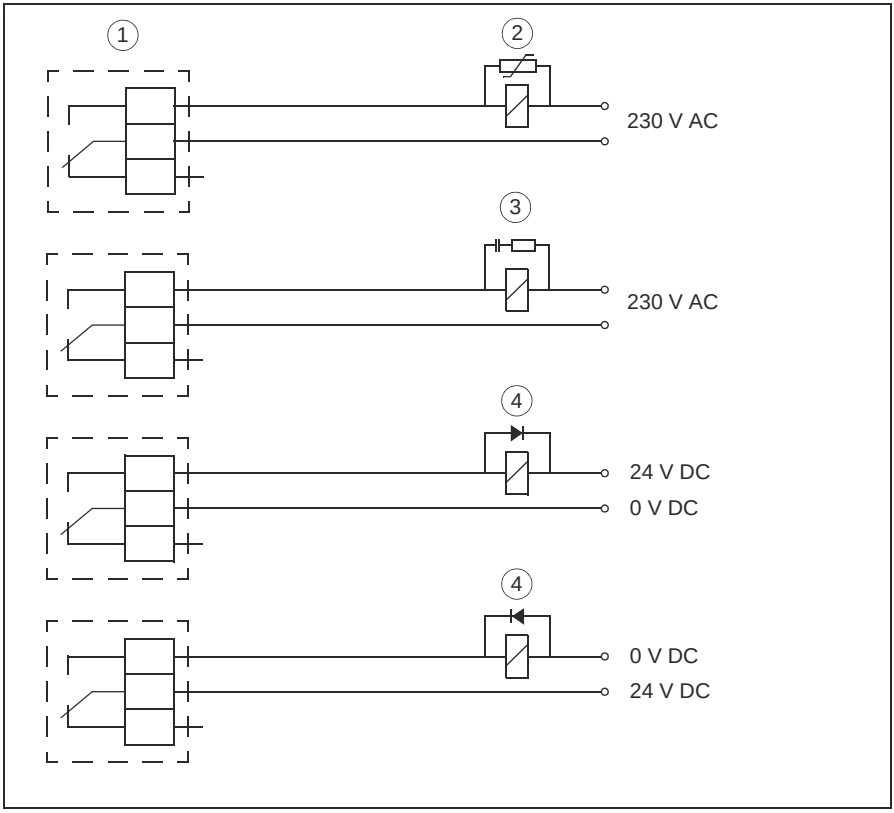
1	Insulation jacket
2	Copper wire screen
3	Helix of copper tape or copper wire
4	Inner insulation
5	Cable core

Protecting the contacts of relay outputs and attenuating inductive loads

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

Equip inductive loads with noise attenuating circuits (varistors, RC filters [AC] or diodes [DC]) in order to minimize the EMC emission at switch-off. If not suppressed, the disturbances might connect capacitively or inductively to other conductors in the control cable and form a risk of malfunction in other parts of the system.

Install the protective component as close to the inductive load as possible. Do not install protective components at the I/O terminal block.



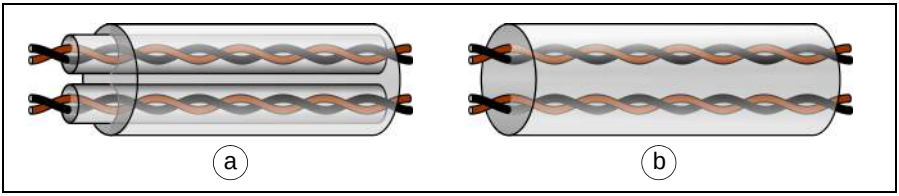
1) Relay outputs; 2) Varistor; 3) RC filter; 4) diode

Selecting the control cables

It is recommended that all control cables are 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 is best for low-voltage digital signals but single-shielded twisted multi-pair cable (Figure b) may also be used.



Run the analog signal and digital signals in separate cables.

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

Never mix 24 V DC and 115/230 V AC signals in the same cable.

Relay cable

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

Connection of a motor temperature sensor to the drive I/O

See *Thermal switch connection* on page *57*.

Routing the cables

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

Where control cables must cross power cables make sure that they are arranged at an angle as near to 90 degrees as possible.

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

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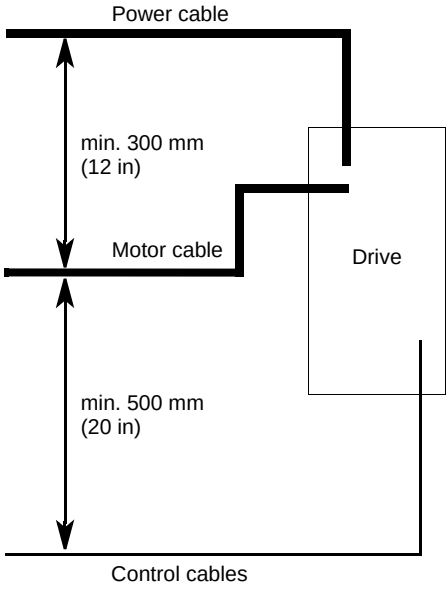
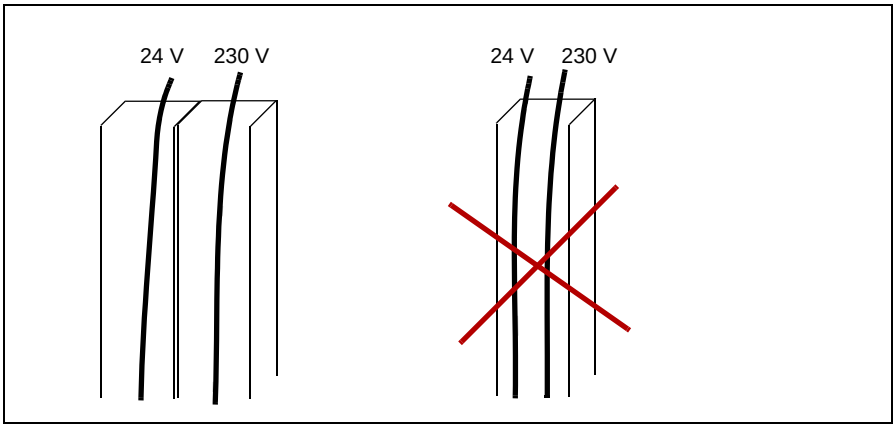
A diagram of the cable routing is shown below:

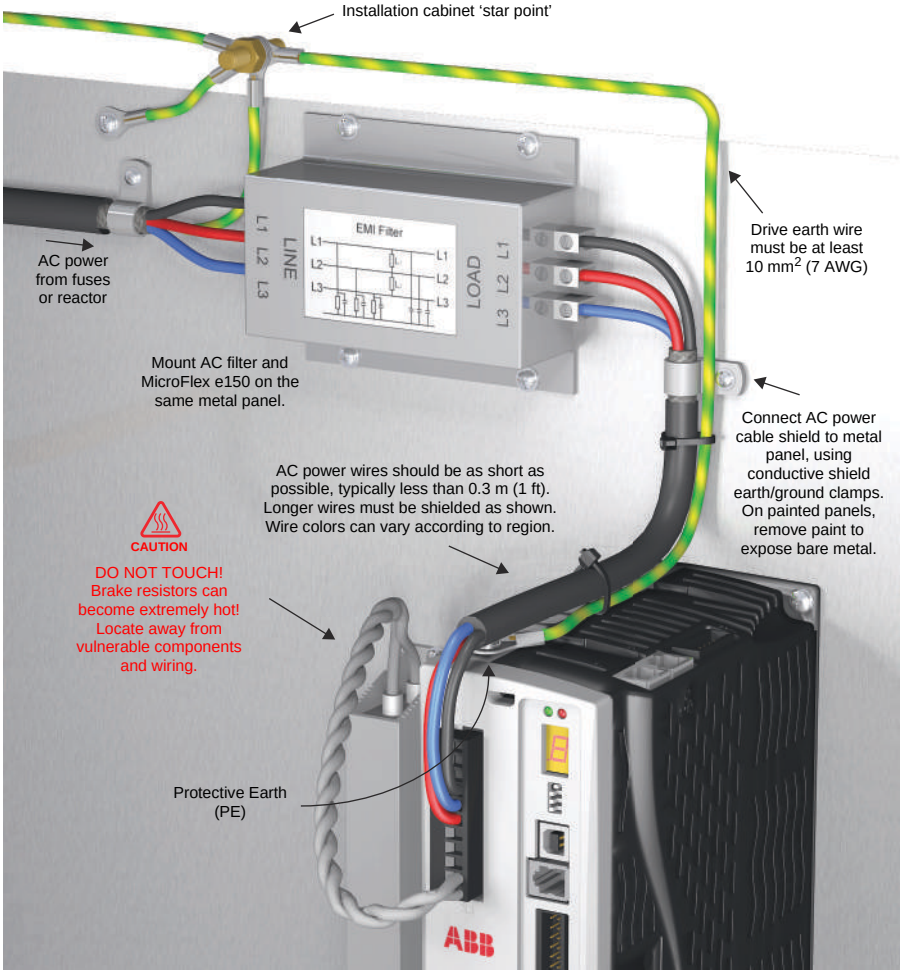


Separate control cable ducts

Route 24 V and 230 V cables in separate ducts unless the 24 V cable is insulated for 230 V or insulated with an insulation sleeving for 230 V.



Typical installation example



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6

Electrical installation: AC input, motor and brake

What this chapter contains

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

WARNING! The work described in this chapter may only be carried out by a qualified electrician. Follow the instructions in chapter *Safety* on page *11*. 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.

See the requirements in *Electrical power network specification* on page *129*. Use a fixed connection to the AC power line.

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Checking the insulation of the assembly

Drive

Every drive has been tested for insulation between the main circuit and the chassis at the factory. If further high potential (‘hipot’) testing is performed, use only DC voltages as AC voltage hipot tests could damage the drive. It is recommended to seek advice from your ABB sales representative before performing hipot tests.

Input power cable

Check the insulation of the input power 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:

1. Check that the motor cable is connected to the motor and disconnected from the drive output terminals U, V and W.
2. Measure the insulation resistance between each phase conductor and the Protective Earth conductor using a measuring voltage of 500 V DC. The insulation resistance of the motor must exceed 100 Mohm (reference value at 25 °C or 77 °F). Please consult the manufacturer’s instructions. Moisture inside the motor casing reduces the insulation resistance. If moisture is suspected, dry the motor and repeat the measurement.

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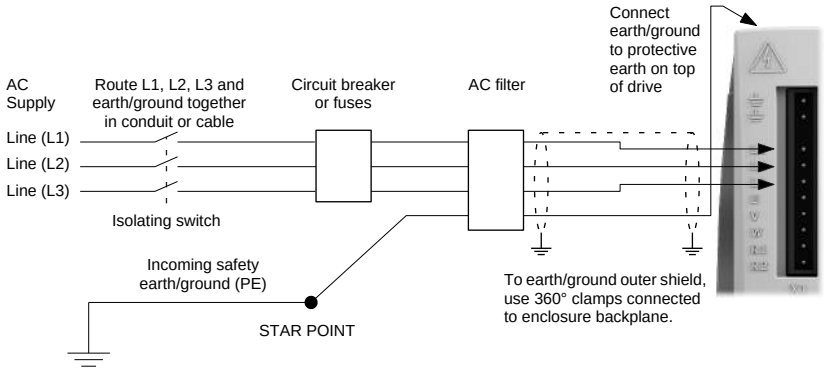
Connecting the power cables

Connection diagram: AC input



MicroFlex e150 is designed to be powered from standard single or three-phase lines that are electrically symmetrical with respect to earth/ground. The power supply module within the MicroFlex e150 provides rectification, smoothing and current surge protection. Fuses or circuit breakers are required in the input lines for cable protection.

For three phase supplies, connect the supply to L1, L2 and L3 as shown above. For single phase supplies, connect the supply and neutral to any two line inputs, for example L1 and L2.

For CE compliance, an AC filter must be connected between the AC power supply and the MicroFlex e150. If local codes do not specify different regulations, use at least the same gauge wire for earth/ground as used for L1, L2 and L3.

The X1 mating connector is a Phoenix COMBICON MSTB 2,5HC/11-ST-5,08. Tightening torque is 0.5-0.6 N·m (4.4-5.3 lb-in). The threaded hole in the top or bottom of the case may be used as an additional functional earth/ground connection for signals on connector X3. The threaded holes may also be used to attach shield or strain relief clamps. The holes are threaded for M4 bolts no longer than 11 mm (0.43 in).

Earthing / grounding

A permanent earth/ground bonding point is provided on the heat sink, which must be used as the protective earth. It is labeled with the protective earth symbol in the casting and does not form any other mechanical function.

Connector X1 contains earth terminals, but these must not be used as protective earth since the connector does not guarantee earth connection first, disconnection last. Earthing methods are shown in *Typical installation example* on page *41*.

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When using unearthed/ungrounded distribution systems, an isolation transformer with an earthed/grounded secondary is recommended. This provides three-phase AC power that is symmetrical with respect to earth/ground and can prevent equipment damage.

Protection class

User protection has been achieved using Protective Class I (EN 61800-5-1), which requires an earth connection to the unit whenever hazardous voltages are applied. The equipment provides protection against electric shock by:

- Means of connection of protective earth to accessible live conductive parts.
- Basic insulation.

Earth leakage

Maximum earth leakage from the MicroFlex e150 is 3.4 mA per phase (230 V, 50 Hz supply). This value does not include the earth leakage from the AC power filter, which could be much larger (see *EMC filters* on page *164*). If the MicroFlex e150 and filter are mounted in an enclosure, it is recommended the enclosure is earthed using a 10 mm^2 conductor.

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Input power conditioning

Certain power line conditions must be avoided; an AC line reactor, an isolation transformer or a step up/step down transformer might be required for some power conditions:

- If the feeder or branch circuit that provides power to the MicroFlex e150 has permanently connected power factor correction capacitors, an input AC line reactor or an isolation transformer must be connected between the power factor correction capacitors and the MicroFlex e150 to limit the maximum symmetrical short circuit current to 5000 A.
- If the feeder or branch circuit that provides power to the MicroFlex e150 has power factor correction capacitors that are switched on line and off line, the capacitors must not be switched while the drive is connected to the AC power line. If the capacitors are switched on line while the drive is still connected to the AC power line, additional protection is required. A Transient Voltage Surge Suppressor (TVSS) of the proper rating must be installed between the AC line reactor (or isolation transformer) and the AC input to the MicroFlex e150.

Supplying input power from a variac (variable transformer)

When AC power is supplied from a variac, the MicroFlex e150's pre-charge circuit might not operate correctly. To ensure that the pre-charge circuitry operates correctly, increase the variac voltage to the desired level and then power cycle the 24 V DC control circuit supply. This will restart the pre-charge circuit and allow it to operate correctly.

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Power supply filters

To comply with EC directive 2004/108/EC, an AC power filter of the appropriate type must be connected. This can be supplied by ABB and will ensure that the MicroFlex e150 complies with the CE specifications for which it has been tested. Ideally, one filter should be provided for each MicroFlex e150; filters should not be shared between drives or other equipment.

Harmonic suppression

When operating the 3 A MicroFlex e150 (part E152A03...) on a single-phase AC supply, a 13 mH, 4 A rms (10 A peak) line reactor is required to ensure compliance with EN 61000-3-2 class A limits, when the total equipment supply load is less than 1 kW.

Reversing the filter

When using filters FI0015A00 or FI0015A02, they must be reversed to ensure that the MicroFlex e150 complies with the CE specifications for which it has been tested. The AC power supply should be connected to the filter terminals marked as the outputs, with the MicroFlex e150 connected to the filter terminals marked as the inputs.

WARNING! This recommendation applies only to filters FI0015A00 and FI0015A02. Alternative filters or protection devices must be connected as specified by the manufacturer.

See *Power supply filters* on page *138*.

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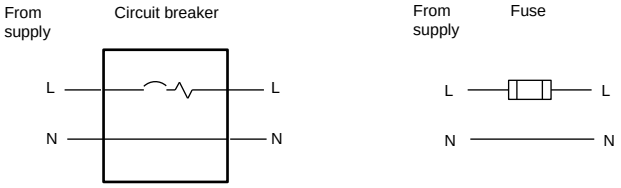
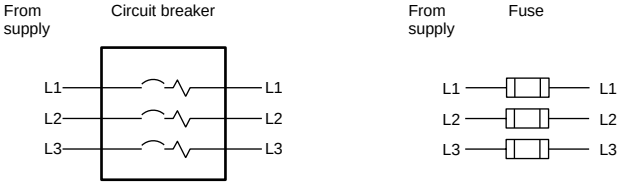
Power disconnect and protection devices

A power disconnect should be installed between the input power supply and the MicroFlex e150 for a fail-safe method to disconnect power. The MicroFlex e150 will remain in a powered condition until all input power is removed from the drive and the internal bus voltage has depleted.

The MicroFlex e150 must have a suitable input power protection device installed, preferably a fuse. Recommended circuit breakers are thermal magnetic devices (1 or 3 phase as required) with characteristics suitable for heavy inductive loads (C-type trip characteristic). Circuit breaker or fuses are not supplied - see *Recommended fuses, circuit breakers and wire sizes* on page *136*. For CE compliance, see *Technical data* on page *153*.



Circuit breaker and fuse, single-phase



Circuit breaker and fuse, three-phase

NOTE: Metal conduit or shielded cable should be used. Connect conduits so the use of a line reactor or RC device does not interrupt EMI/RFI shielding.

Using 2 phases of a 3-phase supply

Power can be derived by connecting two phases of an appropriate three-phase supply (L1 and L2 for example). When supplying AC power in this way, the voltage between the two phases must not exceed the rated input voltage of the MicroFlex e150. A two pole breaker must be used to isolate both lines. Fuses must be fitted in both lines.

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Drive overload protection

The MicroFlex e150 will immediately trip and disable if there is an overload condition. The parameters for managing drive overloads are configured automatically by the *Commissioning Wizard* (page *100*). If they need to be changed, use the *Parameters tool* in Mint WorkBench (page *112*).

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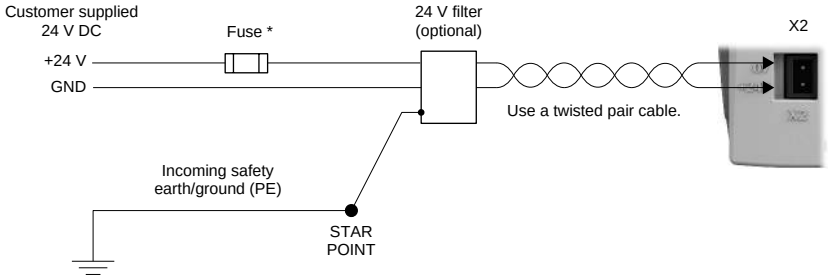
24 V control circuit supply

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

A separate fused 24 V supply should be provided for the MicroFlex e150. If other devices are powered from the same 24 V supply, a filter (part FI0014A00) should be installed to isolate the MicroFlex e150 from the rest of the system. Alternatively, a ferrite sleeve can be attached to the supply cable near connector X2.



* Recommended fuse: Bussman S504 20 x 5 mm anti-surge 2 A.
** Recommended ferrite sleeve: Fair-Rite part 0431164281 or similar.

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Motor connections

MicroFlex e150 will operate with a large number of brushless servo motors. For information on selecting servo motors please contact your local ABB representative. The motor must be capable of being powered by an inverter PWM output. The motor can be connected directly to the MicroFlex e150 or through a motor contactor (M-Contactor). Motors should ideally have a minimum inductance of 1 mH per winding; for motors with lower inductance an output reactor can be fitted in series with the motor.

The motor outputs are fully short circuit proof according to EN 61800-5-1. The drive trips on a motor phase short circuit and will not restart unless AC power is removed. See page *35*.

When using a motor in the Mint WorkBench catalog, the parameters for managing motor overloads are configured automatically by the *Commissioning Wizard* (page *100*). If they need to be changed, or you are using an alternative motor, use the *Parameters tool* (page *112*).

WARNING! Hazardous voltages can exist on the motor output connections. Do not touch the motor output connections before you first ensure there is no high voltage present.

WARNING! The motor cables U, V and W must be connected to their corresponding U, V or W terminal on the motor. Misconnection will result in uncontrolled motor movement.

WARNING! Do not connect supply power to the MicroFlex e150 UVW outputs. The MicroFlex e150 might be damaged.

For CE compliance, the motor earth/ground should be connected to the drive earth/ground, and the motor power cable must be shielded; see *Motor power cable shielding* on page *53*. The connector or gland used at the motor must provide 360 degree shielding. The maximum recommended cable length is 30.5 m (100 ft). See *Recommended fuses, circuit breakers and wire sizes* on page *136* for recommended wire sizes.

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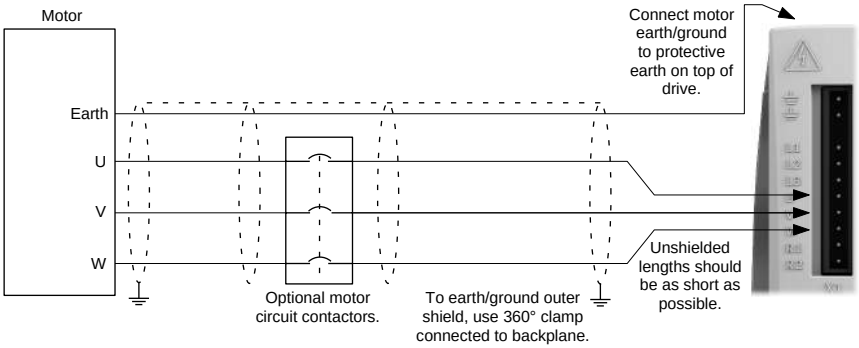

Motor power cable shielding

It is essential that the motor cable shield is correctly bonded to a functional earth, typically the same earthed metal backplane on which the MicroFlex e150 is mounted. The motor power output cable carries a high frequency high current waveform to the motor, so the cable's shielding must be earthed to prevent the cable radiating electromagnetic contamination into the surrounding area. Such contamination can cause spurious errors in unrelated parts of the installation, such as low voltage communication cables. To provide a low impedance path to earth and effective shielding, the conductor must provide contact with a large proportion of the cable's circumference. The following diagram shows two possible methods.

Exposing the cable shield

1. Make a single circular cut in the cable's outer sheath, ensuring that the cable's braided shield is not damaged.
2. Slide the section of outer sheath towards the end of the cable to expose an area of braided shield. Carefully remove the excess sheath at the end of the cable.
3. Attach the metal P-clip or clamp to the exposed area of braided shield.
4. Ensure that the P-clip (or Motor Cable Management Bracket, OPT-CM-001) is securely attached to an unpainted area of the metal backplane.

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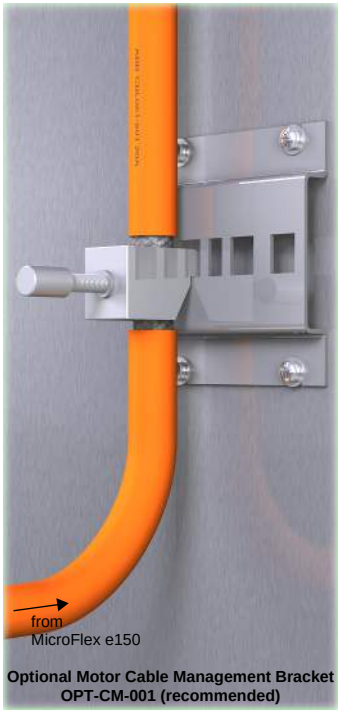
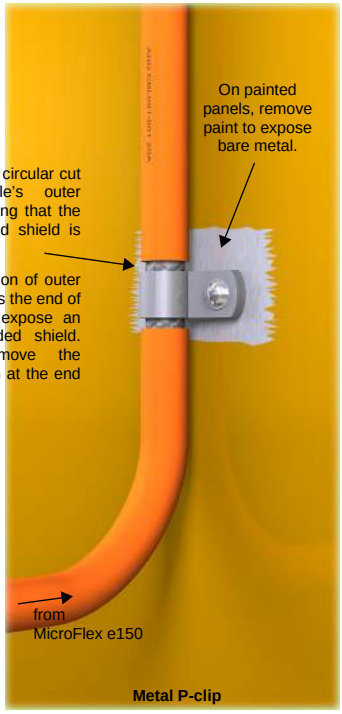


Optional Motor Cable Management Bracket OPT-CM-001 (recommended)

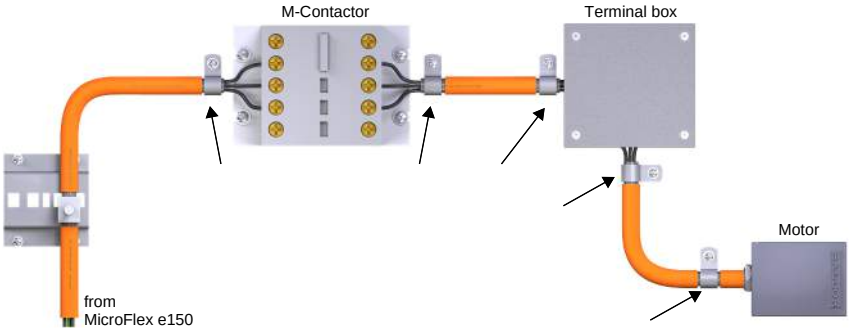
1. Make a single circular cut in the cable's outer sheath, ensuring that the cable's braided shield is not damaged.
2. Slide the section of outer sheath towards the end of the cable to expose an area of braided shield. Carefully remove the excess sheath at the end of the cable.



Metal P-clip

Continuation of motor power cable shielding

When using a motor contactor, or extending the motor cable through a terminal box, ensure that the motor cable shielding is continued all the way to the motor.



Motor circuit contactors

If required by local codes or for safety reasons, an M-Contactor (motor circuit contactor) can be installed to provide a physical disconnection of the motor windings from the MicroFlex e150 (see *Motor connections* on page *52*). Opening the M-Contactor ensures that the MicroFlex e150 cannot drive the motor, which might be necessary during equipment maintenance or similar operations.

If an M-Contactor is installed, the MicroFlex e150 must be disabled at least 20 ms before the M-Contactor is opened. If the M-Contactor is opened while the MicroFlex e150 is supplying voltage and current to the motor, the MicroFlex e150 can be damaged. Incorrect installation or failure of the M-Contactor or its wiring can result in damage to the MicroFlex e150.

Ensure that shielding of the motor cable is continued on both sides of the M-Contactor, as shown in the previous diagram.

Sinusoidal filter

A sinusoidal filter is used to provide a better quality waveform to the motor, reducing motor noise, temperature and mechanical stress. It will reduce or eliminate harmful dV/dt values (voltage rise over time) and voltage doubling effects which can damage motor insulation. This effect occurs most noticeably when using very long motor cables, for example 30.5 m (100 ft) or more. ABB servo motors intended to be used with drives are designed to withstand the effects of large dV/dt and overvoltage effects. However, if very long motor cables are unavoidable and are causing problems, then a sinusoidal filter can be beneficial.

Motor brake connection

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

You can wire a motor's brake, via relays, to digital outputs on connector X3 or OPT1 (see *Connections - front panel* on page *23*, and *Connections - top panel* on page *24*). This provides a way for the MicroFlex e150 to control the motor's brake. A typical circuit is shown in the following diagram:

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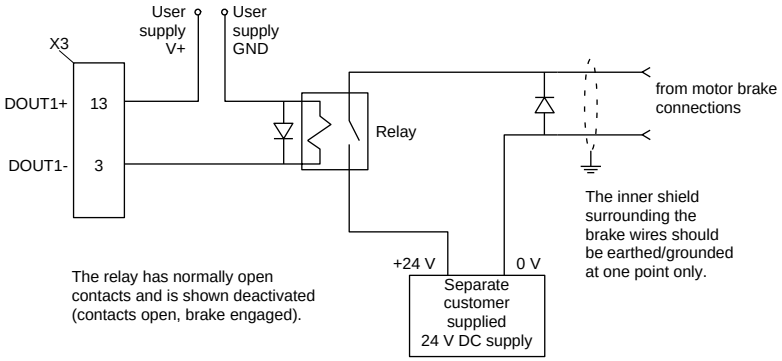

This circuit uses DOUT1 as a motor brake output. The output is configured using Mint keyword MOTORBRAKEOUTPUT; see the Mint help file for details. With this configuration, the following sequences can be used to control the brake.

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 MOTORBRAKEDELAY keyword.

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 e150 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.

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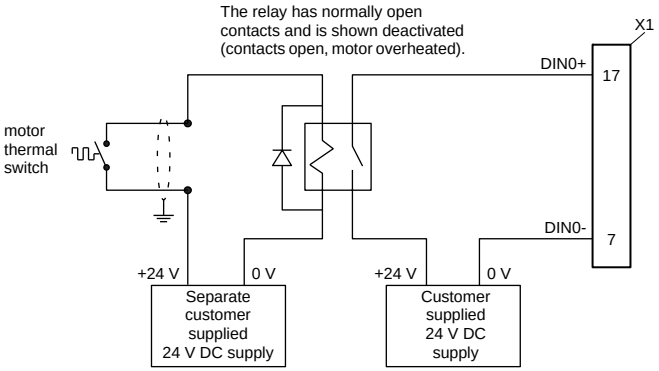
Thermal switch connection

You can use the motor's thermal switch contacts (normally closed), to control a relay connected to a digital input on connector X3 or OPT1 (see *Connections - front panel* on page *23*, and *Connections - top panel* on page *24*). This allows the MicroFlex e150 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 DIN0 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.

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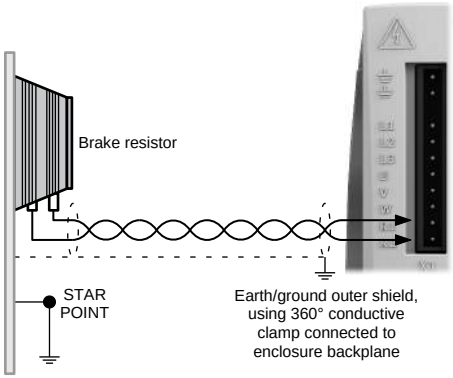
Brake resistor (regeneration resistor)

An optional external brake resistor might be required to dissipate excess power from the internal DC-bus during motor deceleration. The brake resistor must have a resistance of at least 39 Ω, an inductance of less than 100 µH, and a minimum power rating of 44 W. Care should be taken to select the correct resistor for the application; see the *Brake (X1)* section starting on page *140*. Suitable brake resistors are listed in *Resistor choice* on page *143*. The brake resistor output is conditionally short circuit proof.

WARNING! Electrical shock hazard. DC-bus voltages can be present at these 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).



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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
AIN . . . . . Analog Input
AOUT . . . . . Analog Output
DIN . . . . . Digital Input
DOUT . . . . . 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 *11*. Ignoring the safety instructions can cause injury or death.

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

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Analog I/O

The MicroFlex e150 provides:

- Two 12-bit resolution ±10 V analog inputs.
- 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.

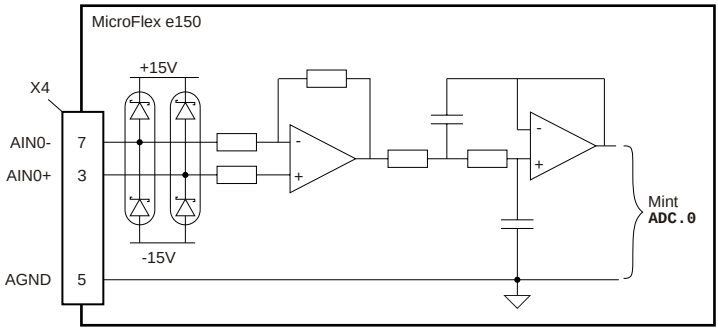
Analog inputs AIN0, AIN1

Location: X4, pins 3 & 7 (AIN0), 2 & 6 (AIN1), 5 (AGND).

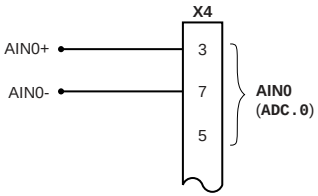
The analog inputs pass through a differential buffer and second order low-pass filter with a cut-off frequency of approximately 1.2 kHz.

In Mint, analog inputs can be read using the ADC keyword. See the Mint help file for full details of ADC, ADCMODE and other related ADC... keywords.

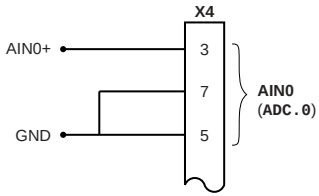
Input circuit:



For differential inputs connect input lines to AIN+ and AIN-. Leave AGND unconnected:

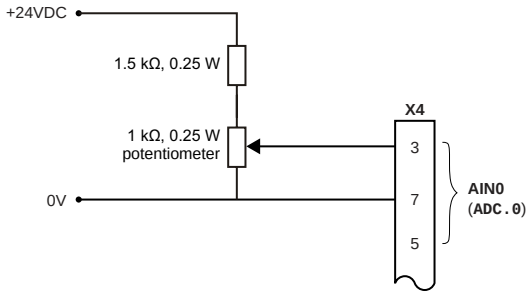


Differential connection



Single ended connection

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



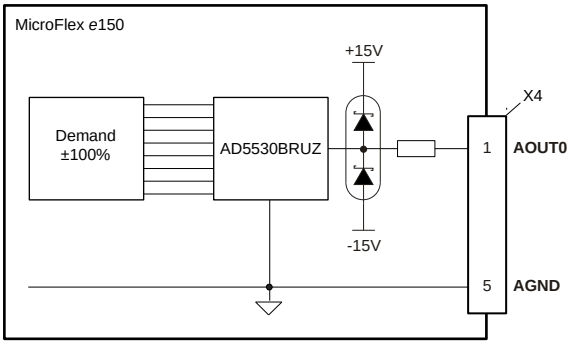
Analog output AOUT0

Location: X4, pin 1 (AOUT0), 5 (AGND)

The analog output can be used to drive loads of 4 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.

Output circuit:



Digital I/O

The MicroFlex e150 provides:

- 10 general purpose digital inputs.
- 2 dedicated Safe Torque Off (STO) inputs.
- 7 general purpose digital outputs.

Connector	Digital input / output	Common connection	Purpose
X3	STO1	SREF	To enable the drive and provide the Safe Torque Off (STO) function (page *64*).
	STO2		
X3	DIN0	(Separate)	General purpose input (page *65*).
	DIN1	(Separate)	General purpose 'fast' inputs (page *66*).
	DIN2	(Separate)	
	DIN3	(Separate)	General purpose input (page *65*).
OPT 1 (top panel)	DIN4	CREF1	General purpose inputs (page *68*).
	DIN5		
	DIN6	CREF0	General purpose inputs (page *68*).
	DIN7		
	DIN8		
	DIN9		
X3	Status out (DOUT0)	(Separate)	Status output (page *69*). Can also be used as a general purpose output
X3	DOUT1	(Separate)	General purpose outputs (page *70*).
	DOUT2	(Separate)	
OPT 1 (top panel)	DOUT3	USRV+	General purpose outputs (page *71*).
	DOUT4		
	DOUT5		
	DOUT6		

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

A general purpose digital input can be configured as a ‘drive enable input’. This input must be activated to allow the drive to operate. This provides an additional method for stopping the drive using a hardware switch or external PLC/controller (e.g. NextMove e100), although it does not provide any of the formal safety features of the Safe Torque Off inputs (page 64). The optional drive enable input is configured using the Digital I/O tool in Mint WorkBench.

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

If homing is being handled locally by the MicroFlex e150, the axis home switch (if present) must be wired directly to the home input on the MicroFlex e150, 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 two options. The choice depends on the accuracy required for the homing and the EtherCAT cycle-time:

- The axis home switch can be wired to an input on the MicroFlex e150, and then mapped back to the master over EtherCAT;
- The home switch can be wired directly to the EtherCAT master.

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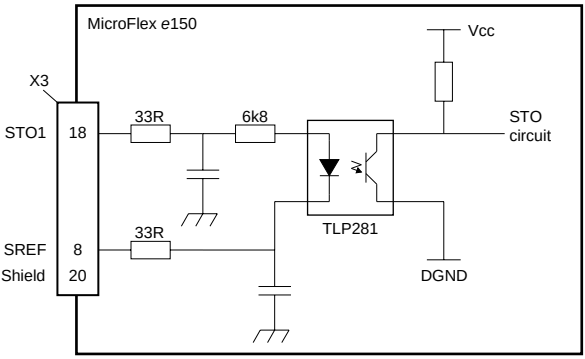
Digital inputs - Safe Torque Off (STO)

Location: X3, pin 18 (STO1), 8 (SREF), 19 (STO2), 9 (SREF)

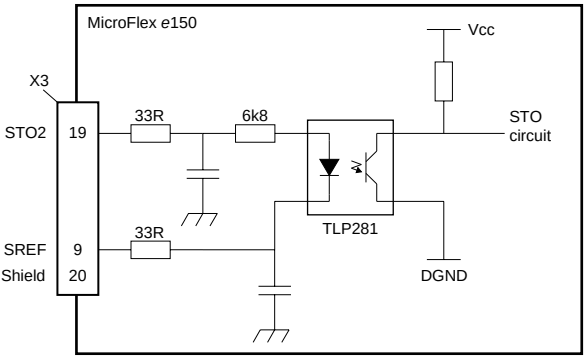
The two safe torque off (STO) inputs are identical. Each input directly enables part of the motor output control circuit. Both inputs must be powered to allow the MicroFlex e150 to supply power to the motor. If an additional hardware drive enable input is used to control the MicroFlex e150, it must not be wired with the STO input circuit. The state of the STO inputs can be viewed using the Mint WorkBench Spy window's Axis tab. See the Mint help file for details.

See *Appendix: Safe Torque Off (STO)* on page *173*.

Safe Torque Off digital input - STO1:



Safe Torque Off digital input - STO2:

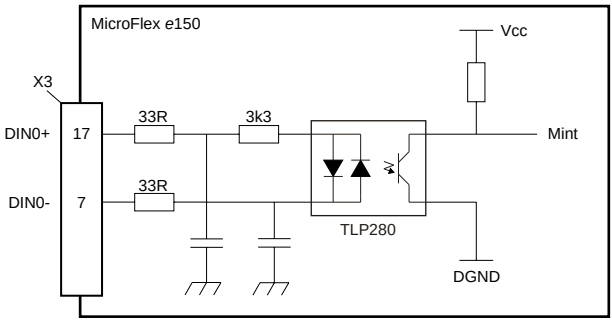


Digital inputs - general purpose DIN0, DIN3

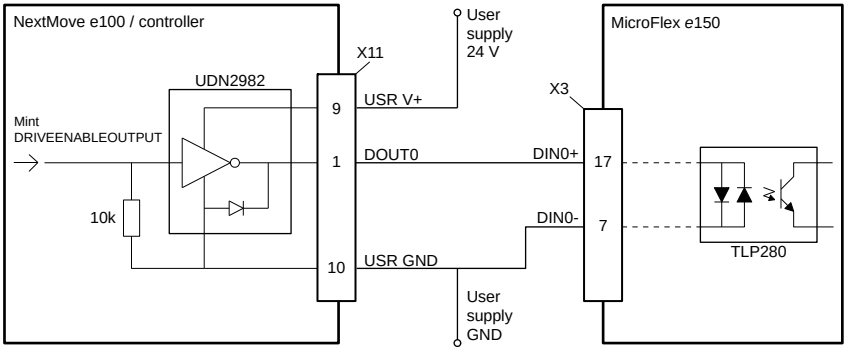
Location: X3, pins 17 & 7 (DIN0), 15 & 5 (DIN3)

These general purpose digital inputs are buffered by a TLP280 opto-isolator, allowing the input signals to be connected with either polarity. The inputs do not share a common reference. When the MicroFlex e150 is connected to Mint WorkBench, the digital inputs can be configured using the Digital I/O tool. Alternatively, Mint keywords including `DRIVEENABLEINPUT`, `RESETINPUT`, `ERRORINPUT` and `STOPINPUT` 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.

General purpose digital input - DIN0 shown:



Digital input - typical connections from an ABB NextMove e100:

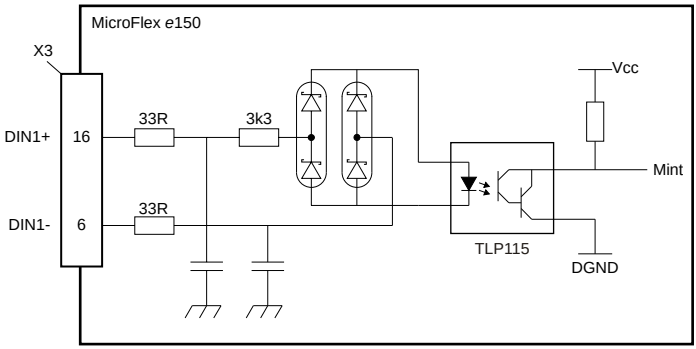


Digital inputs - general purpose DIN1, DIN2

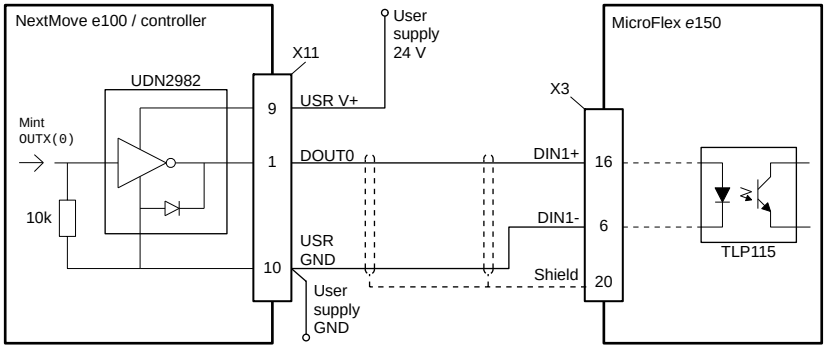
Location: X3, pins 16 & 6 (DIN1), 14 & 4 (DIN2)

These general purpose fast digital inputs are buffered by a TLP115 opto-isolator, allowing the input signals to be connected with either polarity. The inputs do not share a common reference. When the MicroFlex e150 is connected to Mint WorkBench, the digital inputs can be configured using the Digital I/O tool. Alternatively, Mint keywords including `DRIVEENABLEINPUT`, `RESETINPUT`, `ERRORINPUT` and `STOPINPUT` 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.

General purpose fast digital input - DIN1 shown:



Digital input - typical connections from an ABB NextMove e100:



Special functions on inputs DIN1, DIN2

DIN1 and DIN2 can be configured to perform special functions.

Step (pulse) and direction inputs

DIN1 and DIN2 can be configured using the statement `ENCODERMODE(1)=4` to become step and direction inputs:

- DIN1 is used as the step input. The step frequency controls the speed of the motor.
- DIN2 is used as the direction input. The state of the direction input controls the direction of motion. An active input will result in forward motion. An inactive input will result in motion in the opposite direction.

Encoder input

DIN1 and DIN2 can be configured using the statement `ENCODERMODE(1)=0` to form an additional encoder input. The two channels are read as a quadrature (CHA, CHB) encoder input.

In Mint, the encoder input formed by digital inputs DIN1 and DIN2 is encoder 1. The primary motor feedback encoder source on connector X8 is encoder 0, and the extra incremental encoder on connector X8 is encoder 2; see pages *80* and *86*.

Fast latch input

DIN1 or DIN2 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 will be 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.

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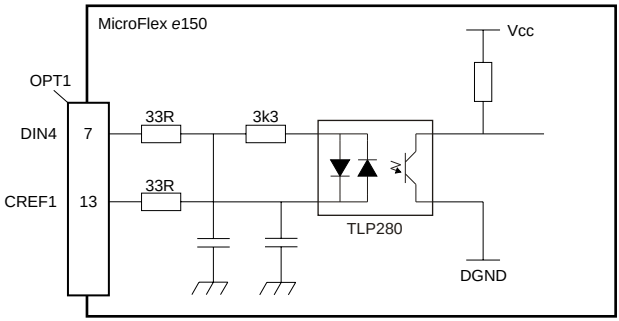
Digital inputs - general purpose DIN4 - DIN9

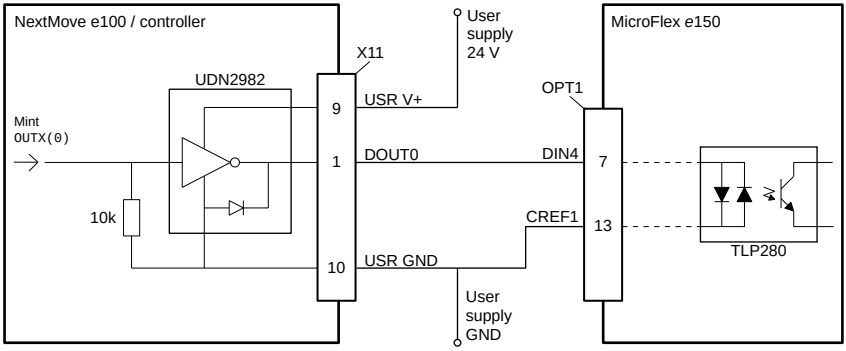
Location: OPT1, pin 3 (CREF0), pin 4 (DIN7), 5 (DIN6), 6 (DIN5), 7 (DIN4), 11 (DIN9), 12 (DIN8), 13 (CREF1)

These general purpose digital inputs are buffered by a TLP280 opto-isolator, allowing the input signals to be connected with either polarity. Inputs DIN4 and DIN5 share a common reference, CREF1. Inputs DIN6 - DIN9 share a common reference, CREF0. When the MicroFlex e150 is connected to Mint WorkBench, the digital inputs can be configured using the Digital I/O tool. Alternatively, Mint keywords including `DRIVEENABLEINPUT`, `RESETINPUT`, `ERRORINPUT` and `STOPINPUT` 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.

General purpose digital input - DIN4 shown:



Digital input - typical connections from an ABB NextMove e100:

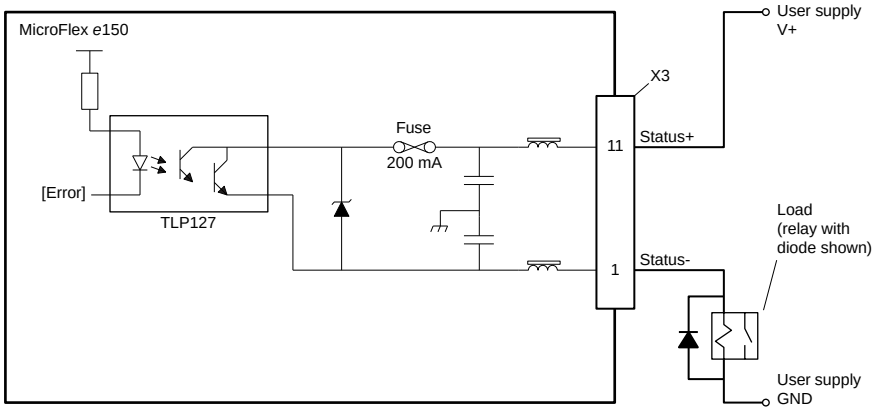


Status output (DOUT0)

Location: X3, pins 1 (Status-), 11 (Status+)

The optically isolated status output is designed to source current from the user supply. The TLP127 has a maximum power dissipation of 200 mW at 25 °C. The output includes a self-resetting fuse that operates at approximately 200 mA. The fuse can take up to 20 seconds to reset after the load has been removed. If the output is used to directly drive a relay, a suitably rated diode must be fitted across the relay coil, observing the correct polarity. This is to protect the output from the back-EMF generated by the relay coil when it is de-energized.

Status output circuit:



The status output becomes active in the event of an error, or when the STO function is activated. When the MicroFlex e150 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. The output's state is displayed in the Spy window. See the Mint help file for details.

General purpose output DOUT0

The status function must be disabled before the output can be used for other purposes. To disable the status function, the command `GLOBALERROROUTPUT=-1` must be issued from a Mint WorkBench Command window, or included in a Mint program. The command `GLOBALERROROUTPUT=0` enables the status function. See the Mint help file for details.

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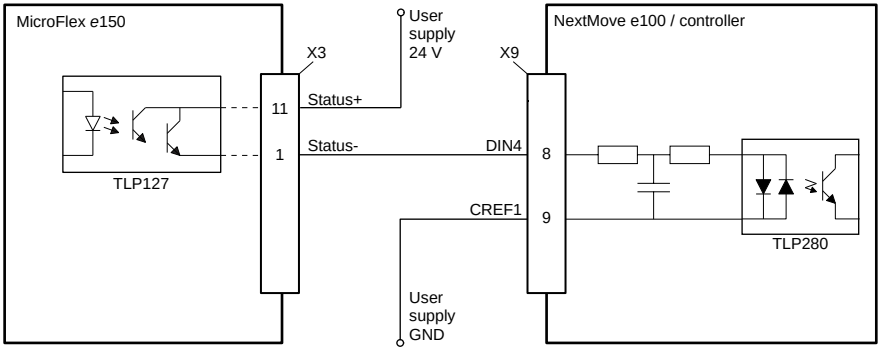
Status output - typical connections to an ABB NextMove e100:

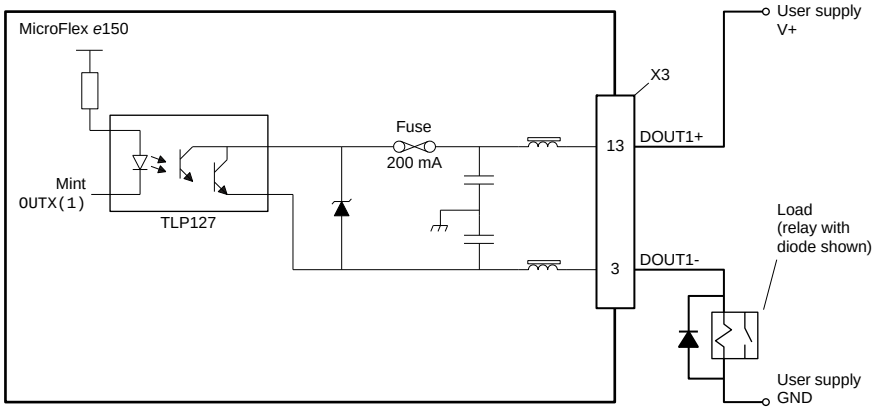


Digital outputs DOUT1, DOUT2

Location: X3, pins 13 & 3 (DOUT1), 12 & 2 (DOUT2)

The optically isolated general purpose outputs are designed to source current from an individual user supply connection. The TLP127 has a maximum power dissipation of 200 mW at 25 °C. Each output includes a self-resetting fuse that operates at approximately 200 mA. The fuse can take up to 20 seconds to reset after the load has been removed. If the output is used to directly drive a relay, a suitably rated diode must be fitted across the relay coil, observing the correct polarity. This is to protect the output from the back-EMF generated by the relay coil when it is de-energized.

Digital output circuit - DOUT1 shown:



When the MicroFlex e150 is connected to Mint WorkBench, the active level of the outputs can be configured using the Digital I/O tool. Alternatively, the Mint keyword `OUTPUTACTIVELEVEL` can be used. The state of the outputs is displayed in the Spy window. See the Mint help file for details.

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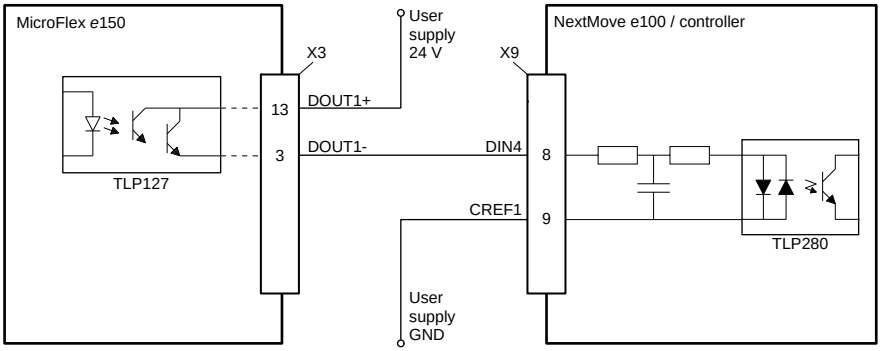
DOUT1 - typical connections to an ABB NextMove e100:

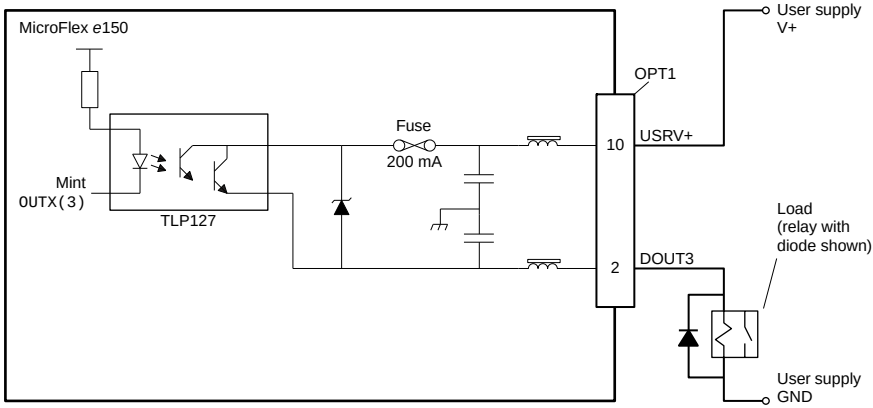


Digital outputs DOUT3 - DOUT6

Location: OPT1, pin 2 (DOUT3), 1 (DOUT4), 9 (DOUT5), 8 (DOUT6), 10 (USRV+)

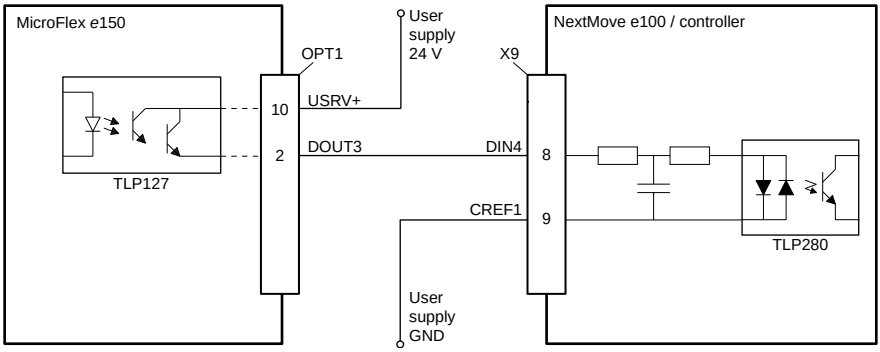
The optically isolated general purpose outputs are designed to source current from a common user supply (USRV+). The TLP127 has a maximum power dissipation of 200 mW at 25 °C. Each output includes a self-resetting fuse that operates at approximately 200 mA. The fuse can take up to 20 seconds to reset after the load has been removed. If the output is used to directly drive a relay, a suitably rated diode must be fitted across the relay coil, observing the correct polarity. This is to protect the output from the back-EMF generated by the relay coil when it is de-energized.

Digital output circuit - DOUT3 shown:



When the MicroFlex e150 is connected to Mint WorkBench, the active level of the outputs can be configured using the Digital I/O tool. Alternatively, the Mint keyword `OUTPUTACTIVELEVEL` can be used. The state of the outputs is displayed in the Spy window. See the Mint help file for details.

DOUT3 - typical connections to an ABB NextMove e100:



USB interface

Location: U1

The USB connector is used to connect the MicroFlex e150 to a PC running Mint WorkBench. The MicroFlex e150 is a self-powered, USB 2.0 (12 Mbps) compatible device. If it is connected to a slower USB 1.0 host PC or hub, communication speed will be limited to the USB 1.0 specification (1.5 Mbps). If it is connected to a faster USB 2.0 'high-speed' (480 Mbps) or USB 3.0 (5 Gbps) host PC or hub, communication speed will remain at the USB 2.0 specification of the MicroFlex e150.

Ideally, the MicroFlex e150 should be connected directly to a USB port on the host PC. If it is connected to a hub shared by other USB devices, communication could be affected by the activity of the other devices. The maximum recommended cable length is 5 m (16.4 ft).

RS485 interface

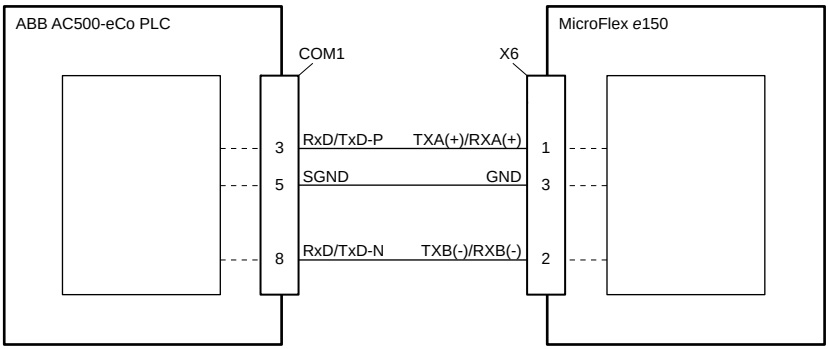
Location: X6

The RS485 interface is used to connect third-party serial devices such as operator panels and PLCs. The interface can operate in 2-wire or 4-wire RS485 mode, which is selected using the Configuration tool in Mint WorkBench. The default mode is 2-wire RS485, 57600 Baud, 8 data bits, 1 stop bit with no parity. MicroFlex e150 supports various protocols over the RS485 interface, such as Modbus RTU and HCP (Host Comms Protocol), as well as simple ASCII character handling.

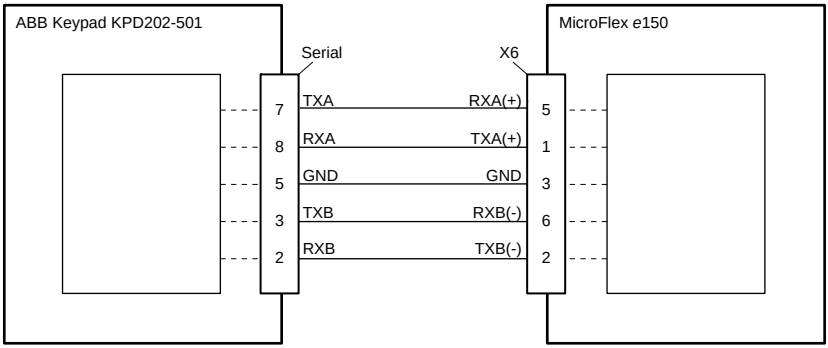
The 7 V supply on pin 4 is provided for future accessories, so care should be taken to ensure this supply will not damage connected devices. The RS485 port could be damaged if a USB plug is accidentally inserted while the drive is powered.

DIP switches 1 and 2 are used to introduce termination resistors; see page *79*.

Connections to a 2-wire RS485 device - ABB AC500-eCo PLC shown:



Connections to a 4-wire RS485 device - ABB Keypad KPD202-501 shown:



Note: The MicroFlex e150 and other ABB equipment use ‘big endian’ word order and byte order for Modbus protocols. If this is incompatible with other Modbus equipment, the word and byte order for the MicroFlex e150 can be changed in Mint WorkBench. See the Mint WorkBench help file for details.

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Ethernet interface

The Ethernet interface supports EtherCAT® (CoE and EoE) and standard Ethernet.

Standard Ethernet

The standard Ethernet connection supports several protocols, including EtherNet/IP, Modbus TCP, HTTP and ICMP. See the application notes at *www.abbmotion.com* for details.

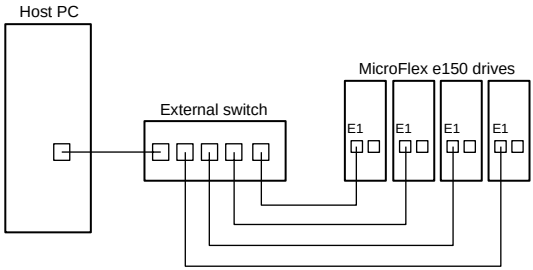
Ethernet port E2 is fixed in EtherCAT mode, so port E1 must be used for other Ethernet connections. To set port E1 (OUT) to standard Ethernet mode, front panel DIP switch 4 (page *79*) must be in the ON position.

Connecting Mint WorkBench using standard Ethernet

TCP/IP allows the MicroFlex e150 to support standard Ethernet communication with a host PC running Mint WorkBench. The connection uses a high level 'Immediate Command Mode' (ICM) protocol to allow Mint commands, Mint programs and even firmware to be sent to the controller over the Ethernet network.

The host PC must be connected to the controller either directly or via a switch, as shown in the following diagram:

Connecting to drives using TCP/IP in standard Ethernet mode:



Note: The MicroFlex e150 and other ABB equipment use 'big endian' word order and byte order for Modbus protocols. If this is incompatible with other Modbus equipment, the word and byte order for the MicroFlex e150 can be changed in Mint WorkBench. See the Mint WorkBench help file for details.

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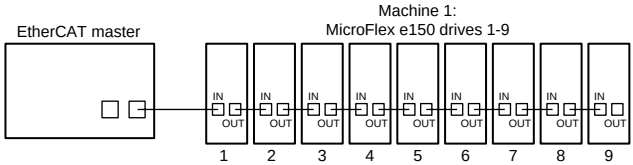
EtherCAT®

MicroFlex e150 supports the EtherCAT protocol. This protocol provides deterministic communication over a standard 100 Mbit/s (100Base-TX) Fast Ethernet (IEEE 802.3u) connection. This makes it suitable for the transmission of control and feedback signals between the MicroFlex e150 and other EtherCAT enabled controllers. EtherCAT's 'CAN application layer over EtherCAT' (CoE) capability allows the drive to implement a device protocol based on IEC61800-7 'Generic interface and use of profiles for power drive systems' (previously CiA 402).

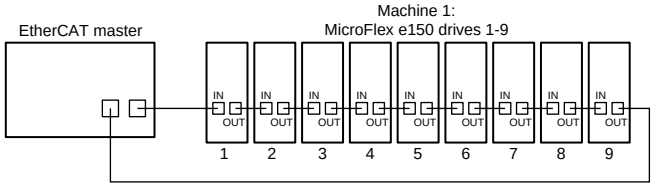
MicroFlex e150 incorporates a built-in multi-port EtherCAT slave controller, providing two ports for connection to other equipment. This allows nodes to be connected in many configurations such as a ring, star, or tree, with EtherCAT's self-terminating technology automatically detecting breaks or an intended end of line.

If only one port is used for EtherCAT operation, it must be the E2 (IN) port.

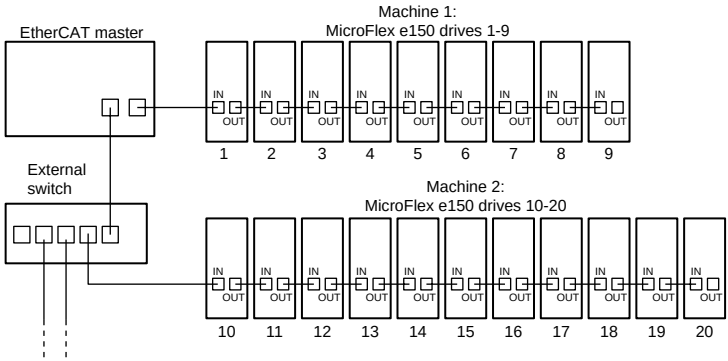
Straight line topology EtherCAT network:



Ring topology EtherCAT network:



Multi-branch EtherCAT network:



EtherCAT configuration

EtherCAT configuration is usually performed from the EtherCAT manager. To assist with configuration, the MicroFlex e150 provides an EtherCAT Slave Information (ESI) file. This .xml file describes the drive's capabilities to the EtherCAT manager. The ESI file can be uploaded from the MicroFlex e150 using the Configuration tool in Mint WorkBench.

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Ethernet connectors

Location: E1 & E2

Ethernet port E2 (IN) is fixed in EtherCAT mode. To set port E1 (OUT) to EtherCAT mode, front panel DIP switch 4 (page *79*) must be in the off position. If only one port is used for EtherCAT operation, it must be the E2 (IN) port.

To connect the MicroFlex e150 to other EtherCAT devices use CAT5e Ethernet cables - either S/UTP (unshielded screened/foiled twisted pairs) or preferably S/FTP (fully shielded screened/foiled twisted pairs). To ensure CE compliance, Ethernet cables longer than 3 m should be S/FTP cables bonded to the metal backplane at both ends using conductive clamps. Cables can be up to 100 m (328 ft) long. Two varieties of CAT5e cable are available; ‘straight’ or ‘crossed’. Straight cables have the TX pins of the connector at one end of the cable wired to the TX pins of the RJ45 connector at the other end of the cable. Crossover cables have the TX pins of the connector at one end of the cable wired to the RX pins of the RJ45 connector at the other end of the cable.

Recommended cables are listed in *Ethernet cables* on page *171*. Crossover or straight cables can be used. Many Ethernet devices, including hubs and ABB e100 / e150 products, incorporate Auto-MDIX switching technology which automatically compensates for the wiring of straight cables.

The MicroFlex e150 Ethernet interface is galvanically isolated from the rest of the MicroFlex e150 circuitry by magnetic isolation modules incorporated in each of the Ethernet connectors. This provides protection up to 1.5 kV. The connector/cable screen is connected directly to the chassis earth of the MicroFlex e150.

The EtherCAT interface supports the 100Base-TX (100 Mbit/s) speed.

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DIP switches

Location: SW1

The MicroFlex e150 has four DIP switches which allow special settings to be selected on power up. Changing the switch positions after power up has no effect.

DIP switch settings:

Switch	Description	
	< OFF	**ON >**
4	E1 (OUT) port: EtherCAT mode	E1 (OUT) port: Standard Ethernet mode
3	Normal operation	Firmware recovery mode
2	X6 port: 2-wire TX/RX (or 4-wire TX): disconnect 120 Ω termination resistor	X6 port: 2-wire TX/RX (or 4-wire TX): connect 120 Ω termination resistor
1	X6 port: 4-wire RX: disconnect 120 Ω termination resistor	X6 port: 4-wire RX: connect 120 Ω termination resistor

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Motor feedback

Location: X8

MicroFlex e150 supports incremental encoder, encoder with BiSS (Bi-directional Synchronous Serial Interface) or SSI (Synchronous Serial Interface), EnDat or Smart Abs absolute encoder, or SinCos encoder feedback, for use with linear and rotary motors. Resolvers are supported by using the optional Resolver adaptor (see page *169*). 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.

Connection summary

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

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When using BiSS, SSI, EnDat 2.2 or Smart Abs, an extra incremental encoder can be simultaneously connected.

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

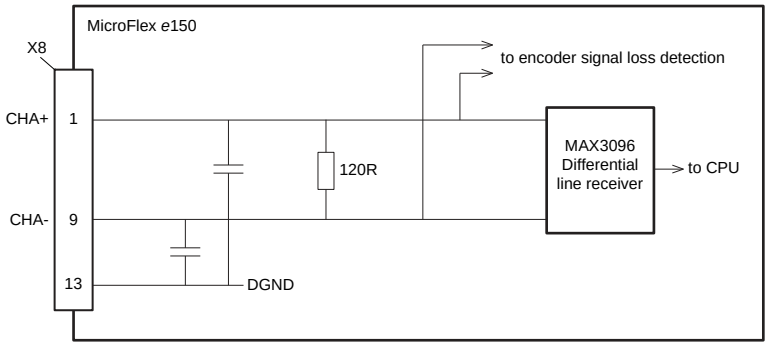
The overall cable shield (screen) must be connected to the metallic shell of the D-type connector.

Incremental encoder interface

See *Connection summary* on page *80* for pin configuration.

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. The Hall inputs can 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.

Encoder channel input circuit - channel A shown:



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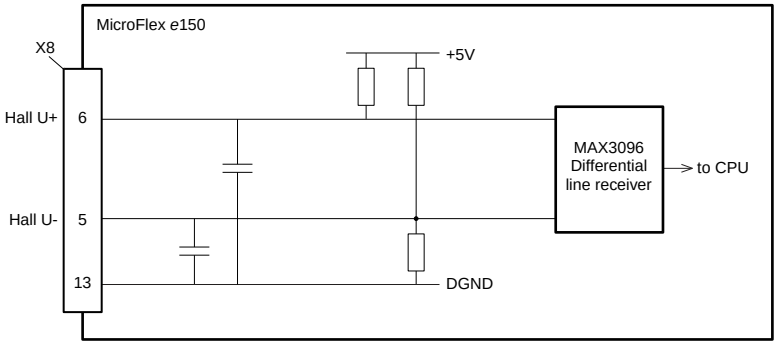
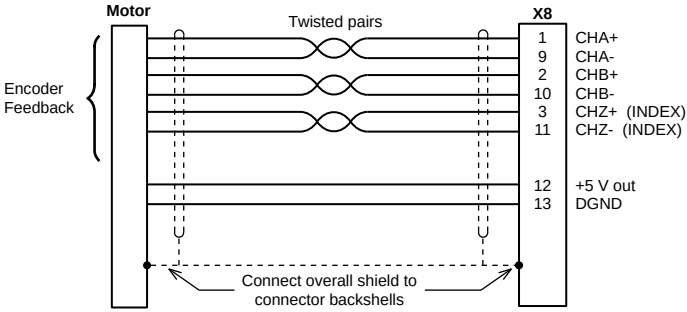
Hall input circuit - U phase shown:



Encoders without Halls

Incremental encoders without Hall feedback connections can be connected to the MicroFlex e150. However, if Hall connections are not present, it will be necessary for the MicroFlex e150 to perform an automatic phase search sequence each time it is powered. This will cause motor movement of up to 1 turn on rotary motors, or one pole-pitch on linear motors.

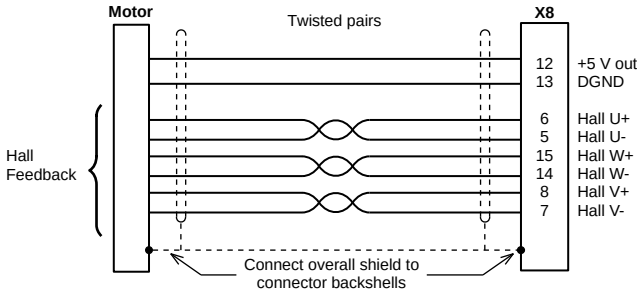
Encoder cable connections without Halls - rotary motors:



Halls-only feedback devices

Feedback devices using only Hall sensors can be connected to the MicroFlex e150. However, since there are no encoder connections, the MicroFlex e150 will not be able to perform smooth speed control or accurate positioning control.

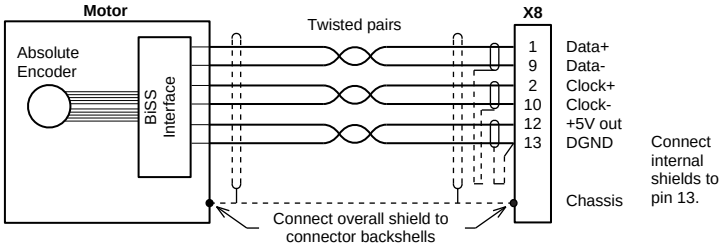
Halls-only feedback cable connections - rotary motors:



BiSS interface

The BiSS (Bi-directional Serial Synchronous interface) is an open-source interface that can be used with many types of absolute encoder. The BiSS interface connections are made using the 15-pin D-type female connector X8.

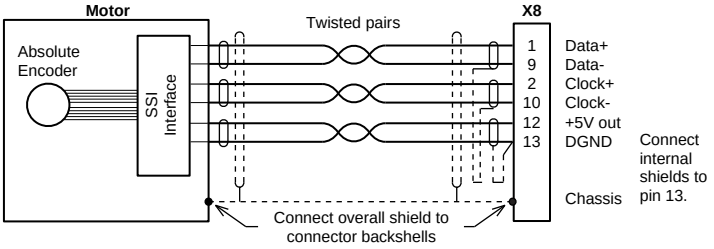
BiSS interface cable connections:



SSI interface

The SSI (Synchronous Serial Interface) encoder interface is specifically designed for use with Baldor SSI motors, which incorporate a custom Baumer SSI encoder. Contact ABB technical support to confirm compatibility of other SSI devices. The SSI encoder connections are made using the 15-pin D-type female connector X8.

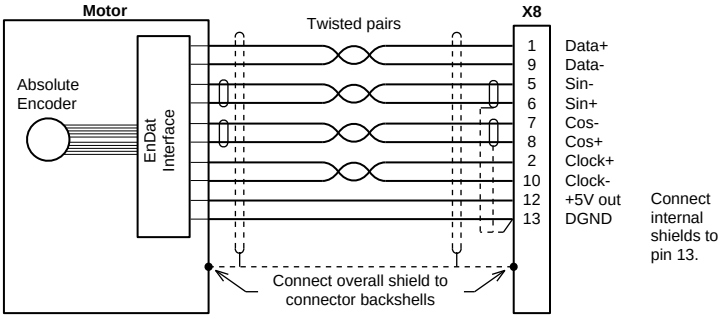
SSI interface cable connections:



EnDat interface

The absolute encoder interface supports both incremental and absolute (multi and single turn) feedback using EnDat technology. It is possible to read and write information to the encoder. The absolute encoder connections are made using the 15-pin D-type female connector X8. Version 2.2 EnDat encoders do not use the Sin and Cos channels.

EnDat 2.1 interface cable connections:



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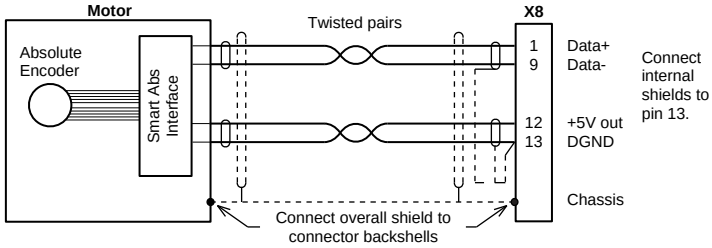
Smart Abs interface

The Smart Abs encoder connections are made using the 15-pin D-type female connector X8.

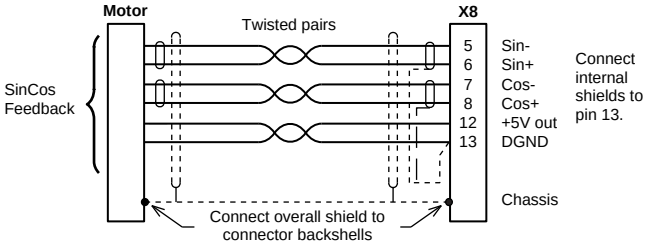
Smart Abs interface cable connections:



SinCos interface

The SinCos connections (Sin and Cos incremental channels only) are made using the 15-pin D-type female connector X8.

SSI cable connections:



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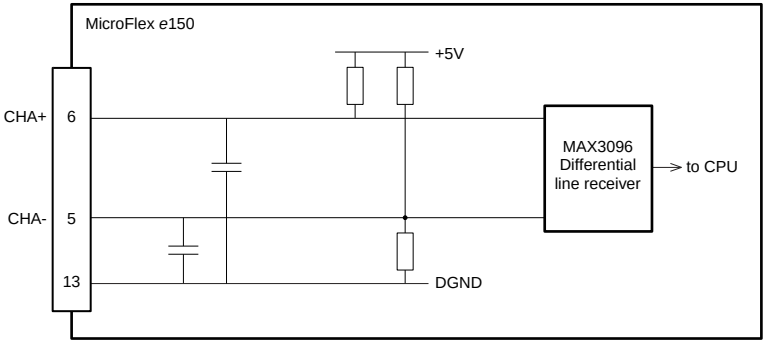
Extra incremental encoder interface

The extra incremental encoder becomes available when using a digital encoder type that does not require the Sin / Cos inputs (BiSS, SSI, EnDat 2.2, Smart Abs). In Mint, the main digital encoder source remains as encoder 0, and the extra incremental encoder is encoder 2. Note that encoder 1 is the input formed by digital inputs DIN1 and DIN2; see *Special functions on inputs DIN1, DIN2* on page *67*.

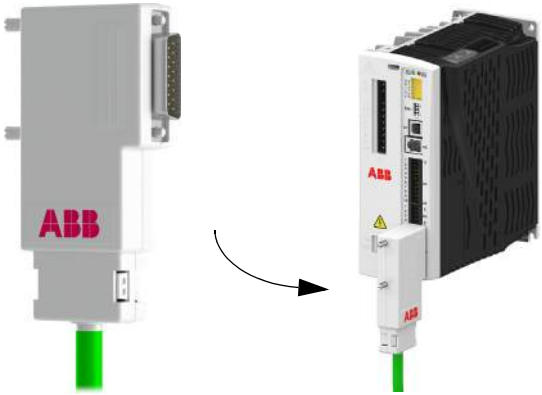
The 5 V encoder inputs (CHA, CHB and CHZ) can be used as differential inputs (recommended for improved noise immunity) or single ended inputs. When used as single ended inputs, leave the CHA-, CHB- and CHZ- pins unconnected.

Extra encoder input circuit - channel A shown:



OPT-MF-201 Resolver adapter

The optional resolver adapter OPT-MF-201 allows a motor with resolver feedback to be connected to the MicroFlex e150. See page *169* for details.



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8

Installation checklist

This chapter contains a list for checking the mechanical and electrical installation of the drive.

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. Follow the complete safety instructions of the drive. 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 that …**
☐	The ambient operating conditions meet the specification in chapter *Technical data*.
☐	There is an adequately sized protective earth (ground) conductor between the drive and the metal mounting surface.
☐	There is an adequately sized protective earth (ground) conductor between the motor and the drive.
☐	All protective earth (ground) conductors have been connected to the appropriate terminals and the terminals have been tightened (pull conductors to check).
☐	The supply voltage matches the nominal input voltage of the drive. Check the type designation label.
☐	The input power cable has been connected to appropriate terminals, the phase order is correct, and the terminals have been tightened (pull conductors to check).

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☑	**Check that …**
☐	Appropriate supply fuses and disconnector have been installed.
☐	The motor cable has been connected to appropriate terminals, the phase order is correct, and the terminals have been tightened (pull conductors to check).
☐	The brake resistor cable (if present) has been connected to appropriate terminals, and the terminals have been tightened (pull conductors to check).
☐	The motor cable (and brake resistor cable, if present) has been routed away from other cables.
☐	No power factor compensation capacitors have been connected to the motor cable.
☐	All low voltage control cables have been correctly connected.
☐	If a drive bypass connection will be used (for induction motors): The direct-on-line contactor of the motor and the drive output contactor are either mechanically or electrically interlocked (cannot be closed simultaneously).
☐	There are no foreign objects or dust inside the drive.
☐	Drive and motor connection box covers are in place.
☐	Verify that all wiring conforms to applicable codes.
☐	The motor and the driven equipment are ready for start-up. Disconnect the load from the motor until instructed to apply a load. If this is not possible, disconnect the motor wires at connector X1.
☐	Check no physical damage is present.
☐	Check all instruments have been properly calibrated.

Safe Torque Off (STO) connections

The STO inputs are an intrinsic part of a safe drive installation.

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

The MicroFlex e150 will operate only when the STO inputs are powered.

See *Appendix: Safe Torque Off (STO)* on page *173*.

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9

Start-up

What this chapter contains

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

Introduction

Before powering the MicroFlex e150 you will need to connect it to the PC using a USB or Ethernet cable and install the Mint WorkBench software. This includes a number of applications and utilities to allow you to configure, tune and program the MicroFlex e150. Mint WorkBench and other utilities can be found on the Mint Motion Toolkit CD (OPT-SW-001), or downloaded from *www.abbmotion.com*.

Install Mint WorkBench

The Windows user account requires administrative user rights to install Mint WorkBench. To install Mint WorkBench from *www.abbmotion.com*, download the application and run it.

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Connect the MicroFlex e150 to the PC using USB

The MicroFlex e150 can be connected to the PC using either USB or Ethernet.

Connect a USB cable between a PC USB port and the MicroFlex e150 USB port. Your PC must be using Windows XP, Windows Vista or Windows 7.

USB driver

The USB driver for the MicroFlex e150 is installed with Mint WorkBench.

- If you are using Windows Vista or a newer operating system, no USB driver configuration should be necessary.
- If you are using Windows XP, it will prompt for the driver. Click Next >, choose 'Install the software automatically', and click Next > again. Windows will locate and install the driver. The MicroFlex e150 is now ready to be configured using Mint WorkBench. If the MicroFlex e150 is later connected to a different USB port on the host computer, Windows might report that it has found new hardware. Either install the driver files again for the new USB port, or connect the MicroFlex e150 to the original USB port.

To confirm that the USB driver is installed, check that a *Motion Control* category is listed in Windows Device Manager:

Connect the MicroFlex e150 to the PC using Ethernet

The MicroFlex e150 can be connected to the PC using either USB or Ethernet.

Connect a CAT5e Ethernet cable between the PC and the E1 / OUT Ethernet port on the top of the MicroFlex e150.

Firmware versions

The IP addresses used in the following section apply to a MicroFlex e150 product with firmware version 5715 or greater, which sets a default IP address of 192.168.0.1. If your MicroFlex e150 uses firmware version 5714 or lower its default IP address is 192.168.100.110, and you should use 192.168.100.241 for the Ethernet adapter. Alternatively, use Mint WorkBench to upgrade your MicroFlex e150 firmware to the latest version.

Configure the PC Ethernet adapter

It is necessary to alter the PC's Ethernet adapter configuration to operate correctly with the MicroFlex e150. By default, the MicroFlex e150 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 e150 without first altering the PC's Ethernet adapter configuration. However, if you have installed a second Ethernet adapter dedicated for use with the MicroFlex e150, 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 e150, 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: From the Start screen, click the down arrow or swipe up to go to the Apps screen. Choose Control Panel, Network and Internet, Network and Sharing Center).
2. On the left of the window, click Change Adapter Settings. Double click the icon for the required Ethernet adapter, then click Properties.
3. Select the ‘Internet Protocol Version 4 (TCP/IPv4)' entry and click Properties.
4. On the General tab, make a note of the existing settings. Click Advanced... and make a note of any existing settings. Click Cancel and then click the Alternate Configuration tab and make a note of any existing settings.

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5. On the General tab, choose the ‘Use the following IP address' option.
6. In the IP address box, enter an IP address, e.g. 192.168.0.241. This is the IP address that will be assigned to the Ethernet adapter.
7. In the Subnet mask box, enter 255.255.255.0 and click OK.
8. Click Close to close the Local Area Connection Properties dialogue.
9. Click Close to close the Local Area Connection Status dialogue.

Enable the Ethernet adapter for Mint WorkBench

Before Mint WorkBench can use the Ethernet adapter to discover the MicroFlex e150, the adapter must be enabled in the Mint HTTP server.

1. On the Windows 7 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.

For the latest information about Mint WorkBench and the Mint HTTP server, see the Mint WorkBench help file.

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Start the MicroFlex e150

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 USB cable or Ethernet cable linking the PC to the MicroFlex e150.

Preliminary checks

Before you apply power for the first time, check all items in *Installation checklist*, starting on page *87*.

Power on checks

See section *MicroFlex e150 indicators* on page *119* for symbols that show if the drive has detected a fault.

1. Turn on the 24 V DC supply.
2. Turn on the AC supply.
3. The drive status display shows the following test sequence, which normally takes approximately 15-20 seconds: 8., ≡ (in sequence), 1 2 3 (in sequence). The sequence ends with the – symbol, or ⁻. if an STO input is not powered. Startup can take more than 1 minute after downloading new firmware.
4. If the motor wires were disconnected in *Preliminary checks* on page *93*, turn off the AC supply and reconnect the motor wires. Turn on the AC supply.
5. To allow the Commissioning Wizard to function, the Safe Torque Off inputs (page *173*) need to be powered to allow the MicroFlex e150 to be enabled.
6. If you do not wish to enable the MicroFlex e150 yet, the Commissioning Wizard will inform you when this step is necessary.

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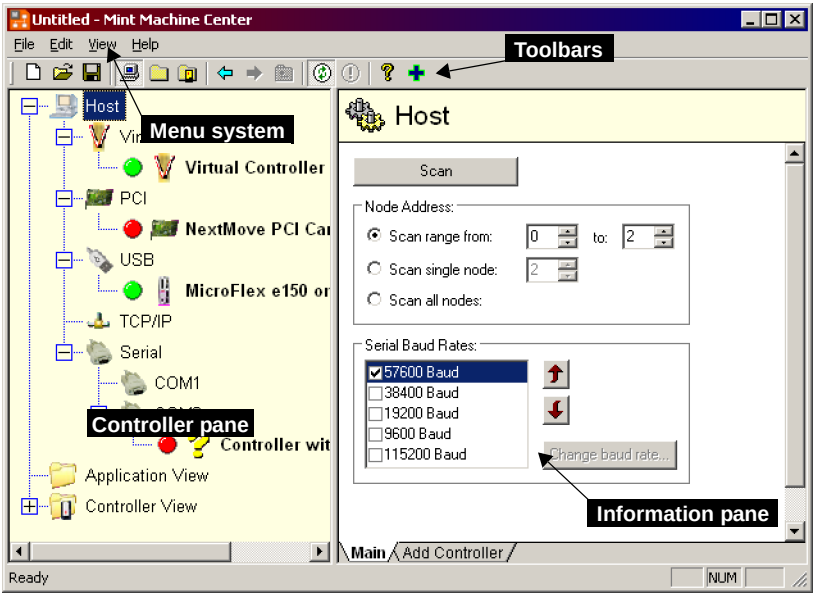
Mint Machine Center

The Mint Machine Center (MMC) is installed as part of the Mint WorkBench software. It is used to view the network of connected controllers in a system. Individual controllers and drives are configured using Mint WorkBench.

If you have only a single MicroFlex e150 connected to your PC, then MMC is probably not required. See *Starting Mint WorkBench* on page *98* to configure the MicroFlex e150.



MMC provides an overview of the controller network currently accessible by the PC. MMC contains a controller pane on the left, and an information pane on the right. In the controller pane select the Host item, then in the information pane click Scan. This causes MMC to scan for all connected controllers. Clicking once on a controller's name causes various options to be displayed in the information pane. Double-clicking on a controller's name launches an instance of Mint WorkBench that is automatically connected to the controller.

Application View allows the layout and organization of controllers in your machine to be modelled and described on screen. Controllers can be dragged onto the Application View icon, and renamed to give a more meaningful description, for example “Conveyor 1, Packaging Controller”. Drives that are controlled by another product, such as MicroFlex e150, can be dragged onto the MicroFlex e150 icon itself, creating a visible representation of the machine. A text description for the system and associated files can be added, and the resulting layout saved as an ‘MMC Workspace’. When you next need to administer the system, simply loading the workspace automatically connects to all the required controllers. See the Mint help file for full details of MMC.

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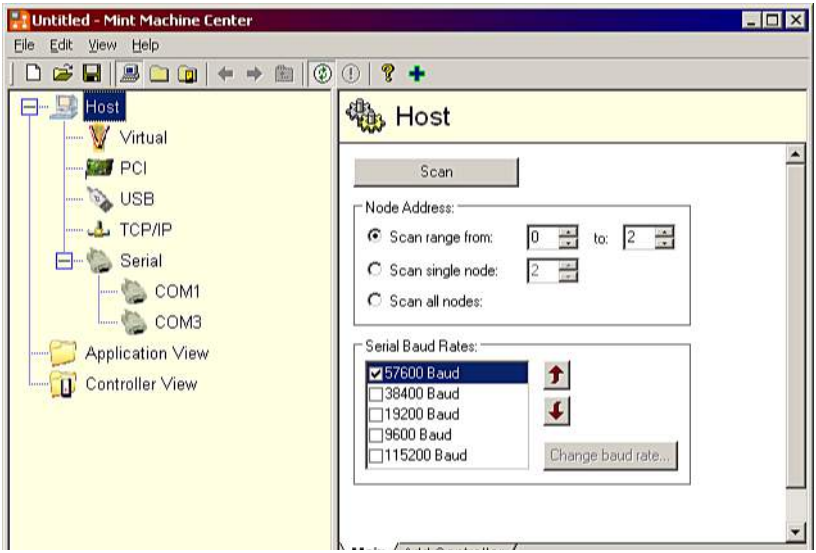
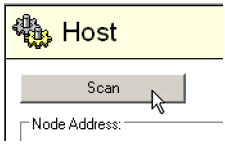
Starting MMC

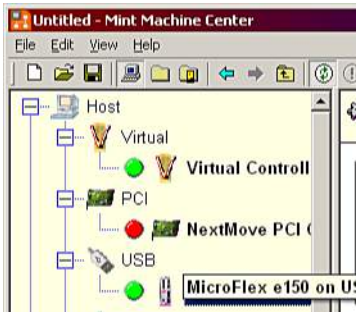
1. On the Windows Start menu, select Programs, Mint WorkBench, Mint Machine Center.



2. In the controller pane, ensure that Host is selected. In the information pane, click Scan.



3. When the search is complete, click once on ‘MicroFlex e150' in the controller pane to select it, then double click to open an instance of Mint WorkBench. The MicroFlex e150 will be already connected to the instance of Mint WorkBench, ready to configure.



Go straight to *Commissioning Wizard* on page *100* to continue the configuration in Mint WorkBench.

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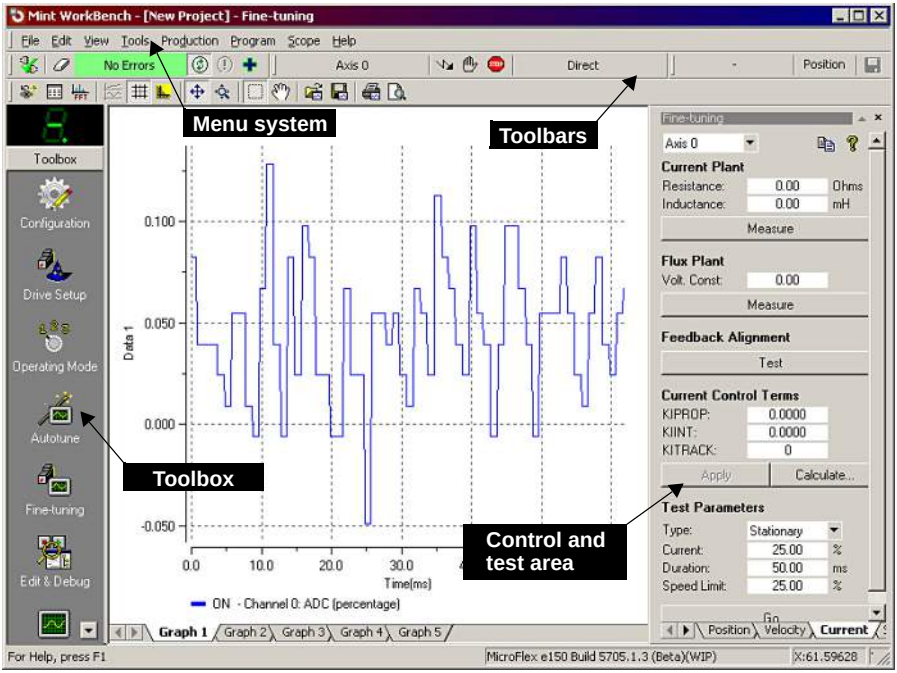
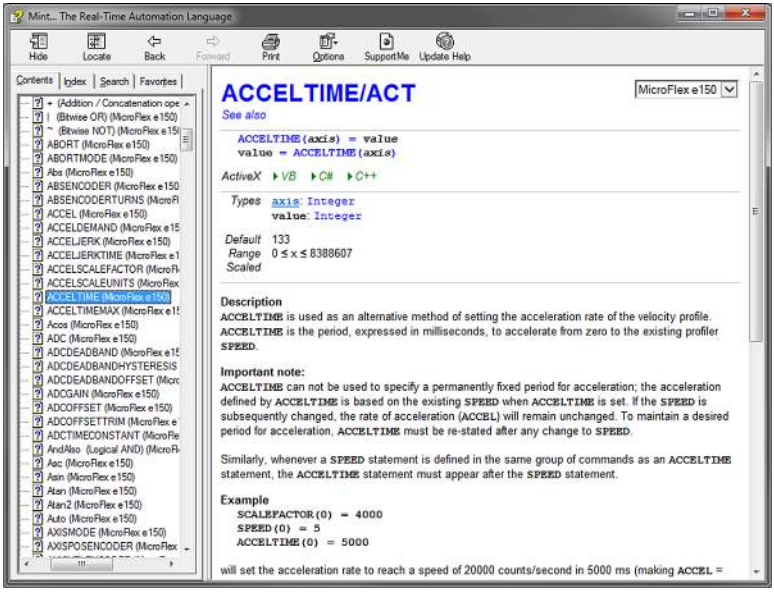
Mint WorkBench

Mint WorkBench is a fully featured application for programming and controlling the MicroFlex e150. The main Mint WorkBench window contains a menu system, the Toolbox and other toolbars. Many functions can be accessed from the menu or by clicking a button - use whichever you prefer. Most buttons include a ‘tool-tip’; hold the mouse pointer over the button (don't click) and its description will appear.



Help file

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. The help file can be displayed at any time by pressing F1. On the left of the help window, the Contents tab shows the tree structure of the help file; each book contains a number of topics. The Index tab provides an alphabetic list of all topics in the file, and allows you to search for them by name. The Search tab allows you to search for words or phrases appearing anywhere in the help file. Many words and phrases are underlined and highlighted with a color (normally blue) to show that they are links. Click on the link to go to an associated keyword. Most keyword topics begin with a list of relevant *See Also* links.

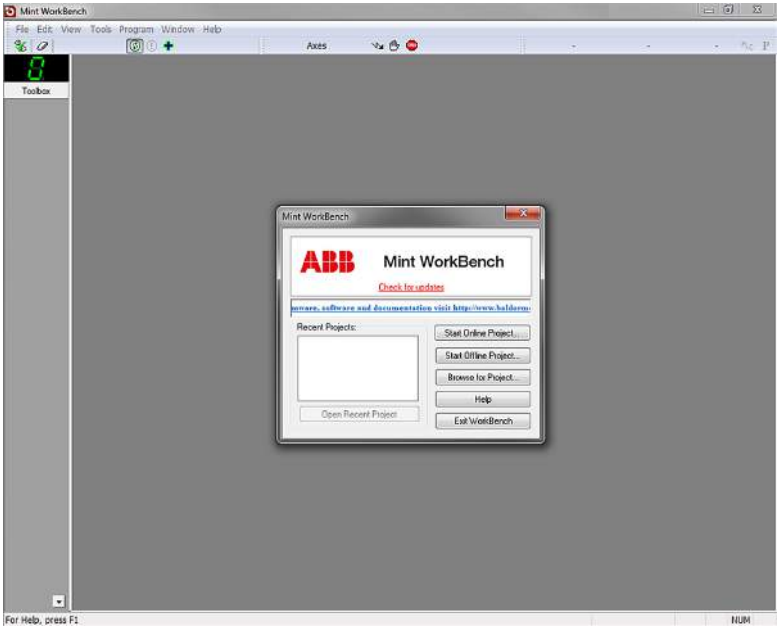


For help on using Mint WorkBench, click the Contents tab, then click the small ⊞ sign beside the Mint WorkBench & Mint Machine Center book icon. Double click a topic name to display it.

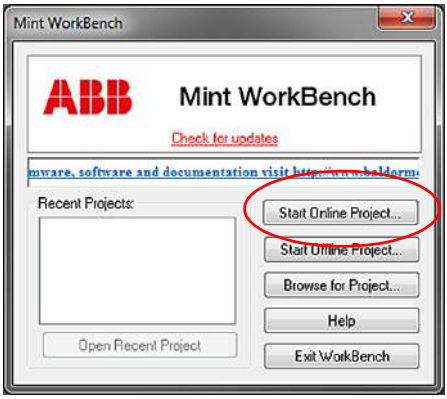
Starting Mint WorkBench

Note: If you have already used MMC to install firmware and start an instance of Mint WorkBench, go straight to section 6.4.3 to continue configuration.

1. On the Windows Start menu, select Programs, Mint WorkBench, Mint WorkBench.



2. In the opening dialog box, click Start New Project...



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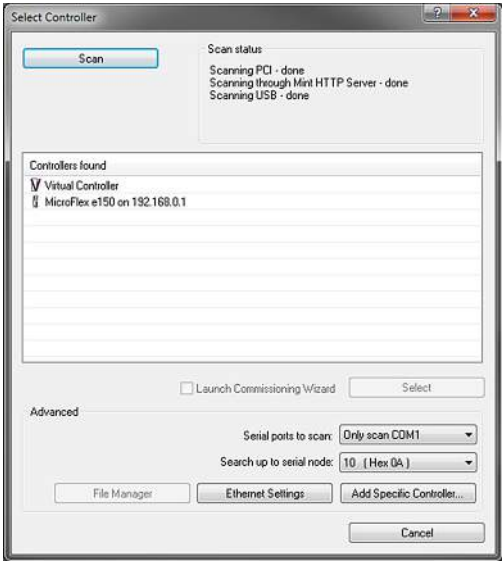
3. Click Scan to search for the MicroFlex e150.

   When the search is complete, click MicroFlex e150 in the list, then click Select.



   Note: If the MicroFlex e150 is not listed, check the USB or Ethernet cable between the MicroFlex e150 and the PC. Check that the MicroFlex e150 is powered correctly. Click Scan to re-scan the ports. It can take up to 5 seconds for Mint WorkBench to detect the MicroFlex e150.

When detection is complete, the Commissioning Wizard is displayed.
If *Launch Commissioning Wizard* was not checked, Edit & Debug mode is displayed.

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Commissioning Wizard

Each type of motor and drive combination has different performance characteristics. Before the MicroFlex e150 can be used to control the motor accurately, the MicroFlex e150 must be 'tuned'. Tuning is the process where the MicroFlex e150 powers the motor in a series of tests. By monitoring the drive's output and the feedback from the motor's encoder, the MicroFlex e150 can make small adjustments to the way it controls the motor. This information is stored in the MicroFlex e150 and can be uploaded to a file if necessary.

The Commissioning Wizard provides a simple way to tune the MicroFlex e150 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 will not need to re-enter everything if you go back to previous screens. If you need extra help, click Help or press F1.

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

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

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

Drive Setup complete:
This screen confirms that drive setup is complete.

Select Operating Mode and Source:
In the Operating Mode section, choose the required operating mode. In the Reference Source section, it is important to select 'Direct (Host/Mint') as the Reference Source. This will allow the Autotune Wizard to operate correctly, and allow further initial testing to be performed using Mint WorkBench. Although the MicroFlex e150 might eventually be controlled over EtherCAT, the 'RT Ethernet' reference source should only be selected after the MicroFlex e150 has been commissioned and is ready to add to the EtherCAT network. This can be selected by choosing the Operating Mode tool in the Toolbox.

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

Select Scale Factor:
It is not necessary to change anything on this screen. However, it is recommended to select a user unit for position, velocity and acceleration. This allows Mint WorkBench to display distance, speed and acceleration using meaningful units, instead of encoder counts. For example, selecting a Position User Unit of Revs (r) will mean that all position values entered or displayed in Mint WorkBench will represent revolutions. The Position Scale Factor value will change 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

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and enter a suitable value in the Position Scale Factor box. Separate velocity and acceleration units can also be defined. See the Mint help file for more information about scale factors.

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

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 e150 for optimal performance with the attached motor. This removes the need for manual fine-tuning of the system, although in some critical applications this still might be required.

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

WARNING! The motor will move 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 will take measurements from the motor and then perform small test moves.

For further information about tuning with the load attached, see *Further tuning - with load attached* on page *105*.

NOTE: Even if you do not perform any further tuning or configuration, the STO function must be tested; see *Appendix: Safe Torque Off (STO)* on page *173*.

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Further tuning - no load attached

The Autotune Wizard calculates many parameters that allow the MicroFlex e150 to provide good control of the motor. In some applications, these parameters might 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.

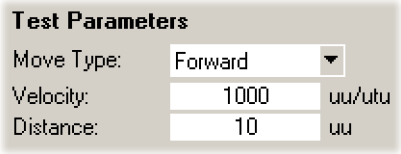
   The main area of the Mint WorkBench window displays the capture window. When further tuning tests are performed, this will display a graph representing the response.

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

   Click on the Velocity tab.

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

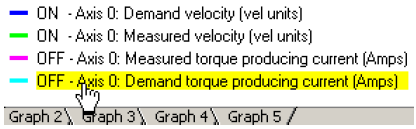
3. In the Test Parameters area at the bottom of the tab, click in the Move Type drop down box and select Forward.



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

4. Click Go to start the test move. Mint WorkBench will perform the test move and display 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.



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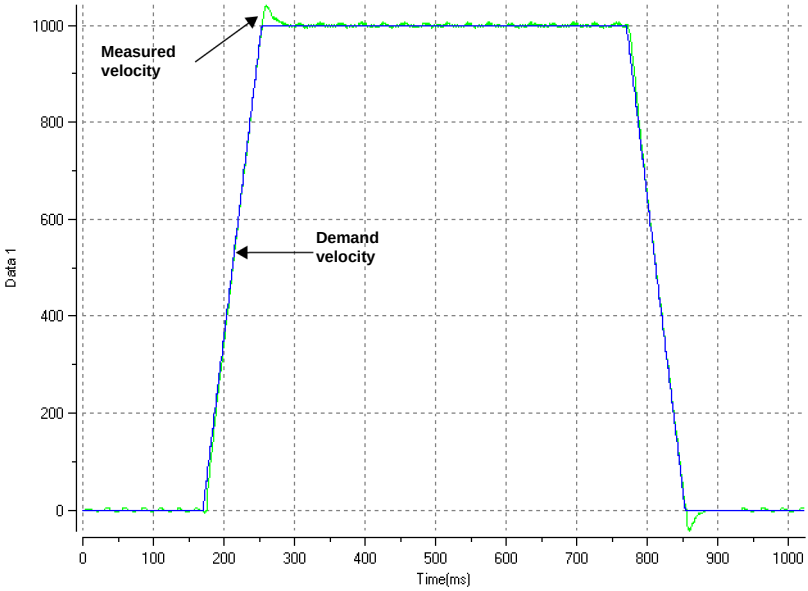
Typical autotuned response (no load):



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 *105*.

Further tuning - with load attached

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

1. Attach the load to the motor.
2. Click the Autotune icon in the Toolbox on the left of the screen.

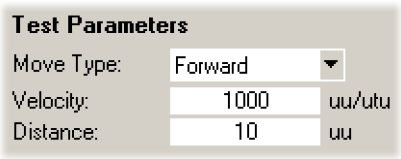
3. Click the Autotune on load check box.

4. Click START to begin the auto-tuning process. Mint WorkBench will take measurements from the motor and then perform 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 will perform the test move and display a graph of the result.



Optimizing the velocity response

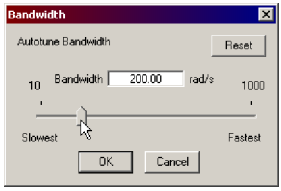
It might be desirable to optimize the default autotuned response to better suit your application. The following sections describe the two main tuning factors and how to correct them.

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.

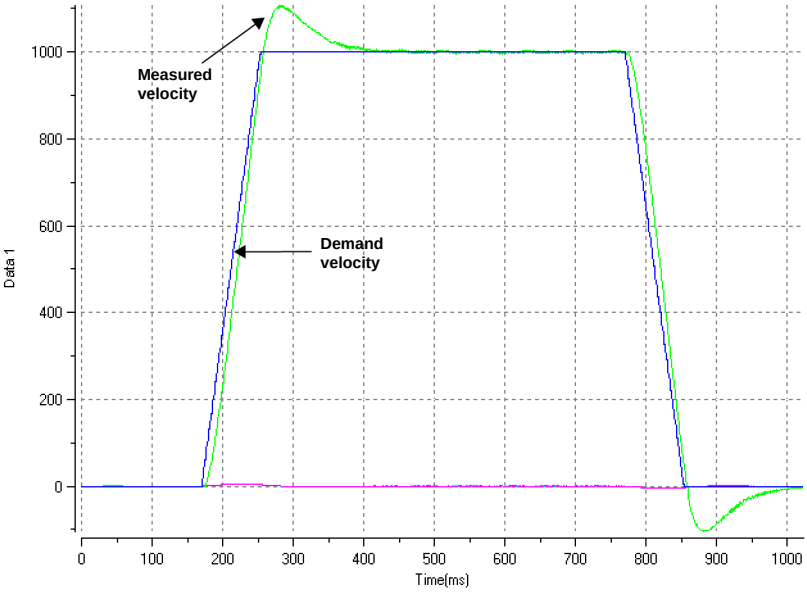
   To reduce the amount of overshoot, click Calculate... and increase the bandwidth using the slider control. Alternatively, type a larger value in the Bandwidth box.

   Click OK to close the Bandwidth dialog.

2. Click Go to start the test move. Mint WorkBench will perform the test move and display a graph of the result.

Velocity overshoots demand:



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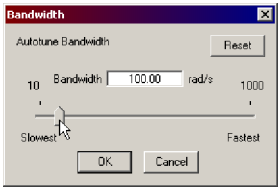
Correcting zero-speed noise in the velocity response

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.

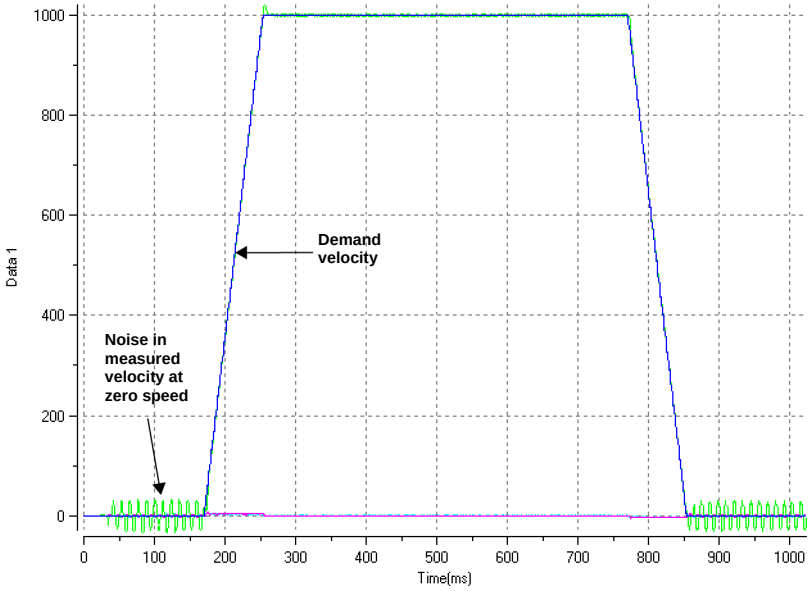
   To reduce the amount of noise, click Calculate... and decrease the bandwidth using the slider control. Alternatively, type a smaller value in the Bandwidth box.

   Click OK to close the Bandwidth dialog.

2. Click Go to start the test move. Mint WorkBench will perform the test move and display a graph of the result.

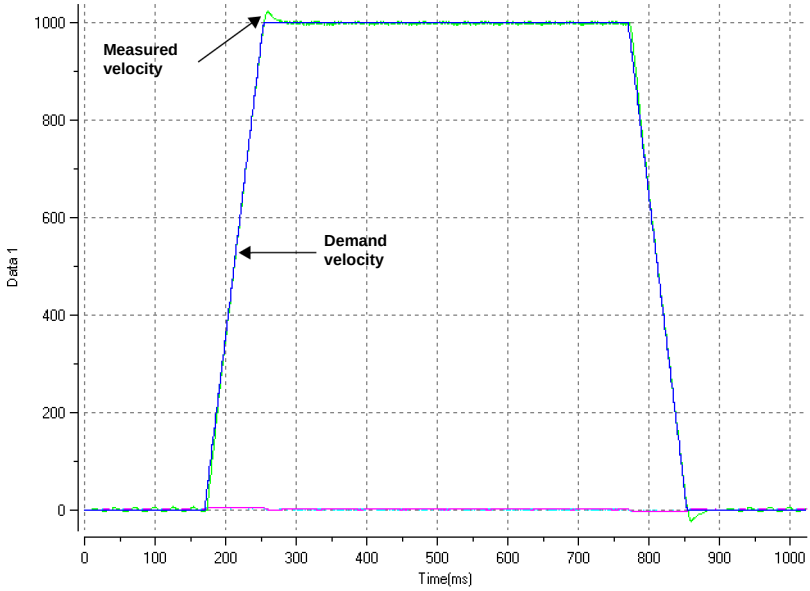
Zero-speed noise:



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:



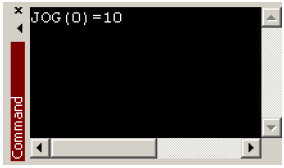
Performing test moves - continuous jog

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 will cause 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.

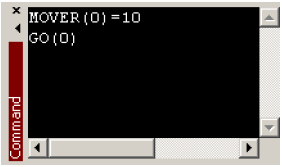
3. Click in the Command window.

   Type:

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

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

   The move will stop when completed.



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

Further configuration

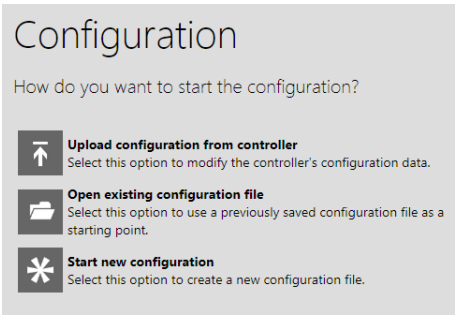
Mint WorkBench provides a number of other tools for testing and configuring the MicroFlex e150. Every tool is explained fully in the help file. Press F1 to display the help file, then navigate to the Mint WorkBench book. Inside this is the Toolbox book.

Configuration tool

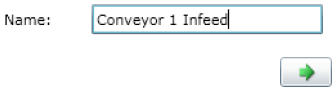
The Configuration tool shows the MicroFlex e150's integrated configuration interface.

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*.

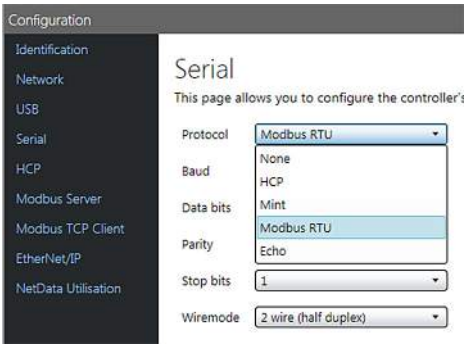


3. Enter a descriptive name for the controller and click the green arrow.



4. Continue through the screens making the required changes.

   Click Apply at any time to save the changes.



5. When you have finished, click Apply to complete the configuration.

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Parameters tool

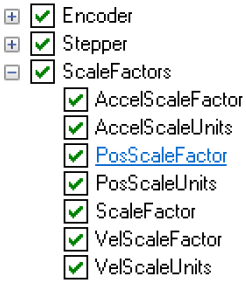
The Parameters tool can be used to view or change most of the drive's parameters.

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 will expand to show all items in the category. Click on the item you wish to edit.



3. The adjacent table will list the chosen item. Click in the Active Table cell and enter a value. This immediately sets the parameter, which will remain in the MicroFlex e150 until another value is defined. The icon to the left of the item will become yellow to indicate that the value has been changed.

Many of the MicroFlex e150's parameters are set automatically by the Commissioning Wizard, or when tests are performed in the fine-tuning window.

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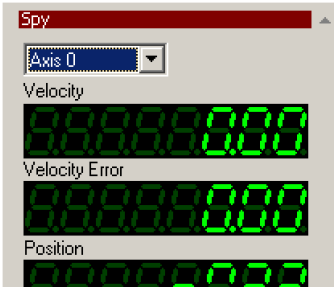
Spy window

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 *109* or *Performing test moves - relative positional move* on page *110* 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.

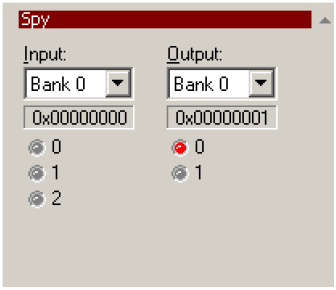
   The Spy Window is displayed on the right of the screen. Click on the tabs at the bottom of the window to select the required function.

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.

   Clicking on an output LED will toggle the output on/off.

4. The Monitor tab allows up to six parameters to be selected for monitoring.

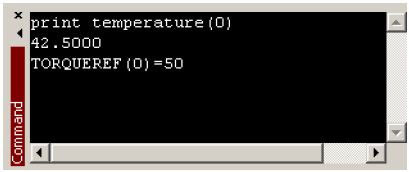
   Click in a drop down box to select a parameter.

   At the bottom of the Monitor tab, real-time data capture can be configured.

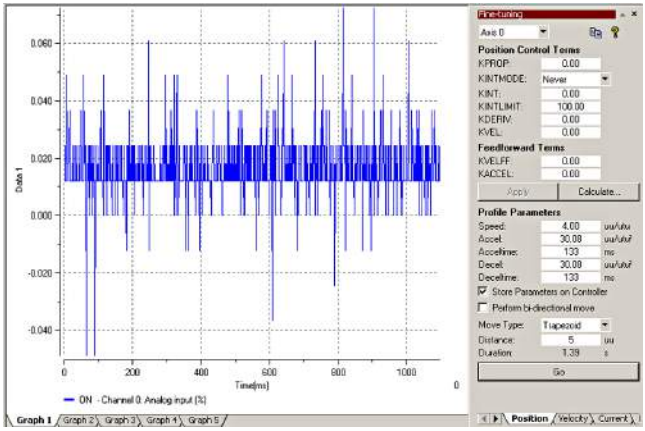
Other tools and windows

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 e150. If you tried the test moves in *Performing test moves - continuous jog* on page *109* or *Performing test moves - relative positional move* on page *110*, then you have already used Edit & Debug mode.
  Press Ctrl+N to open a Mint programming window (except models ..EI**N**A..).

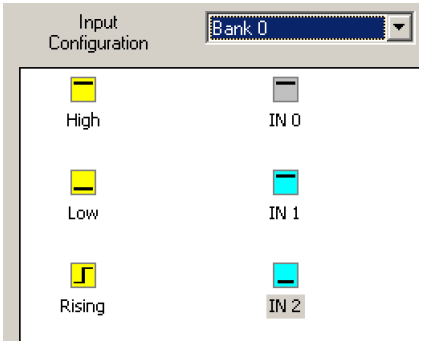


- Scope Tool
  Displays the capture screen. This screen is also shown when the Fine-tuning tool is selected.



- Digital I/O 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 *63* and *65* - *68*.

  If a digital input is to be used as a home switch input, see *Using a digital input as a home switch input (optional)* on page *63* for important details.



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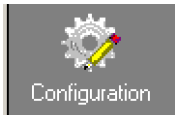
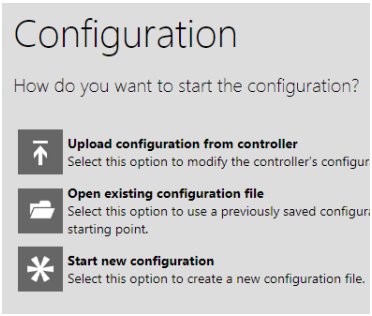
Modbus configuration (optional)

Modbus communication is set up using the Configuration tool in Mint WorkBench.

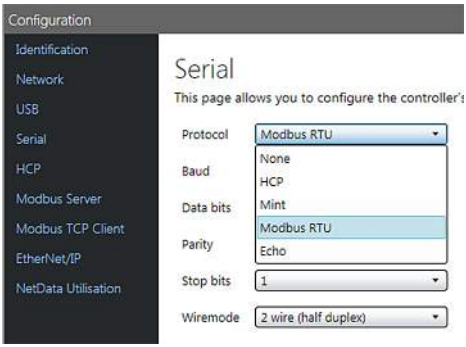
1. Click the Configuration tool icon in the Toolbox on the left of the screen.



2. Select *Upload configuration from controller* or *Start new configuration*.



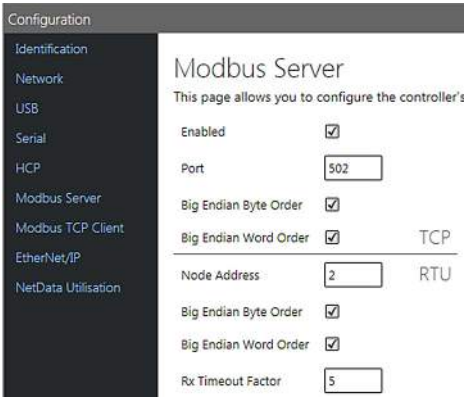
3. (*Modbus RTU only*) Choose the Serial tab, and then select Modbus RTU as the Protocol.



4. Choose the Modbus Server tab and Modbus TCP Client tabs to make other changes to the configuration.

   Click Apply at the bottom of the screen to save the changes.

   Press F1 to view help file topics that explain each setting.



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Safe Torque Off (STO) acceptance test

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

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

See *Appendix: Safe Torque Off (STO)* on page *173*.

10

Fault tracing

What this chapter contains

This section explains common problems and their solutions. The LED indicators are described in *MicroFlex e150 indicators* on page *119*.

Problem diagnosis

If you have followed all the instructions in this manual in sequence, you should have few problems installing the MicroFlex e150. 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.

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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.

Please have the following information ready:

- The serial number of your MicroFlex e150 (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 e150

The term ‘power-cycle the MicroFlex e150’ is used in the Troubleshooting sections. Remove the 24 V supply, wait for the MicroFlex e150 to power down completely (the Status LED will turn off), then re-apply the 24 V supply.

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MicroFlex *e*150 indicators

Ethernet LEDs

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.

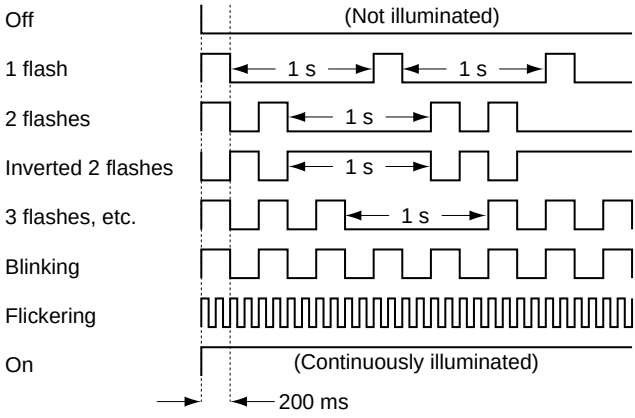
NET ERR (Red)	
	Off: No errors or not powered.
	Blinking: Invalid mailbox configuration in BOOT. Invalid mailbox configuration in PREOP. Invalid Sync manager configuration. Invalid output configuration. Invalid input configuration. Invalid watchdog configuration. Invalid DC Sync configuration. Invalid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

LED flash periods

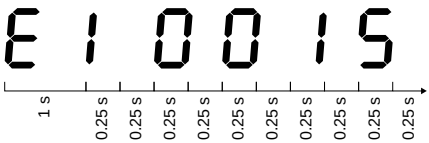
The following diagram shows the definitions of the terms ‘blinking’, ‘flashing’ and ‘flickering’ used in the previous sections, as defined by the EtherCAT Technology Group.

LED flash timing definitions:



Drive status display

The drive status display indicates errors and general MicroFlex e150 status information. When an error occurs, the drive displays a sequence starting with the symbol E, followed by the five digit error code. For example, error code 10015 is displayed:



The decimal point to the right of the number also illuminates to indicate STO errors. For a complete list of error codes, open Mint WorkBench, press F1, and locate the Error Handling book. This contains topics listing the drive status display indicators and basic error codes.

The following information symbols can be displayed:

Symbol	Description
	Drive disabled, and one or both STO inputs are not powered. The drive must be enabled before operation can continue. Both STO inputs must be powered. If an optional drive enable input has been configured, it must also be powered.
	Drive disabled. The drive must be enabled before operation can continue. If an optional drive enable input has been configured, it must also be powered.
	Suspend active. The Mint SUSPEND command has been issued and is active. Motion will be ramped to zero demand whilst active.
	Firmware loading (segments are illuminated sequentially). This sequence is followed by a numerical sequence representing firmware initialization stages.
	Hold to Analog (HTA) mode. The axis is in Hold To Analog mode. See the Mint keyword HTA.
	Drive enabled, but idle.
	Cam move. A cam profile is in progress. See the Mint keyword CAM.
	Dwell. A dwell (wait) ‘move’ is in progress. See the Mint keyword MOVEDWELL.
	Flying shear. A flying shear is in progress. See the Mint keyword FLY.
	Follow move. The drive is in follow mode. See the Mint keyword FOLLOW.

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Symbol	Description
	Homing. The drive is currently homing. See the Mint keyword HOME.
	Incremental move. An incremental linear move is in progress. See the Mint keywords INCA and INCR.
	Jog. The drive is jogging. See the Mint keywords JOG, JOGCOMMAND and related topics.
	Offset move. An offset move is in progress. See the Mint keyword OFFSET.
	Position move. A linear move is in progress. See the Mint keywords MOVEA and MOVER.
	Torque move. The drive is in torque mode. See the Mint keywords TORQUEREF, TORQUEREFSOURCE and related commands.
	Stop input active. A Mint STOP command has been issued or an optional stop input is active.
	Velocity reference move. The drive is under velocity control. See the Mint keywords VELREF and related keywords.
	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.

Drive status display shows ‘r’:

- The MicroFlex e150 is in firmware recovery mode. This means that it cannot boot fully, so will allow Mint WorkBench to download firmware from the scan controller dialog.

Mint WorkBench fails to detect the MicroFlex e150:

- Ensure that the MicroFlex e150 is powered and the drive status display is illuminated (page *121*).
- Check that the Ethernet or USB cable is connected between the PC and MicroFlex e150.
- For Ethernet connections, check that DIP switch 4 is in the ON position to set standard Ethernet mode. Power cycle the MicroFlex e150 after changing DIP switch 4. Check that the cable is connected to port E1 (the port nearest the front panel).
- Check that the PC's Ethernet port has been correctly configured for TCP/IP operation (see *Configure the PC Ethernet adapter* on page *91*).
- Try an alternative cable or different port on the PC.
- For USB connections, check that the cable is properly connected. Check the USB connector socket pins for damage or sticking. Check that the USB device driver has been installed; a ‘ABB USB Motion Product’ device should be listed in Windows Device Manager, and 'MicroFlex e150' should be listed in Windows Devices and Printers (Windows 7).

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).

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Cannot communicate with the controller after downloading firmware:

- After firmware download, always power cycle the MicroFlex e150.

Mint WorkBench loses contact with MicroFlex e150 while connected using USB:

- Check that the MicroFlex e150 is powered.
- Check that a ‘ABB USB Motion Product’ device is listed in Windows Device Manager, and 'MicroFlex e150' is listed in Windows Devices and Printers (Windows 7). If not, there could be a problem with the PC's USB interface.

Tuning

Cannot enable the MicroFlex e150 because there is an error 10010:

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

Cannot enable the MicroFlex e150 because there is an error 10033, 10034 and/or 10035:

- Check the Safe Torque Off inputs on connector X3 pins 18 & 8 and 19 & 9 are both connected and powered correctly.

When the MicroFlex e150 is enabled the motor is unstable:

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

Ethernet

Cannot connect to the drive over TCP/IP:

- Check that the PC's Ethernet adapter has been correctly configured, as described in *Configure the PC Ethernet adapter* on page *91*.

How do I configure my EtherCAT manager to operate with the MicroFlex e150?

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

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I can’t control the MicroFlex e150 from my EtherCAT manager

The drive’s reference source must be set to allow the EtherCAT manager to take control of the MicroFlex e150. There are several ways to do this:

- Set the CONTROLREFSOURCESTARTUP parameter to '1' using the Mint WorkBench Parameter viewer or Command window, and restart the drive. This will give control to the manager each time the MicroFlex e150 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 (DS402)’ in the Axis 0 drop-down.
- Confirm that the reference source on all controlled nodes has been set to EtherCAT in the Mint WorkBench Operating Mode Wizard, and that the master has been configured correctly.

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11

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.

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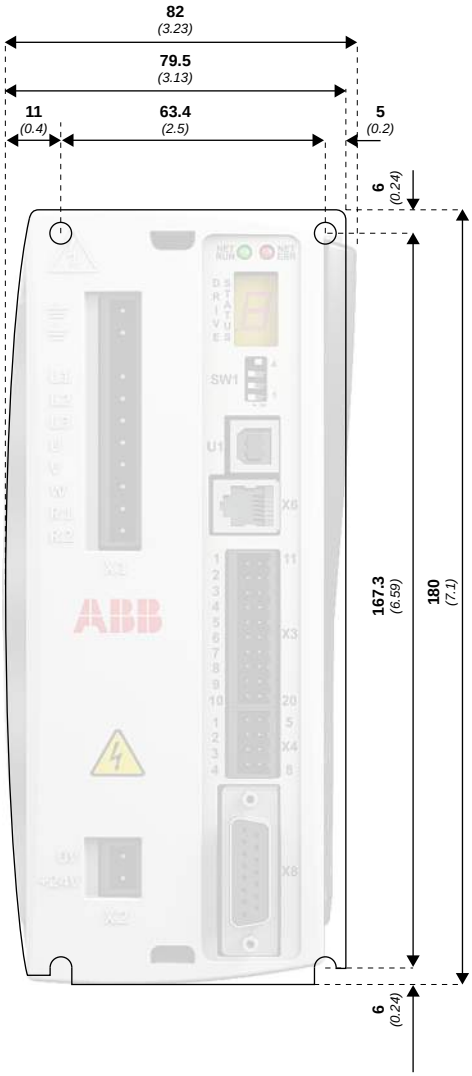
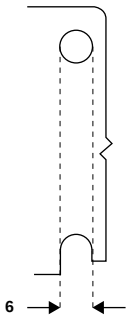
Dimension drawing (all models)





Dimensions shown as: **mm** (inches)

Depth: **157 mm** (6.2 in)
Weight: 3 A: 1.45 (3.2 lb)
6 A: 1.50 kg (3.3 lb)
9 A: 1.55 kg (3.4 lb)

Electrical power network specification

A 115 - 230 V AC 3-phase power source (EN 61010 over-voltage category III or less) is required. An AC power filter is required to comply with the CE directive for which the MicroFlex e150 was tested (see *CE marking* on page *153*).

Description	Unit	AC input					
		1Φ			3Φ		
Nominal input voltage	V AC	115 or 230			115 or 230		
Minimum input voltage		105*			105*		
Maximum input voltage		250			250		
		3 A	6 A	9 A	3 A	6 A	9 A
Nominal input current @ maximum rated output current	A	7.5	15	22	4	8	12
Nominal DC-bus voltage @ 230 V AC input		305			321		
Frequency		48 to 63 Hz, maximum rate of change 17%/s					
Imbalance					Max. ± 3% of nominal phase to phase input voltage		
Fundamental power factor		0.98 (at nominal load)					
Network type		TN (grounded) systems. Corner grounded TN, and IT (ungrounded) systems not allowed.					
Short circuit current protection (UL 508C)		The drive is suitable for use on a circuit capable of delivering not more than 5000 A symmetrical amperes (rms) at 230 V maximum when protected by fuses given in the fuse table on page *136*.					

* The MicroFlex e150 will operate at lower input voltages, although the drive will trip if the DC-bus voltage falls below 50 V or 60% of the no-load voltage, whichever occurs first.

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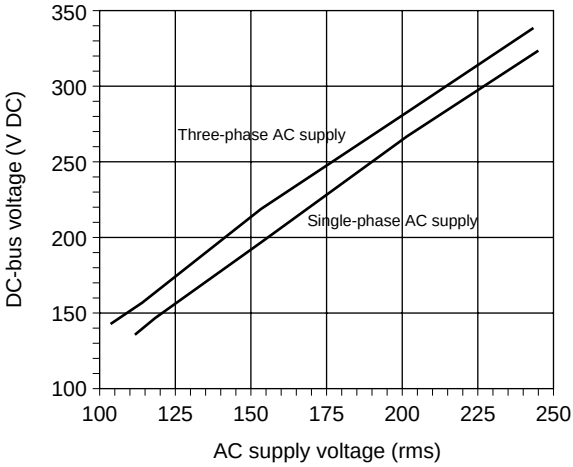
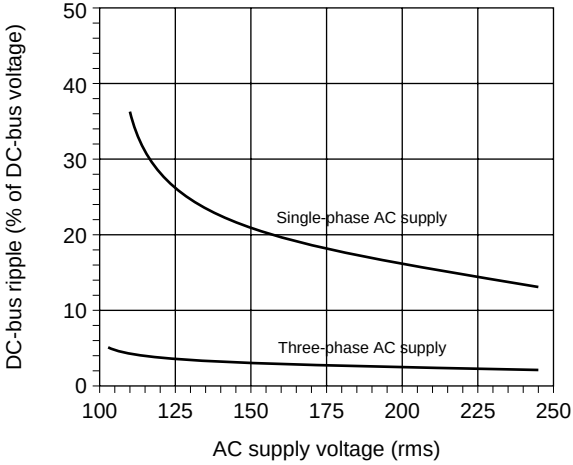
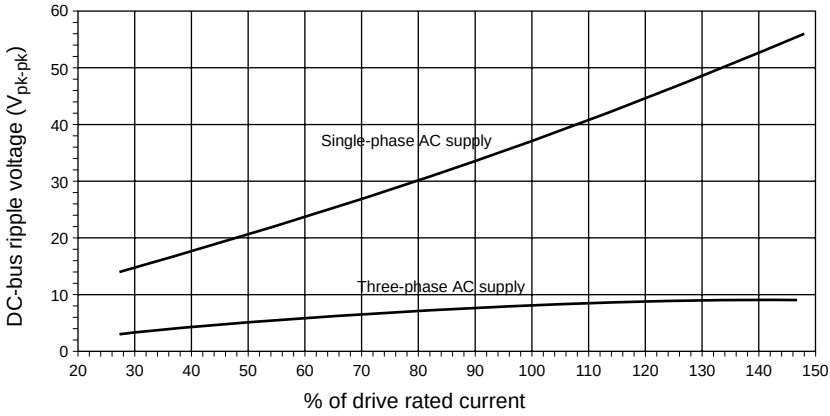
Effect of AC power supply voltage on DC-bus voltage



Effect of AC power supply voltage on DC-bus ripple voltage



Effect of output current on DC-bus ripple voltage



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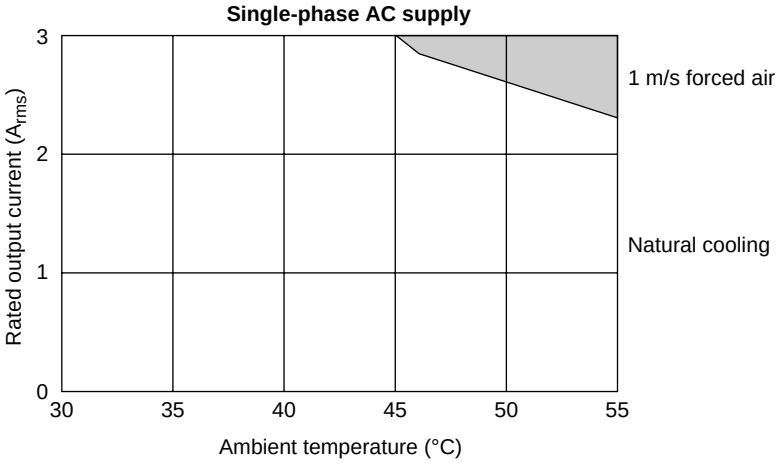
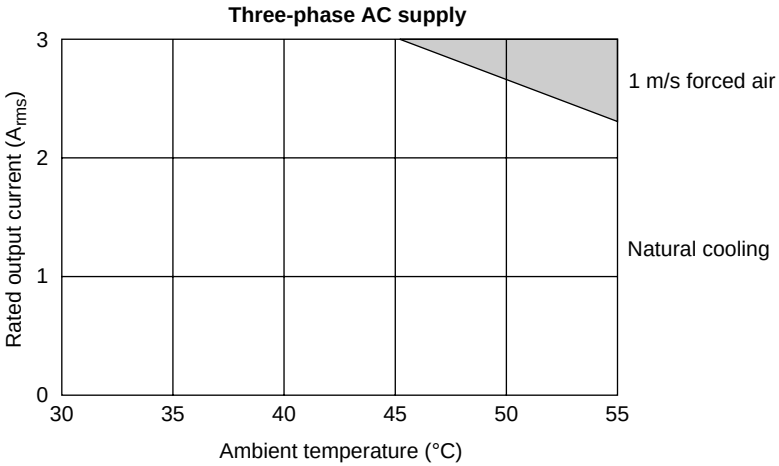
Temperature derating

The derating characteristics assume the MicroFlex e150 is mounted vertically on 3 mm thick (or less) metal plate. If the MicroFlex e150 is mounted on 10 mm metal plate, the current characteristics shown below can be increased by up to 7% if there is no forced air cooling, or 15% if forced air cooling is present. See also *Mounting and cooling* on page *29*.

Derating characteristic for 3 A models (E152A03...):





Notes:
Load power factor = 0.75.
Overload limit for models E152A**03**... is 6 A.

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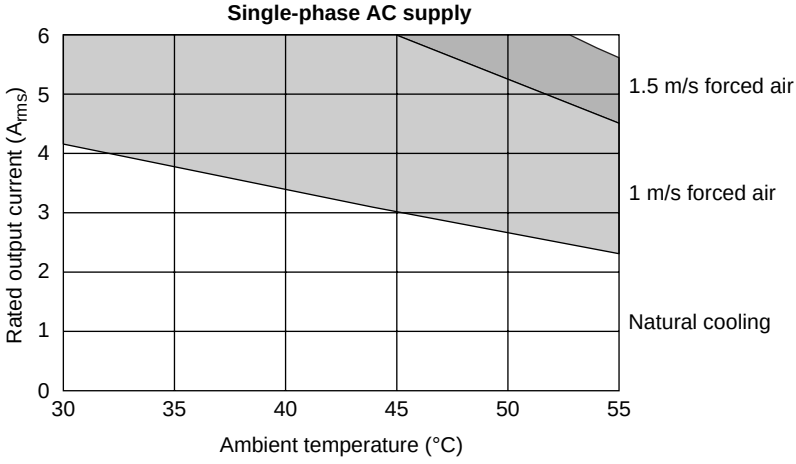
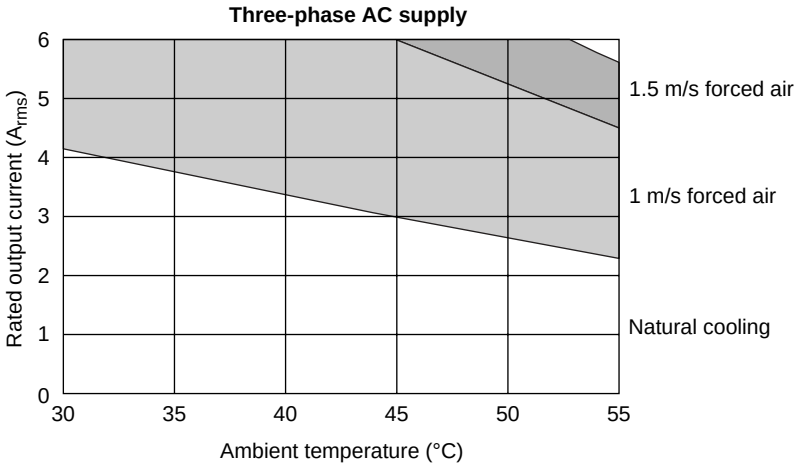
Derating characteristic for 6 A models (E152A06...):





Notes:
Load power factor = 0.75.
Overload limit for models E152A**06**... is 12 A.

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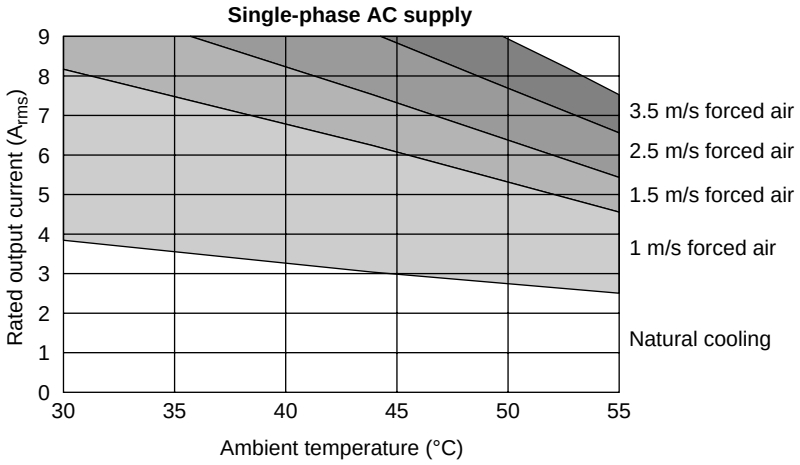
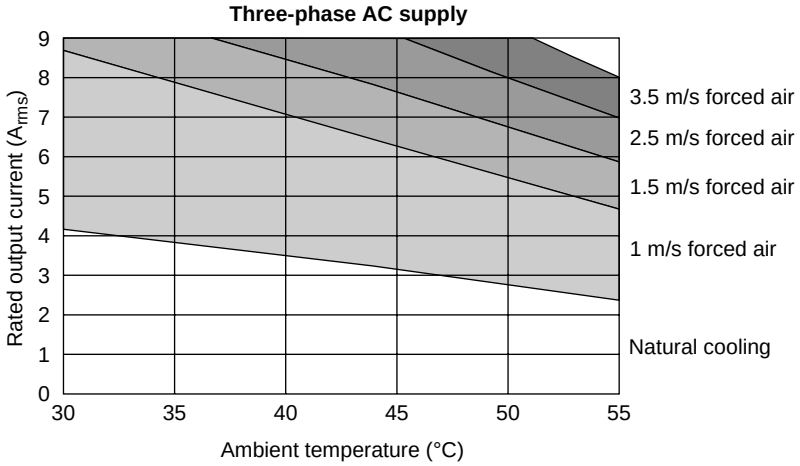
Derating characteristic for 9 A models (E152A09...):





Notes:
Load power factor = 0.75.
Overload limit for models E152A**09**... is 18 A.

Overtemperature trips

The MicroFlex e150 contains internal temperature sensors that will cause it to trip and disable if the temperature exceeds 80 °C (3 A model), or 75 °C (6 A and 9 A models). This limit can be read using the `TEMPERATURELIMITFATAL` keyword - see the Mint help file for details.

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Heat dissipation

These figures assume drive efficiency = 95%, power factor = 0.8:

MicroFlex e150 model	Heat dissipation (W)
3 A	50
6 A	101
9 A	151

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Recommended fuses, circuit breakers and wire sizes

The following table describes the recommended fuses and circuit breakers for AC power connections, and suitable wires sizes for AC and motor power connections.

Drive catalog number	Cont. output amps (RMS)	AC supply type	Input fuse	Circuit breaker (C-type)	Minimum wire gauge	
					AWG	mm^2
E152A03..	3 A	1Ø	Ferraz Shawmut: 6x32 FA series, 10 A (W084314P) or BS88 2.5 URGS 10 A (N076648J)	10 A	14	2.0
		3Ø	Ferraz Shawmut: 6x32 FA series, 8 A (V084313P) or BS88 2.5 URGS, 7 A (M076647J)	8 A	14	2.0
E152A06..	6 A	1Ø	Ferraz Shawmut: 6x32 FA series, 20 A (A084318P) or BS88 2.5 URGS, 20 A (L097507J)	20 A	14	2.0
		3Ø	Ferraz Shawmut: 6x32 FA series, 12.5 A (X084315P) or BS88 2.5 URGS, 12 A (P076649J)	12.5 A	14	2.0
E152A09..	9 A	1Ø	Ferraz Shawmut: BS88 2.5 URGS, 25 A (R076651J)	25 A	14	2.5
		3Ø	Ferraz Shawmut: 6x32 FA series, 20 A (A084318P) or BS88 2.5 URGS, 20 A (L097507J)	20 A	14	2.0

Note: All wire sizes are based on 75 °C (167 °F) copper wire. Higher temperature smaller gauge wire can be used per National Electric Code (NEC) and local codes. Recommended fuses are based on 25 °C (77 °F) ambient, maximum continuous control output current and no harmonic current. Earth/ground wires must be the same gauge, or larger, than the L1, L2 and L3 wires.

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Input power-cycling and inrush

If AC power has been removed from the MicroFlex e150, it should remain disconnected for the specified period before it is reapplied:

MicroFlex *e*150 current rating	Minimum power cycle delay period (seconds)
3 A	25
6 A	45
9 A	65

This delay allows the input surge protection circuit to perform correctly, ensuring that the inrush current (typically 1.7 A) is below the drive rated current. Power-cycling the drive more frequently could cause high inrush current and corresponding nuisance operation of circuit breakers or fuses. Repeated failure to observe the delay period could reduce the lifetime of the MicroFlex e150.

Discharge period

WARNING! After AC power has been removed from the MicroFlex e150, high voltages (greater than 50 V DC) can remain on the brake resistor connections until the DC-bus circuitry has discharged. The high voltage can remain for the period specified in the table below.

MicroFlex *e*150 current rating	Time for DC-bus to discharge to 50 V or less (maximum, seconds)
3 A	83
6 A	166
9 A	248

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Power supply filters

MicroFlex e150 current rating	230 V AC, 1Ø	230 V AC, 3Ø
3 A	FI0015A00 + line reactor * *or* FI0029A00 **	FI0018A00 *
6 A	FI0015A02 * *or* FI0029A00 **	FI0018A00 *
9 A	FI0029A00 **	FI0018A03 *

* See *EMC filters* starting on page *164* for further details.
** See *Foot-mount filter (single phase only)* on page *163* for further details.

Maximum earth leakage from the MicroFlex e150 is 3.4 mA per phase (230 V, 50 Hz supply). This value does not include the earth leakage from the AC power filter, which could be much larger (see *EMC filters* on page *164*).

24 V control circuit supply (X2)

Description	Unit	3 A	6 A	9 A
Nominal input voltage	V DC	24		
Minimum input voltage	V DC	20		
Maximum input voltage	V DC	30		
Maximum ripple	%	±10		
Typical input current (not powering feedback device)	A	0.5 - 0.6		
Typical input current (powering feedback device)	A	0.6 - 0.8		
Maximum continuous current @ 24 V DC	A	1		
Power on surge current (typical) @ 24 V DC, 100 ms	A	4		

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Motor output power (X1)

Description	Unit	3 A	6 A	9 A
Nominal phase current	A_{rms}	3	6	9
Peak phase current for 3 s	A_{rms}	6	12	18
Nominal output @ 230 V, 3Φ	VA	1195	2390	3585
Output voltage (line-line) @ V DC-bus = 320 V	V_{rms}	0 - 230		
Output frequency	Hz	0 - 550		
Output dV/dt at drive, phase-phase at drive, phase-ground at motor (using 20 m cable), phase-phase at motor (using 20 m cable), phase-ground	kV/µs	 2 1.1 1.9 1.8		
Nominal switching frequency	kHz	8.0		
Minimum motor inductance	mH	1		
Efficiency	%	>95		

Motor output rating adjustment

3 A		6 A		9 A	
200%, 3 s overload	**300%, 3 s overload**	**200%, 3 s overload**	**300%, 3 s overload**	**200%, 3 s overload**	**300%, 3 s overload**
3 A	2.5 A	6 A	5.25 A	9 A	7.5 A

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Brake (X1)

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
Minimum load inductance	µH	100

Braking capacity

The braking capacity of the MicroFlex e150 can be calculated from the following formula:

$$E = \frac{1}{2} \times \textit{DC bus capacitance} \times \left((\textit{Brake switching threshold})^2 - \left(\sqrt{2} \times \textit{Supply voltage} \right)^2 \right)$$

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

MicroFlex e150 catalog number	DC-bus capacitance (µF)	Braking capacity (J)	
		115 V AC supply	230 V AC supply
E152A03...	560	34.7	12.5
E152A06...	1120	69.4	25
E152A09...	1680	104.2	37.6

Brake resistor selection

The following calculations can be used to estimate the type of brake resistor that will be required for the application. Some basic information is required to complete the calculation. Remember to use the worst-case scenario for the application, to ensure that the braking power is not underestimated. For example, use:

- The maximum possible motor speed.
- The maximum inertia.
- The minimum deceleration time.
- The minimum cycle time.

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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. See *Duty cycle* on page *144*.	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 $kg \cdot m^2$ 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 $kg \cdot cm^2$ by 0.0001 to give $kg \cdot m^2$.* *Multiply $lb\text{-}ft^2$ by 0.04214 to give $kg \cdot m^2$.* *Multiply $lb\text{-}in\text{-}s^2$ by 0.113 to give $kg \cdot m^2$.*	Total inertia: J = _____ $kg \cdot m^2$

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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:

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

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

= _____ **J (joules)**

Calculate E using the values for J, U and V entered in the table on page *141*. If E is less than the drive's braking capacity (see *Braking capacity* on page *140*), a brake resistor is not required.

If E is greater than the drive's braking capacity, then continue to the next section to calculate the braking and average power dissipation.

Braking power and average power

The braking power P_r is the rate at which the braking energy is dissipated. This rate is defined by the deceleration period, D. The shorter the deceleration period, the greater the braking power.

$$P_r = \frac{E}{D}$$

= _____ **W (watts)**

The resistors shown in the following table can withstand brief overloads, but the average power dissipation, P_{av}, must not exceed the stated power rating. The average power dissipation is determined by the proportion of the application cycle time, C, spent braking. The greater the proportion of time spent braking, the greater the average power dissipation.

$$P_{av} = P_r \times \frac{D}{C}$$

= _____ **W (watts)**

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Resistor choice

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

Required resistor power rating = 1.25 × P_{av}

_____ **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 (X1)* on page *140*.

Dimensions of brake resistors are shown in *Brake resistors* on page *167*.

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

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Resistor derating

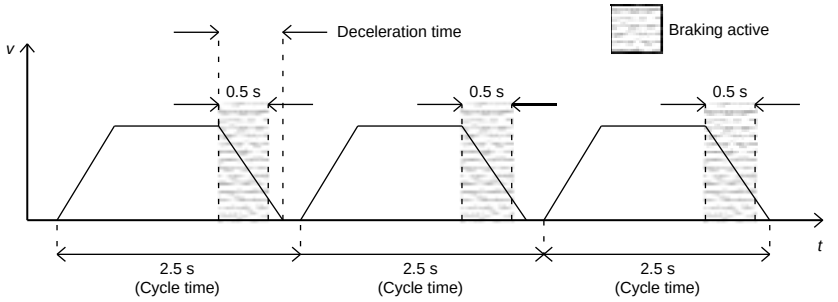
The brake resistors shown in the previous table can achieve their stated power rating only when mounted on a heat sink. In free air a derating must be applied. Furthermore, in ambient temperatures greater than 25 °C (77 °F), a temperature derating must be applied.

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):



Input / output

Analog inputs AIN0, AIN1 (X4)

Description	Unit	All models
Type		Differential
Common mode voltage range	V DC	±10
Common mode rejection	dB	40
Input impedance	kΩ	60
Input ADC resolution	bits	12 (includes sign bit)
Equivalent resolution	mV	±4.9
Sampling interval	µs	1000 (Mint) 250 (Control loop)

Analog output AOUT0 (X4)

Description	Unit	All models
Type		Bipolar
Output voltage range	V DC	±10
Output current (max)	mA	1
Output DAC resolution	bits	12 (includes sign bit)
Equivalent resolution	mV	±4.9
Update interval	ms	1

Digital inputs STO1, STO2 (X3)

See *Technical data: Digital inputs STO1, STO2 (X3)* on page *177*.

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Digital inputs DIN0, DIN3 (X3)

Description	Unit	All models
Type		Opto-isolated inputs
Input voltage Nominal Minimum Maximum Active Inactive	V DC	 24 12 30 > 12 < 2
Input current (maximum, per input)	mA	50
Sampling interval	ms	1
Minimum pulse width	µs	5

Digital inputs DIN1, DIN2 - high speed (X3)

Description	Unit	All models
Type		Opto-isolated inputs
Input voltage Nominal Minimum Maximum Active Inactive	V DC	 24 12 30 > 12 < 2
Input current (maximum, per input)	mA	20
Sampling interval	ms	1
Minimum pulse width	ns	250
Minimum step time	ns	250
Minimum space time	ns	250
Direction input setup time	ns	100
Direction input hold time	ns	100

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Digital inputs DIN4 - DIN9 (OPT1)

Description	Unit	All models
Type		Opto-isolated inputs
Input voltage Nominal Minimum Maximum Active Inactive	V DC	 24 12 30 > 12 < 2
Input current (maximum, per input)	mA	50
Sampling interval	ms	1
Minimum pulse width	µs	5

Digital outputs DOUT0 (Status), DOUT1, DOUT2 (X3)

Description	Unit	All models
User supply (maximum)	V DC	28
Output current (maximum)	mA	100
Fuse: Approximate trip current Reset time	 mA s	 200 < 20
Update interval	ms	1

Digital outputs DOUT3 - DOUT6 (OPT1)

Description	Unit	All models
User supply (maximum)	V DC	28
Output current (maximum)	mA	100
Fuse: Approximate trip current Reset time	 mA s	 200 < 20
Update interval	ms	1

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Incremental encoder interface (X8)

Description	Unit	All models
Encoder interface		RS422 A/B Differential, Z index
Maximum input frequency (quadrature)	MHz	8
Hall inputs		RS422 A/B Differential
Output power supply to encoder		5 V DC (±7%), 400 mA max.*
Maximum recommended cable length		30.5 (100 ft)

BiSS encoder interface (X8)

Description	Unit	All models
BiSS encoder interface		Differential Data and Clock
Operating mode (Baldor motors)		Single or multi-turn. A wide range of devices can be supported. Contact ABB technical support before selecting a device.
Output power supply to encoder		5 V DC (±7%), 400 mA max.*
Maximum recommended cable length		30.5 (100 ft)

SSI encoder interface (X8)

Description	Unit	All models
SSI encoder interface		Differential Data and Clock
Operating mode (Baldor motors)		Single turn. Positioning resolution up to 262144 counts/rev (18-bit). Contact ABB technical support before selecting a device.
Output power supply to encoder		5 V DC (±7%), 400 mA max.*
Maximum recommended cable length		30.5 (100 ft)

* Total current for this encoder and extra incremental encoder, which may be connected simultaneously (see page 86).

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SinCos / EnDat encoder interface (X8)

Description	Unit	All models
Absolute encoder interface		EnDat / SinCos differential inputs and data input
Operating mode (Baldor motors)		Single or multi-turn. 512 or 2048 Sin/Cos cycles per turn, with absolute positioning resolution of up to 65536 steps. (Many other encoder specifications are supported - contact ABB.)
Output power supply to encoder		5 V DC (±7%), 400 mA max.*
Maximum recommended cable length		30.5 (100 ft)

Smart Abs encoder interface (X8)

Description	Unit	All models
Smart Abs encoder interface		Differential Data
Operating mode		Single or multi-turn. A wide range of devices can be supported. Contact ABB technical support before selecting a device.
Output power supply to encoder		5 V DC (±7%), 400 mA max.*
Maximum recommended cable length		30.5 (100 ft)

* Total current for this encoder and extra incremental encoder, which may be connected simultaneously (see page 86).

Ethernet interface (E1, E2)

Description	Unit	All models
Signal		2 twisted pairs, magnetically isolated
Protocols		EtherCAT® & TCP/IP
Bit rates	Mbit/s	100

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Ambient conditions

Description	Unit	All models		
Operating temperature range		**°C**		**°F**
Minimum Maximum Derate	V DC	+0 +45 See *Temperature derating* on page *132*.		+32 +113 See *Temperature derating* on page *132*.
Storage temperature range		-40 to +85		-40 to +185
Humidity (maximum)	%	93		
		3 A	**6 A**	**9 A**
Forced air cooling flow (vertical, from bottom to top)	m/s	None required	1	2.5
Maximum installation altitude (above m.s.l.)	m ft	1000 Derate 1.1% / 100 m over 1000 m 3300 Derate 1.1% / 330 ft over 3300 ft		
Shock		10 G		
Vibration		1 G, 10-150 Hz		

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Applicable standards

MicroFlex e150 complies with the following standards.

Design and test standards

UL508C: Power Conversion Equipment.
UL840: Insulation coordination including clearance and creepage distances for electrical equipment.
EN 61800-5-1:2007 Adjustable speed electrical power drive systems. Safety requirements. Electrical, thermal and energy.
EN 60529:1991 + A1:2000 Degrees of protection provided by enclosures.
EN 61800-3:2004 Electromagnetic compatibility. When installed as directed in this manual, MicroFlex e150 conforms to the category C2 emission limits and the 'second environment' immunity requirements defined by this standard.

Environmental test standards:

EN 60068-1:1994 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 60068-2-78:2001 Environmental testing, Test Cab. Damp heat, steady state.

Functional safety standards:

IEC 61508:2010 Functional safety of electrical/electronic/programmable electronic safety-related systems.
IEC 61800-5-2:2007 Adjustable speed electrical power drive systems: Safety requirements, Functional.
EN ISO 13849-1:2008 Safety of machinery: Safety-related parts of control systems, Basic principles.
IEC 62061:2005 Safety of machinery: Functional safety of safety-related electrical, electronic and programmable electronic control systems

Marks

See also *CE marking* on page *153* for general recommendations for CE compliance.

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EtherCAT Conformance Test Certificate

Certificate

EtherCAT Conformance Test

ABB Oy

Hiomotie 13, P.O.Box 184, FI-00381 Helsinki, Finland

EtherCAT Technology Group hereby confirms the above named company that the following device is successfully **EtherCAT Conformance Tested**.

Device under Test

Product Name:	MicroFlex e150
Product Code:	0x2BC
Revision Number:	0x164A

Assigned Vendor ID:	0xB7
Test Report Number:	0xB7_001
EtherCAT Test Center:	Beckhoff Automation GmbH, Nuremberg, Germany

The following tests were performed:

- EtherCAT Protocol Test (CTT Ver.1.20.52.0)
- Indicator Test
- Labeling Test
- Interoperability Test

Nuremberg, March 14, 2012

Martin Rostan, Executive Director
EtherCAT Technology Group

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Degree of protection

MicroFlex e150 complies with EN 60529, IP20 provided connector X1 is shrouded.

For UL purposes the MicroFlex e150 is defined as an open-type, single or three phase, single axis servo amplifier.

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

NOTE: 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	Side cover: PC+ABS-FR Bayblend FR3010 Black Front Cover: PC/ABS GN-5001RFH Lupoy Light grey RAL9002 Heat sink: Die cast Aluminium LM6
Package	Cardboard.
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. The electrolytic DC capacitors and Integrated Power Module are classified as hazardous waste within the EU and must be removed and handled according to local regulations. For further information on environmental aspects and more detailed recycling instructions, please contact your local ABB distributor.

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.

Compliance with the European EMC Directive

The EMC Directive defines the requirements for immunity and emissions of electrical equipment used within the European Union. The EMC product standard EN 61800-3 covers requirements stated for drives. See section *Compliance with the EN 61800-3* below.

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Compliance with the EN 61800-3

Definitions

EMC stands for **E**lectro**m**agnetic **C**ompatibility. It is the ability of electrical/electronic equipment to operate without problems within an electromagnetic environment. Likewise, the equipment must not disturb or interfere with any other product or system within its locality.

First environment includes establishments connected to a low-voltage network which supplies buildings used for domestic purposes.

Second environment includes establishments connected to a network not supplying domestic premises.

Drive of category C2: drive of rated voltage less than 1000 V and intended to be installed and started up only by a professional when used in the first environment. **Note:** A professional is a person or organization having necessary skills in installing and/or starting up power drive systems, including their EMC aspects.

Drive of category C3: drive of rated voltage less than 1000 V and intended for use in the second environment and not intended for use in the first environment.

Category C2

The drive complies with the standard with the following provisions:

1. The drive is equipped with a suitable EMC filter; see *Power supply filters* on page *138*.
2. The motor and control cables are selected as specified in this manual.
3. The drive is installed according to the instructions given in this manual.
4. Maximum cable length is 30 meters.

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.

Category C3

The drive complies with the standard with the following provisions:

1. The drive is equipped with a suitable EMC filter; see *Power supply filters* on page *138*.
2. The motor and control cables are selected as specified in this manual.
3. The drive is installed according to the instructions given in this manual.
4. Maximum cable length is 30 meters.

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WARNING! A drive of category C3 is not intended to be used on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if the drive is used on such a network.

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 IEC 61800-5-2:2007, EN ISO 13849-1:2008, IEC 62061:2005, and IEC 61508:2010 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.

Validating the operation of the Safe Torque Off function

See *Appendix: Safe Torque Off (STO)* on page *173*.

RoHS compliance

MicroFlex e150 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 3AXD10000377752 is available on www.abb.com/drives.

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UL marking

The MicroFlex e150 is C-UL US Listed (file NMMS.E470302) only when used in conjunction with optional Fan Tray (part FAN001-024, see page *162*). The approval is valid with rated voltages. When used without optional fan tray FAN001-024, the MicroFlex e150 is UL Recognized.

UL checklist

- The drive is to be used in a heated, indoor controlled environment. 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. See page *150*.
- The maximum ambient air temperature is 45 °C (113 °F) at rated current. The current is derated for 45 to 55 °C (113 to 131 °F).
- The drive is suitable for use in a circuit capable of delivering not more than 5,000 rms symmetrical amperes, 230 V maximum. The ampere rating is based on tests done according to UL 508C.
- The cables located within the motor circuit must be rated for at least 75 °C (167 °F) in UL-compliant installations.
- Use copper conductors only.
- The input cable must be protected with fuses. Circuit breakers must not be used without fuses in the USA. Page *136* lists IEC fuses that are suitable for UL applications. For suitable circuit breakers, contact your local ABB representative.
- 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.
- 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.
- The drive provides overload protection in accordance with the National Electrical Code (NEC).

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Control system

The MicroFlex e150 can use two main control configurations:

- Servo (Position).
- Torque Servo (Current).

The configuration is selected using the Mint `CONFIG` keyword (object 5000h), or by using the Mint WorkBench System Configuration Wizard. Each configuration supports different control modes, selected using the Tools, Control Mode menu item or by using the `CONTROLMODE` keyword in the Command window (see the Mint help file). This sets the control mode switch (object 6060h).

Servo configuration

The servo configuration is the default configuration for the drive, allowing the motor control system to operate as a torque controller, a velocity controller or a position controller. This configuration comprises 3 nested control loops; a current control loop, a velocity control loop and a position control loop, as shown on page *158*.

The universal encoder interface reads rotor position from the encoder and estimates velocity. The commutation block uses the position to calculate the electrical angle of the rotor. The current sensor system measures U and V phase currents. These are fed into a current conversion block that converts them into quantities representing torque producing and magnetizing currents (the 'vector' currents which are locked to the rotor).

In the current control loop, a current demand and the final measured current values form the inputs to a PI (Proportional, Integral) control system. This control system generates a set of voltage demands that are fed into a PWM (pulse-width modulation) block. The PWM block uses the space-vector modulation method to convert these voltage demands into a sequence of U, V and W phase switching signals, which are applied to the output bridge of the drive. The PWM block uses the measured DC-bus voltage to compensate for variations in supply voltage.

The torque controller converts a torque demand into a current demand and compensates for various load non-linearities. A 2-stage notch or low-pass filter allows the effects of load compliance to be reduced. To avoid motor damage, a user-defined application current limit is also applied, as well as individual positive and negative torque limits.

In the velocity control loop, a velocity demand and measured velocity form the inputs to a PI control system. The output of the control system is a torque demand which, when the drive is operating as a velocity controller, forms the input to the current control loop.

Finally, in the position control loop, a position demand and measured position form the inputs to a PID (Proportional, Integral, Differential) control system incorporating velocity feedback, velocity feed-forward and acceleration feed-forward. The output of the position control system is a velocity demand which, when the drive is operating as a position controller, forms the input to the velocity control loop.

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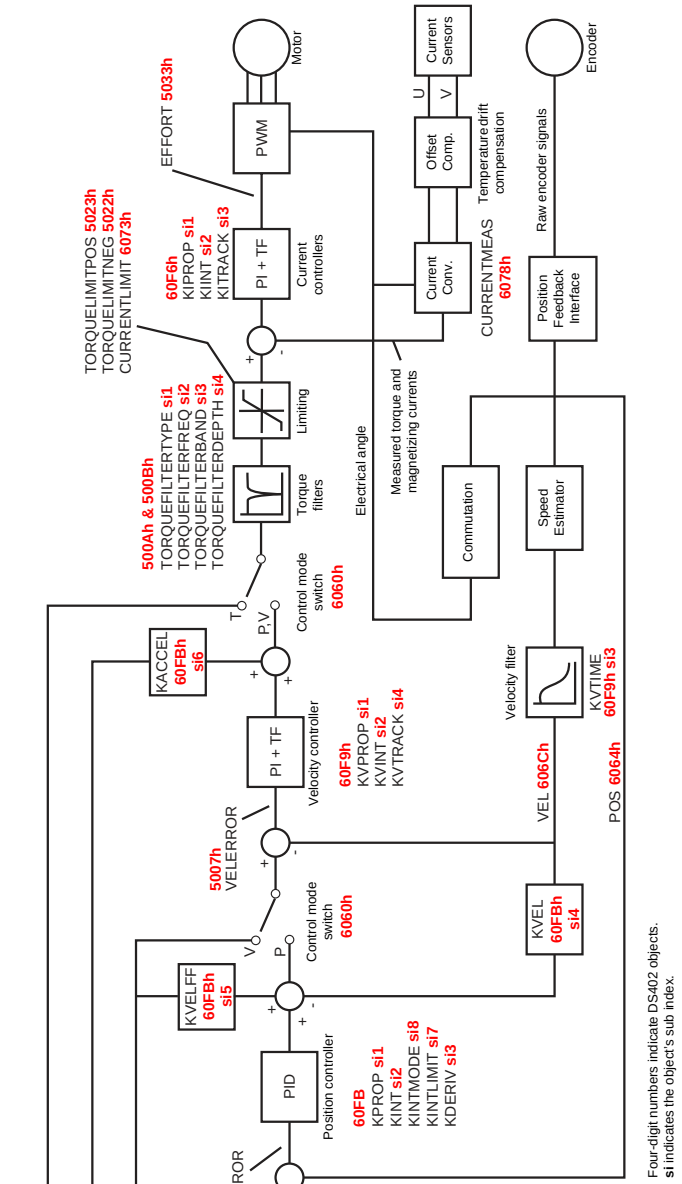

Servo configuration control structure, showing DS402 objects

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Torque servo configuration

The diagram on page *160* shows the torque-servo control configuration. Here, the velocity loop has been removed and the output of the position controller is fed into the current loop via the torque filters.

The torque servo configuration is useful when the drive is operating as a closed-loop position controller and settling time must be minimized. Although the servo configuration tends to give better velocity tracking when operating in position mode, settling times can be longer.

The control mode switch allows the drive to operate in either torque or position modes, but not velocity mode.

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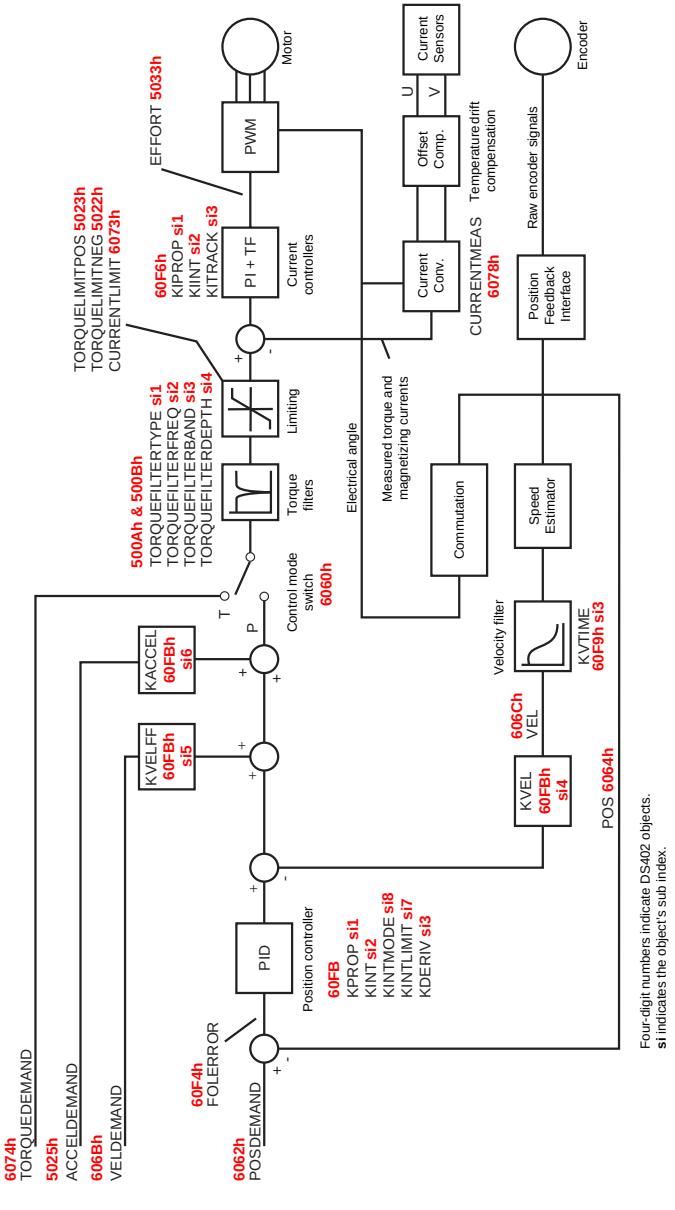

Torque servo configuration control structure, showing DS402 objects

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12

Accessories

What this chapter contains

This section describes accessories and options that you might need to use with your MicroFlex e150. 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.

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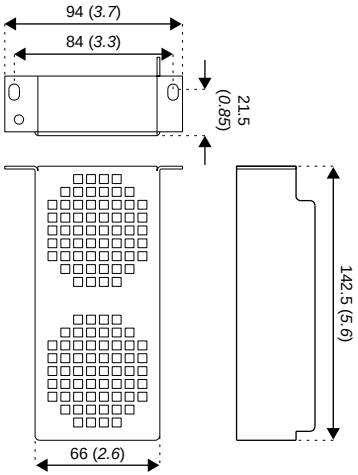
Fan tray

The fan tray (part FAN001-024) provides sufficient cooling for the 6 A and 9 A MicroFlex e150. The fan tray might be required for the 3 A model when operating in high ambient temperatures (see *Temperature derating* on page *132*). The fan tray requires 23 - 27.5 V DC at 325 mA, which can be sourced from the same filtered control circuit supply used for the MicroFlex e150. The MicroFlex e150 is UL Listed (file NMMS.E470302) when used in conjunction with the fan tray, mounted exactly as shown in the following diagram.

Fan tray
FAN001-024

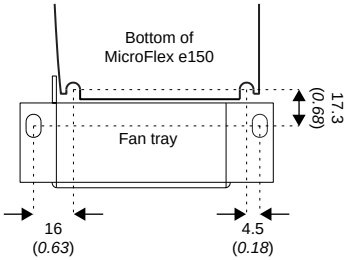
Fan tray
dimensions



All dimensions shown as mm (*inches*)

Assembled MicroFlex e150 and fan tray

Position of fan tray mounting holes relative to MicroFlex e150



It is important that the fan tray is mounted in close proximity to the MicroFlex e150 as shown above. Failure to do so will result in decreased cooling efficiency.

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Foot-mount filter (single phase only)

The single-phase foot-mount AC power filter (part FI0029A00) provides mounting holes for the MicroFlex e150 and fan tray. This allows the filter, fan tray and MicroFlex e150 to use minimal panel mounting space. See pages *164* and *166* for details of filter FI0029A00.

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
DR-75-24	110-230 V AC	24 V DC	75 W (3.2 A)
DR-120-24			120 W (5 A)
DR-240-24			240 W (10 A)

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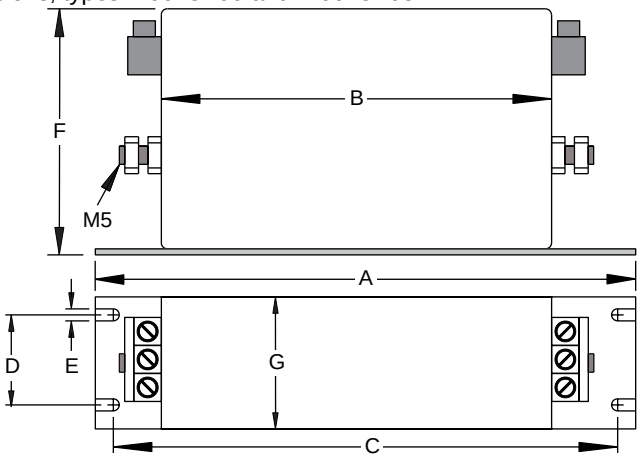
EMC filters

AC filters remove high frequency noise from the AC power supply, protecting the MicroFlex e150. These filters also prevent high frequency signals from being transmitted back onto the power lines and help meet EMC requirements. To select the correct filter, see *Power supply filters* on page *138*.

Part	Manufacturer	Rated volts	Rated amps @ 40°C	Leakage current (mA)	Weight kg (lbs)
FI0014A00	Schaffner FN9675-3/06	250	3	0.4	0.27 (0.6)
FI0015A00	Schaffner FN2070-6/06	250	6	0.4	0.45 (0.99)
FI0015A02	Schaffner FN2070-12/06	250	12	0.4	0.73 (1.61)
FI0018A00	Schaffner FN3258-7/45	480	7	33	0.5 (1.1)
FI0018A03	Schaffner FN3258-16-44	480	16	33	0.8 (1.76)
FI0029A00	Epcos B84142A22R215	250	22	33	3.0 (6.6)

Filter dimensions, types FI0018A00 and FI0018A03:



	Dimensions: mm (inches)	
Dimension	**FI0018A00**	**FI0018A03**
A	190 (7.48)	250 (9.84)
B	160 (6.30)	220 (8.66)
C	180 (7.09)	235 (9.25)
D	20 (0.79)	25 (0.98)
E	4.5 (0.18)	5.4 (0.21)
F	71 (2.80)	70 (2.76)
G	40 (1.57)	45 (1.77)

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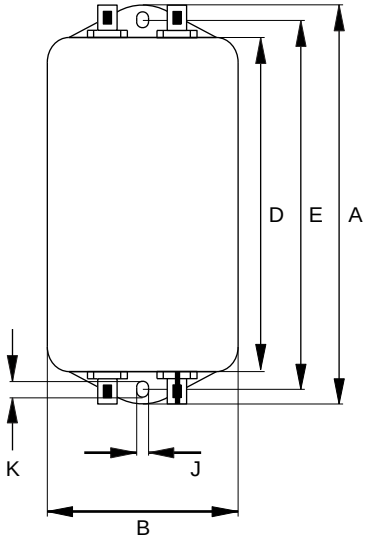
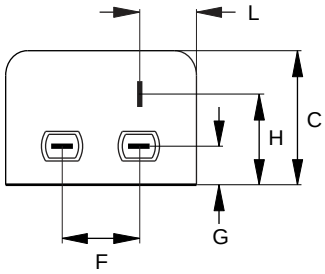
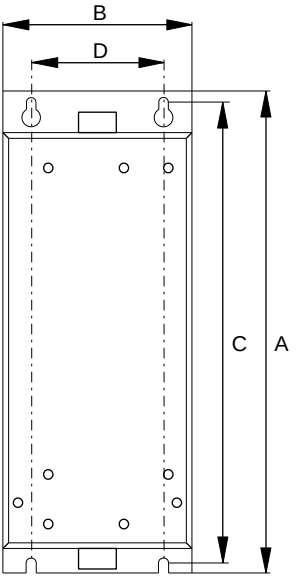
Filter dimensions, types FI0014A00, FI0015A00, FI0015A02:

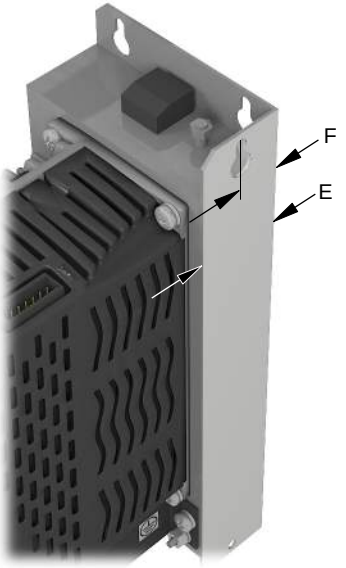


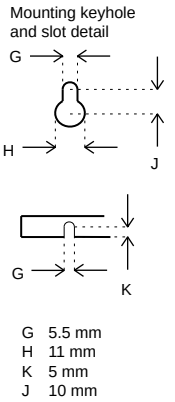


	Dimensions: mm (inches)		
Dimension	**FI0014A00**	**FI0015A00**	**FI0015A02**
A	85 (3.35)	113.5 (4.47)	156 (6.14)
B	54 (2.13)	57.5 (2.26)	
C	40 (1.57)	46.6 (1.83)	
D	65 (2.56)	94 (3.70)	130.5 (5.14)
E	75 (2.95)	103 (4.06)	143 (5.63)
F	27 (1.06)	25 (0.98)	
G	12 (0.47)	12.4 (0.49)	
H	29.5 (1.16)	32.4 (1.28)	
J	5.3 (0.21)	4.4 (0.17)	5.3 (0.21)
K	6.3 (0.25)	6 (0.24)	
L	13.5 (0.53)	15.5 (0.61)	

Filter dimensions, type FI0029A00:







	Dimensions *mm (inches)*
Dimension	**FI0029A00**
A	255 (10.04)
B	100 (3.94)
C	244.5 (9.63)
D	70 (2.76)
E	40 (1.57)
F	20 (0.79)

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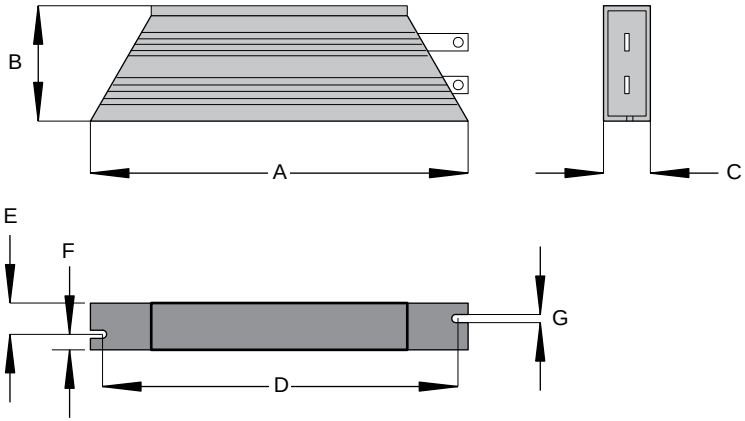
Brake resistors

Depending on the application, MicroFlex e150 might require an external brake resistor to be connected to pins R1 and R2 of connector X1. The brake resistor dissipates energy during braking to prevent an over-voltage error occurring. See section *Brake (X1)* on page *140* for details about choosing the correct resistor.

WARNING! Electrical shock hazard. DC-bus voltages can be present at these 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).

Brake resistor 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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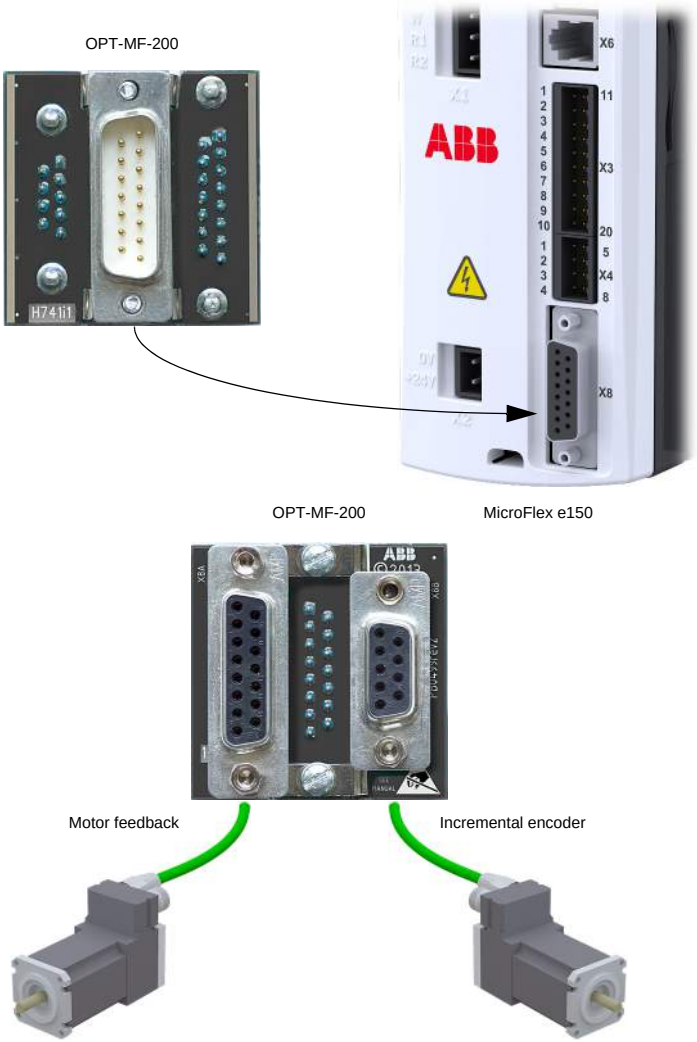
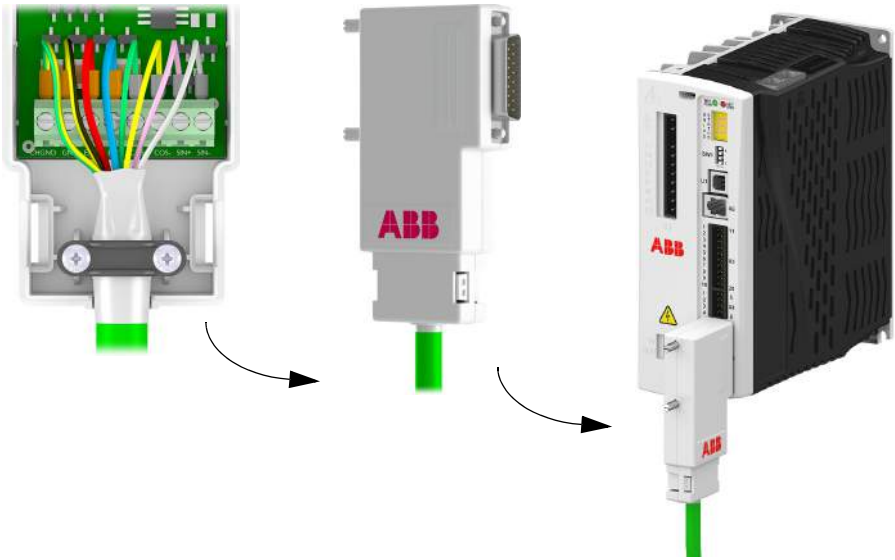
Encoder breakout

The encoder breakout (part OPT-MF-200) can be used to connect motor feedback and an extra incremental encoder (see page 80). 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).



Resolver adapter OPT-MF-201

The resolver adapter (OPT-MF-201) allows a motor with resolver feedback to be connected to the MicroFlex e150.* The MicroFlex e150 must be power-cycled after connecting the resolver adapter. The resolver adapter sends an absolute position to the MicroFlex e150 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 adaptor specifications

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

Resolver requirements

- Transformation ratio: 0.5
- Excitation supply load: 100 mA maximum.

** This feature is not supported on older MicroFlex e150 models. In Mint WorkBench, click the SupportMe icon and find the* Controller Hardware *information. The* Functional Revision *entry must be 8 or greater to support the resolver adapter.*

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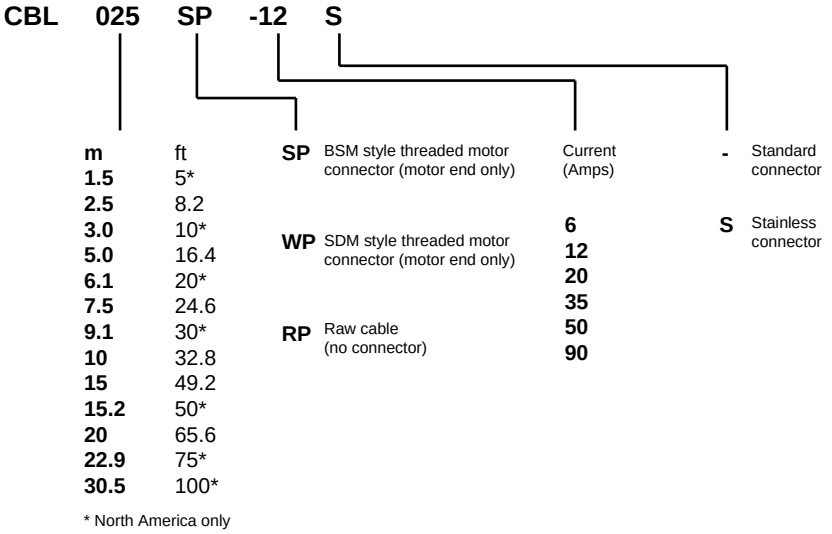
Cables

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:



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**.

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Feedback cables

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

CBL 020 SF -E 1 S

m	ft
0.5	1.6
1.0	3.3
2.0	6.6
2.5	8.2
5.0	16.4
7.5	24.6
10	32.8
15	49.2
20	65.6

SF	BSM servo motor feedback cable with at least 1 connector
WF	SDM servo motor feedback cable with at least 1 connector
DF	Servo motor feedback cable with drive connector only
RF	Raw cable (no connector)

B	BiSS
D	EnDat SinCos
E	Incremental encoder
S	SSI
A	Smart Abs

-	Raw cable
1	Legacy controllers
2	e100 / e150

-	Standard connector
S	Stainless steel connector

Other lengths available on request

Example:
A 2 m encoder feedback cable for a MicroFlex e150 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 e150 to other Ethernet nodes such as NextMove e100, additional MicroFlex e150s, or other Ethernet compatible hardware. The cables are standard CAT5e shielded twisted pair (S/UTP) ‘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

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13

Appendix: Safe Torque Off (STO)

What this chapter contains

The appendix describes the basics of the Safe torque off function (STO) for the MicroFlex e150. In addition, application features and technical data for the safety system calculation are presented.

Basics

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

The drive supports the Safe Torque Off (STO) function according to standards IEC 61800-5-2, EN 61508:2010, EN ISO 13849-1 and IEC 62061:2005.

See *Safety Manual: Safe Torque Off (STO) function for MicroFlex e150 drives* (LT0313...) before using the STO function.

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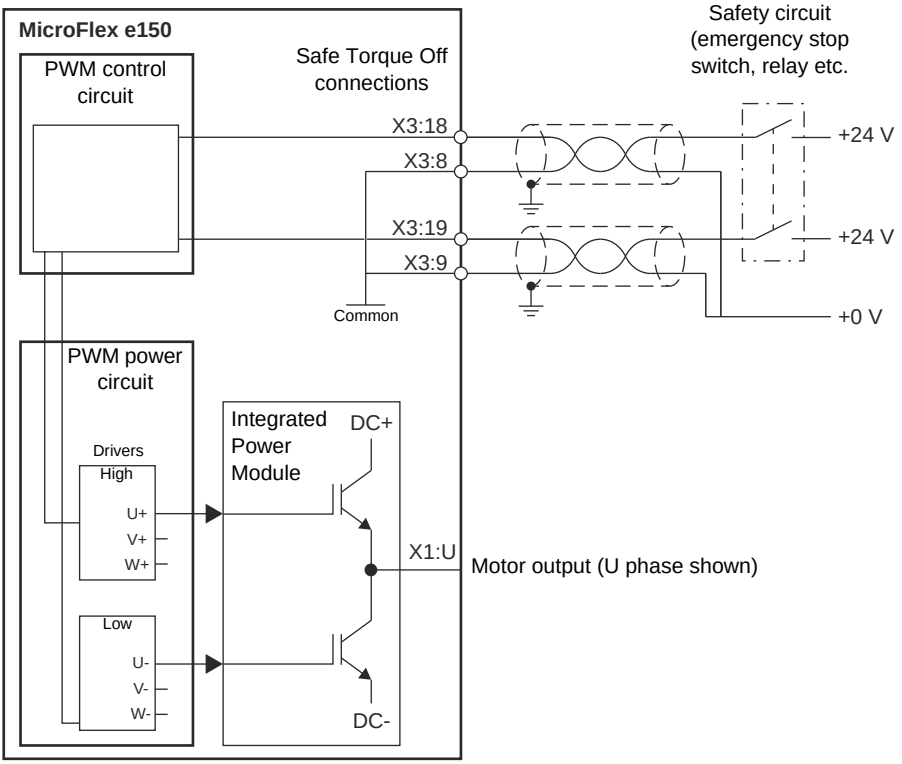

WARNING! The STO function does not disconnect the voltage of the main and auxiliary circuits from the drive. Therefore maintenance work on electrical parts of the drive or the motor can only be carried out after isolating the drive system from the main supply. If the drive was connected to the input power, wait for 5 minutes after disconnecting the input power.

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Operation of the STO function and diagnostics

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's motor output power stage is disabled, and the status output (page 69) becomes inactive. Starting is possible only after both STO inputs have been powered, and the fault has been cleared.

The SAFETORQUEOFF Mint keyword reports the status of the STO hardware registers. SAFETORQUEOFF contains an array of values indicating the states of the STO1 and STO2 inputs, two internal hardware fault circuits, and one internal STO status output. This array is described in the following table:

Parameter	Meaning
SAFETORQUEOFF(0)	The combined state of the two STO inputs: STO1 = bit 0, STO2 = bit 1
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(3)	The combined state of the two hardware fault circuits: STO1 = bit 0, STO2 = bit 1
SAFETORQUEOFF(4)	The state of the STO1 internal hardware fault circuit: 0 = no fault, 1 = fault
SAFETORQUEOFF(5)	The state of the STO2 internal hardware fault circuit: 0 = no fault, 1 = fault
SAFETORQUEOFF(6)	The state of the internal STO status output: 0 = fault, 1 = no fault

See *Safety Manual: Safe Torque Off (STO) function for MicroFlex e150 drives* (LT0313...) for full details.

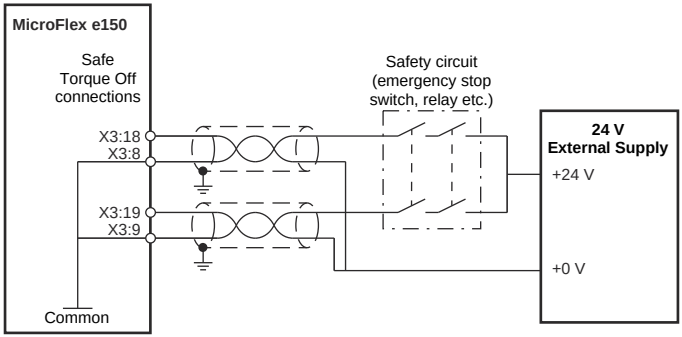
Status display

When an STO error occurs, the drive displays error code 10033, 10034 or 10035 on its front panel Drive Status display. The right decimal point is always (and only) illuminated for STO errors.

STO error

Installation

Typical input connections:



Note: If the contacts of the safety circuit do not open/close within 1 ms of each other, then a fault in the STO circuit or wiring is assumed and the drive will become disabled. The maximum allowed cable length between the drive and the activation switch is 30 m (98 ft).

Validating the operation of the Safe Torque Off function

IEC 61508 and EN 62061 require that the final assembler of the machinery validates the operation of the safety function with an acceptance test.

The acceptance test must be performed:

- at initial start-up of the safety function
- after any changes related to the safety function (wiring, components, settings, etc.)
- after any maintenance work related to the safety function.

If you connect an external Safe Torque Off circuit to the drive, perform the acceptance test for the Safe Torque Off function as described in *Safety Manual: Safe Torque Off (STO) function for MicroFlex e150 drives* (LT0313...).

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Technical data: Digital inputs STO1, STO2 (X3)

Description	Unit	All models
Type		Opto-isolated inputs
Input voltage Nominal Minimum Maximum Active Inactive	V DC	 24 12 30 > 12 < 2
Input current (maximum, per input)	mA	50
Sampling interval	ms	1
Minimum pulse width	µs	5

STO function: data related to safety standards

IEC 61508						EN ISO 13849-1				
SIL	**PFH**	**HFT**	**SFF**	**PTI**	**PFD**	**PL**	**CCF**	**$MTTF_D$**	**DC***	**Category**
3	1.12×10^{-10} /h (0.112 FIT)	1	96.48%	10 years	1.12×10^{-5}	e	75 points	20420.9 years	90%	3

* According to the categorization defined in EN ISO 13849-1:2008.

Abbreviation	Reference	Description
CCF	EN ISO 13849-1	Common Cause Failure (%)
DC	EN ISO 13849-1	Diagnostic Coverage
FIT	IEC 61508	Failure In Time: 1E-9 hours
HFT	IEC 61508	Hardware Fault Tolerance
$MTTF_D$	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	IEC 61508	Probability of Failure on Demand
PFH	IEC 61508	Probability of Dangerous Failures per Hour
PL	EN ISO 13849-1	Performance Level: Corresponds SIL, Levels a-e
PTI		Proof Test Interval
SFF	IEC 61508	Safe Failure Fraction (%)
SIL	IEC 61508	Safety Integrity Level
STO	IEC 61800-5-2	Safe Torque Off

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STO function: TüV certificate

TÜV NORD

Certificate

No. SLA-0041/2010, V1.0

TÜV NORD Systems GmbH & Co. KG hereby certifies

Baldor UK Ltd

Mint Motion Centre
6 Bristol Distribution Park
Hawkley Drive
Bristol BS32 0BF
United Kingdom

that the safety function "Safe Torque Off" (STO) in the drive system

MicroFlex e150

is capable for safety related applications up to SIL 3, PL e respectively. The requirements listed in the following standards are fulfilled.

- IEC 61508 part 1:2010; part 2:2010; capable up to SIL 3
- ISO 13849-1:2008; capable up to PL e
- IEC 62061:2005; capable up to SIL_{CL} 3
- IEC 61800-5-2:2007; capable up to SIL 3

The certification is based on the report No. SLA-0041/2010TB-2 in the valid version.

This certificate entitles the holder to use the pictured Safety Approved mark.

Expiry date: 2017-01-31
Reference No.: G.SEB.BS.02.027.01.031

Gerhard M. Rieger
Augsburg, 2012-01-31

Voluntary Certification

TÜV NORD
TÜV NORD Systems GmbH & Co. KG
Safety Approved
MicroFlex e150
IEC 61508 SIL3
ISO 13849-1 PL e
IEC 62061 SIL_{CL}3
IEC 61800-5-2 SIL3
SLA-0041/2010

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Further information

Product and service inquiries

Address any inquiries about the product to your local ABB representative, quoting the type designation and serial number of the unit in question. A listing of ABB sales, support and service contacts can be found by navigating to www.abb.com/drives and selecting *Sales, Support and Service network*.

Product training

For information on ABB product training, navigate to www.abb.com/drives and select *Training courses*.

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