EC-PX

Installation Guide

November 2024

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EC-PX

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PATENTS

Israel Patent No. 235022
US Patent Application No. 14/532,023
Europe Patent application No.15187586.1
Japan Patent Application No.: 2015-193179
Chinese Patent Application No.: 201510639732.X
Taiwan(R.O.C.) Patent Application No. 104132118
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www.acsmotioncontrol.com

support@acsmotioncontrol.com

sales@acsmotioncontrol.com

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Revision History

Date	Revision	Description
Nov 2024	4.00	Initial release

Conventions

The following conventions are used in the document.

Text Formats

Format	Description
Bold	Names of GUI objects or commands
BOLD + UPPERCASE	ACSPL+ variables and commands
`Monospace + grey background`	Code example
Italics	Names of other documents
Blue	Hyperlink
[ ]	In commands indicates optional item(s)
|	In commands indicates either/or items

Flagged Text

	**Note** - includes additional information or programming tips.
	**Caution** - describes a condition that may result in damage to equipment.
	**Warning** - describes a condition that may result in serious bodily injury or death.
	**Model** - highlights a specification, procedure, condition, or statement that depends on the product model
	**Advanced** - indicates a topic for advanced users.

Related Documentation

Documents listed in the following table provide additional information related to this document.

Authorized users can download the latest versions of the documents from ACS Downloads.

Document	Description
SPiiPlus ACSPL+ Programmer's Guide	Provides practical instruction on how to use ACSPL+ to program your motion controller.
SPiiPlus Command & Variable Reference Guide	Describes all of the variables and commands available in the ACSPL+ programming language.
SPiiPlus MMI Application Studio User Guide	Explains how to use the SPiiPlus MMI Application Studio and associated monitoring tools.
EtherCAT Network Diagnostics	An application note describing how to perform diagnostics of the EtherCAT network.
SPiiPlus Setup Guide	Provides guidance on how to configure and adjust the SPiiPlus systems to work with supported types of motors and feedback devices.

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1. Scope of document

This document describes the installation information for the EC-PX (External Controller), including electrical interfacing, device compatibility, mounting, and ventilation.

1.1 Product overview

The EC-PX is an EtherCAT®-based motion controller designed to meet the needs of high-tech original equipment manufacturers with demanding multi-axis motion control applications. The EC-PX extends the performance and capabilities of the SPiiPlusEC motion controller and SPiiPlus Platform motion control ecosystem.

It is equipped with a powerful MPU and provides enhanced processing power. The unit consists of a plastic enclosure and can be mounted using a panel or a din-rail.

- Control up to 128 axes and thousands of I/O
- Up to 10kHz EtherCAT / controller cycle rate
- ACSPL+ real-time motion programming language – flexible and customizable for advanced OEM applications
  - Up to 64 buffers/threads
  - Multi-level application protection – protect intellectual property while maintaining serviceability
  - User-defined functions in native ACSPL+ or C (Real-Time C Functions)
  - Object-oriented programming with data structures
- Advanced profile generation and servo control algorithm options for optimizing motion performance
  - ***Learning****Boost*
  - ***Motion****Boost*
  - SmoothPath
  - ***Servo****Boost*
  - SmoothPTP
  - More…
- Advanced EtherCAT network topologies for improving machine throughput and reducing downtime
  - Dual EtherCAT network enables faster cycle rates for critical axes and I/O
  - ***Network****Boost* provides redundancy to cable failure
- Identical form factor to previous generation SPiiPlusEC motion controller
- Complemented by full-featured ADK Suite and motion controller simulator for rapid controller application development
- Complemented by full-featured host programming libraries for rapid host application / machine UI development

The EC-PX provides flexibility for both single and dual EtherCAT networks with support for a range of axes and cycle rates.

Single Network

Number of Axes	Maximum Cycle Rate
2, 4 axes	10kHz[1]
8 axes	5kHz
16 axes	4kHz
32 axes	2kHz
64 axes	1kHz

[1] ACS drives supporting 10 kHz EtherCAT cycle rate: MDMst, UDMsa, UDMdx (single axis)

Dual Network

EtherCAT Network 1		EtherCAT Network 2	
Number of Axes	Cycle Rate	Number of Axes	Cycle Rate
Up to 4 axes	10kHz[1]	Up to 8	5kHz
		Up to 32	2kHz
		Up to 64	1kHz
Up to 8 axes	5kHz	Up to 8	5kHz
		Up to 64	1kHz
Up to 16 axes	4kHz	Up to 16	4kHz
		Up to 32	2kHz
		Up to 64	1kHz
Up to 32 axes	2kHz	Up to 32	2kHz
		Up to 64	1kHz
Up to 64 axes	1kHz	Up to 64	1kHz

[1] ACS drives supporting 10 kHz EtherCAT cycle rate: MDMst, UDMsa, UDMdx (single axis)

Figure 1-1 shows the block diagram for the EC-PX.

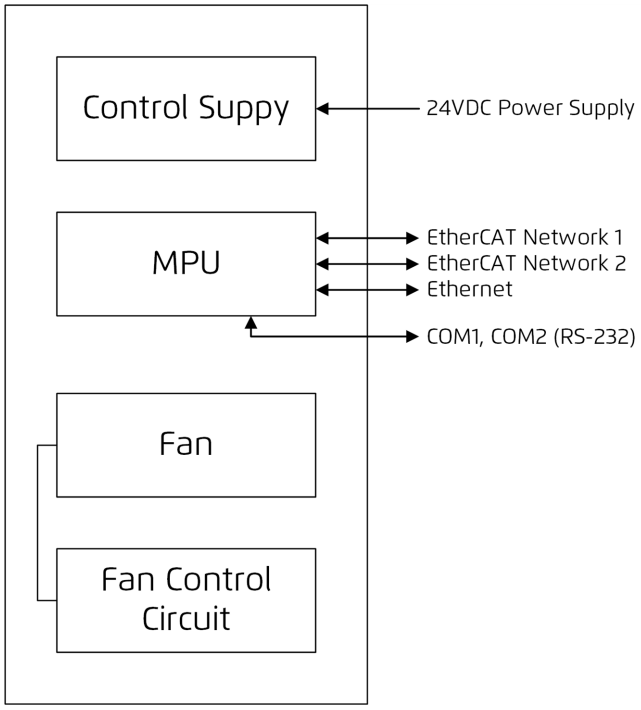


Figure 1-1. EC-PX Interface

1.2 Communication channels

The EC-PX supports the following Ethernet communication ports:

- Connection to a host computer using TCP/IP protocol.
- Connection to real-time network components using the EtherCAT protocol.

Optionally, you can use RS232 serial communication port for communications with the host.

2. Description

This section provides an overview of the EC-PX (External Controller), the available product options and associated kits and accessories.

2.1 Connectors

Figure 2-1 and Table 2-1 show the location and description of the EC-PX connectors.

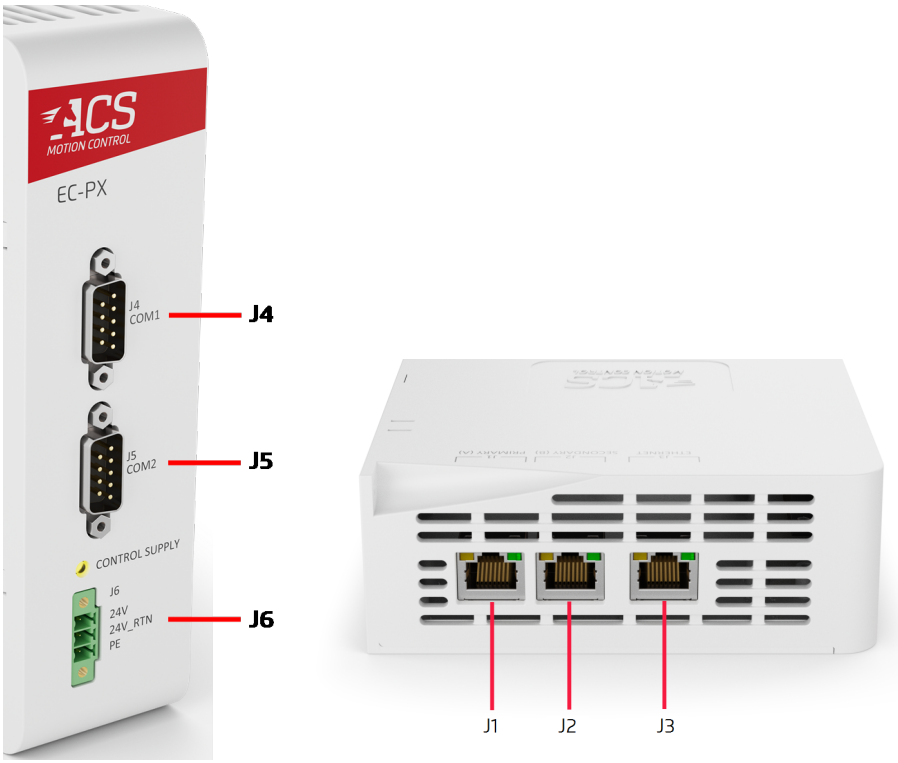


Figure 2-1. Connectors on Front and Top Panel

Table 2-1. EC-PX Connectors

Connector	Name	Type	Mating Connector
J1	EtherCAT primary (A)	RJ45	Ethernet plug
J2	EtherCAT secondary (B)	RJ45	Ethernet plug
J3	Ethernet	RJ45	Ethernet plug
J4	RS232 port COM1	D-type 9 pin male	D-type 9 pin female
J5	RS232 port COM2*	D-type 9 pin male	D-type 9 pin female
J6	Control supply	Phoenix MC 1,5/ 3-GF-3,81 1827871	Phoenix MC 1,5/ 3-STF-3,81 1827716

*When necessary, use RS232 communications over port COM2 to run the MMI Application Studio Upgrade and Recovery Wizard Recovery Task (see the *MMI Application Studio User Guide* for details).

2.1.1 Factory Default Reset

The product may be reset to factory defaults as follows:

1. Connect one loopback plug to COM1 and a second loopback plug to COM2
2. Hardware reboot the controller
3. Wait 30 seconds (Factory Defaults operation is performed automatically)
4. Disconnect the loopback plugs
5. Hardware reboot the controller
6. The controller powers up with the default IP address 10.0.0.100.

Figure 2-2 illustrates the connections for a loopback plug.

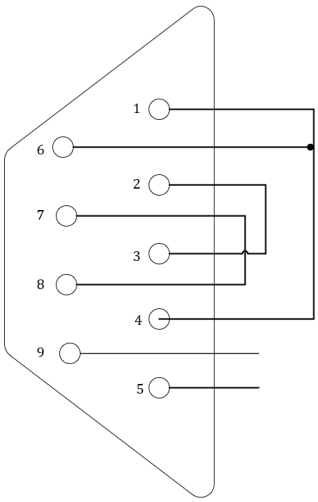


Figure 2-2. Loopback Plug

2.2 Indicators

Figure 2-3 and Table 2-2 show the location and description of the EC-PX indicators.

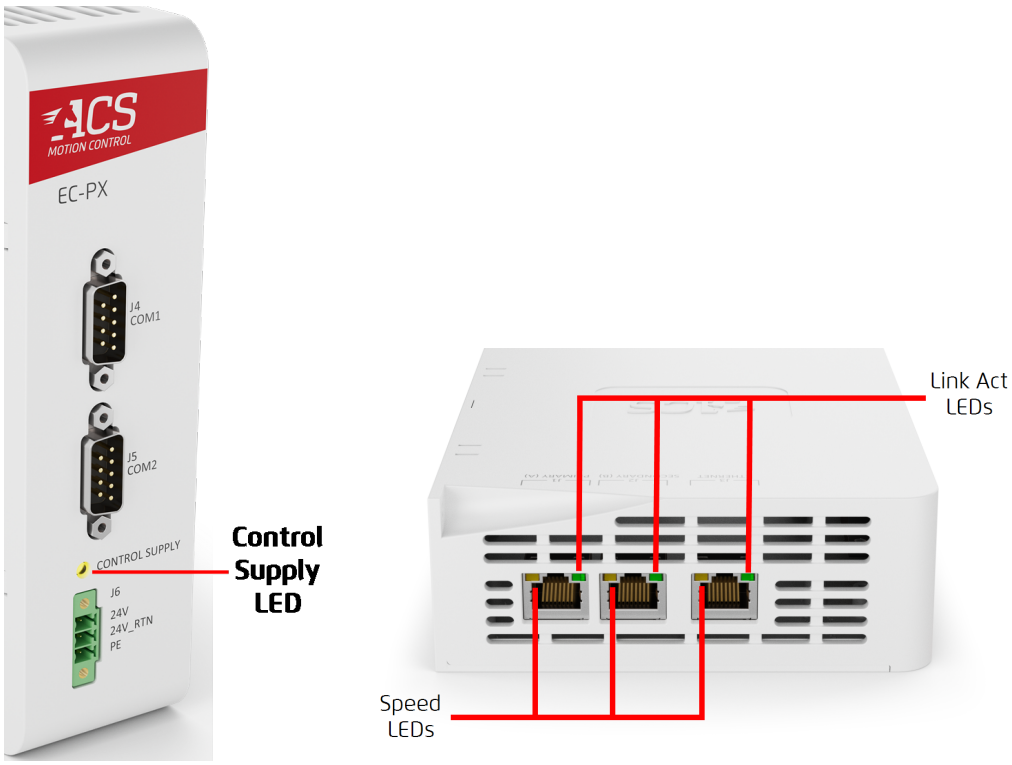


Figure 2-3. Indicators on Front and Top Panel

Table 2-2. EC-PX Indicators

LED	Description
Control supply	Green LED: > Off – Logic supply doesn't function. > On – Power supply is OK.
Link Act	3 green LEDs (one per Ethernet/EtherCAT port): > Off – No cable is connected. > Blinking – Link and activity > On – Link without activity
Speed	Three dual color LEDs (one per Ethernet/EtherCAT port): > Amber – 1000Mbit > Green – 100Mbit

2.3 Package Contents

The EC-PX package contains the following items:

> EC-PX Module

> DIN rail mounting kit: Part Number DINM-13-ACC

2.4 Order Part Number

The ordering part number (P/N) contains several characters (see example in Figure 2-4) that each specify a configuration characteristic ordered for the EC-PX.

Figure 2-4. Label with ordered P/N - example

Table 2-3. Configuration as indicated by P/N

	Field	Example	Optional Values
Maximum number of axes	1	A	2 = 2 4 = 4 8 = 8 A = 16 B = 32 C = 64 D = 128[1]
Maximum controller cycle rate	2	B	A = 2 kHz[2] B = 4 kHz / 5 kHz C = 10 kHz
Advanced Network Topologies	3	C	N = None A = Dual EtherCAT Network B = NetworkBoost C = Flexible Configuration
Advanced Control Algorithms - ***ServoBoost*** and ***ServoBoost*** Plus	4	B	N = None A = 4 axes ServoBoost B = 4+ axes ServoBoost C = 4 axes ServoBoost Plus (includes ServoBoost) D = 4+ axes ServoBoost Plus (includes ServoBoost)
Advanced Control Algorithms - Additional Algorithms	5	A	N = None A = Level 1: Autofocus B = Level 2: Level 1 options, Non-Linear Control C = Level 3: Level 2 options, ***LearningBoost***

	Field	Example	Optional Values
Advanced Programming	6	B	N = None A = Level 1: Max Number of Program Buffers (64), G-Code, Real-Time C Functions B = Level 2: Level 1 options, Tool Center Point Programming
Advanced Profile Generation	7	A	N = None A = Level 1: MotionBoost, SmoothPTP, Input Shaping, 2-Axis SmoothPath, 2-Axis NURBS B = Level 2: Level 1 options, 3+ Axis SmoothPath, 3+ Axis NURBS
XL SCAN	8	A	N = None A = XL SCAN with 1 node SLEC B = XL SCAN with 2 nodes SLEC
Reserved	9	N	N
Reserved	10	N	N

[1] 128 axes requires the *Dual EtherCAT Network* option.

[2] Limited to 1 kHz for 64 axes on a single network or 128 axes on a dual network.

Example

Example: EC-PX-ABCBA-BAANN

Field		1	2	3	4	5	6	7	8	9	10
PN	**EC-PX-**	A	B	C	B	A	B	A	A	N	N

The product is shipped with the ordered configuration. Modifications are only possible at ACS's facilities.

3. Mounting

3.1 Location Planning

When planning the mounting location of the EC-PX, take into account the following:

- The EC-PX has dimensions of 159.6 x 124.5 x 45.8 mm, see Figure 3-1
- Sufficient clearance is needed of 25 millimeters on all open sides for cable routing and free air flow.
- The EC-PX operates in a temperature range of 0-50^{0}C.
- A 10 CFM velocity-controlled fan in the unit starts operating when the internal ambient temperature exceeds 30^{0}C.

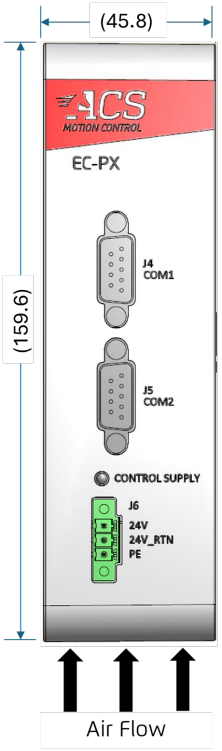


Figure 3-1. Hardware Version A Dimensions

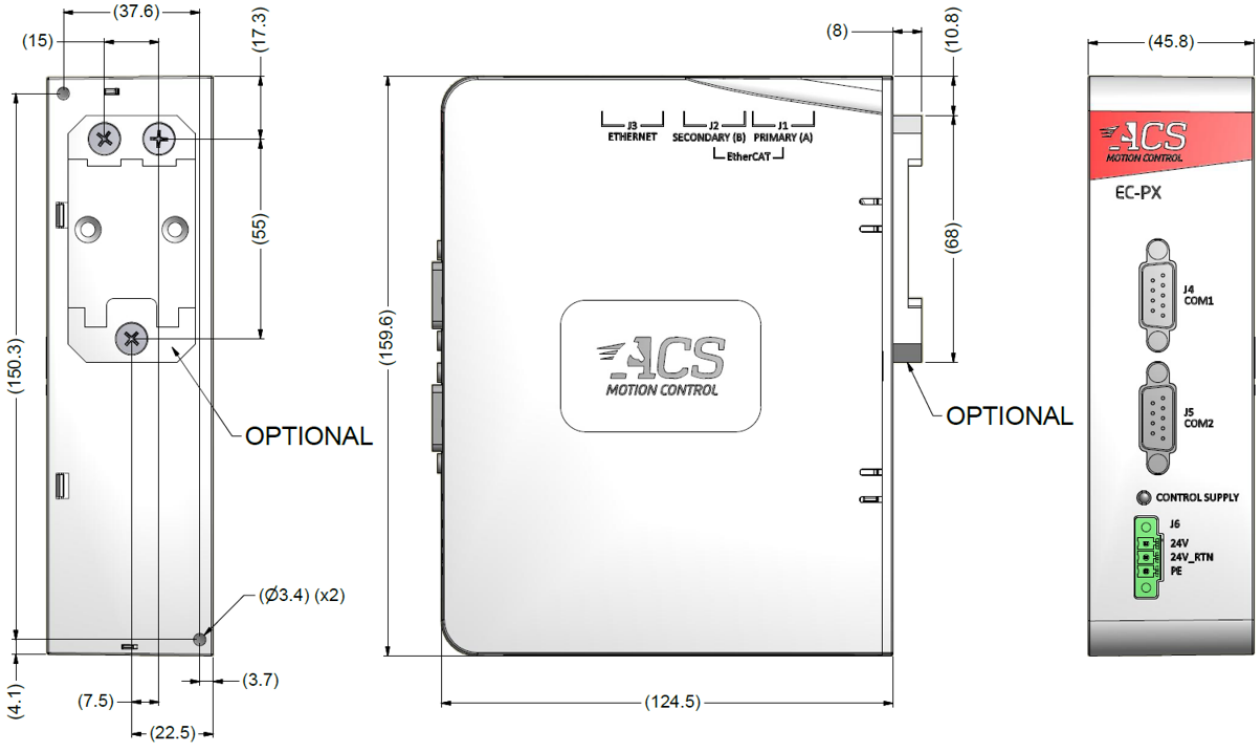


Figure 3-2. EC-PX Hardware Version A Dimensions: Side and Front Views

3.2 Mounting Procedure

1. Use two M3 screws as shown in Figure 3-3 to mount the EC-PX on a vertical surface.
2. Tighten the screws with a maximum torque of 3 Kgf.

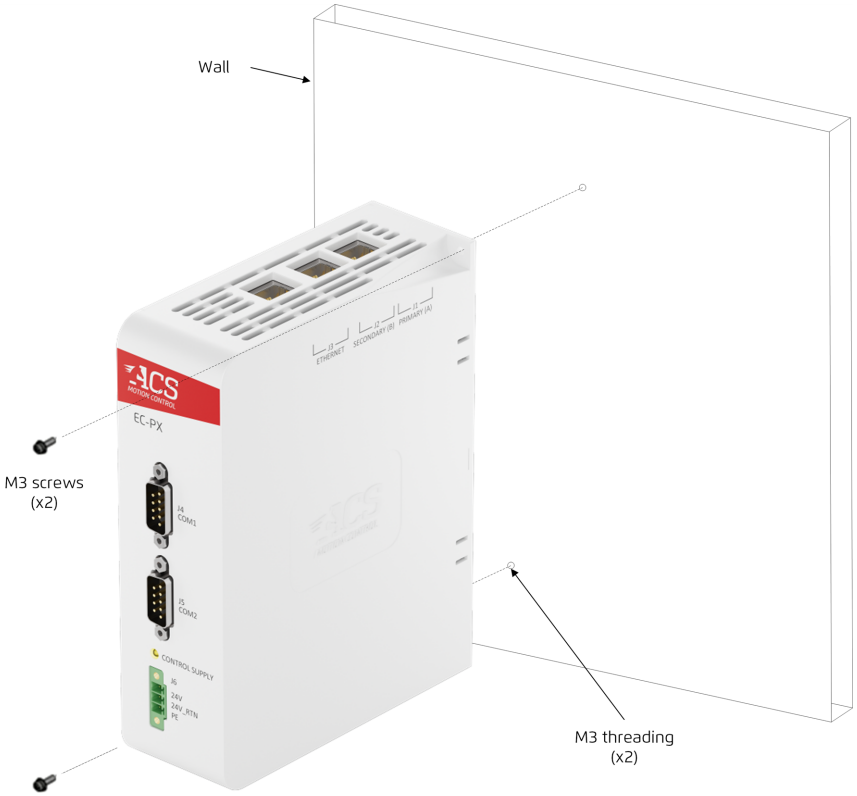


Figure 3-3. Vertical Mounting Diagram

4. Connections

This section describes how to interface with the EC-PX while following proper safety, EMC and wiring guidelines.

4.1 Safety, EMC and Wiring Guidelines

Read this section carefully before beginning the installation process.

- Make sure that the following guidelines and procedures are addressed and observed prior to powering up and while handling any of the EtherCAT network elements.
- Installation and maintenance must be performed only by qualified personnel who have been trained and certified to install and maintain high power electrical and electro-mechanical equipment, servo systems, power conversion equipment and distributed networks.
- Prior to powering up the system, ensure that all EtherCAT network devices are properly installed and grounded. Further ensure that all of the attached power and signal cables are in good operating condition. Maintenance should be performed only after the relevant network devices have been powered down, and all associated and surrounding moving parts have settled in their safe mode of operation. Certain drives, in the network, require a longer time to fully discharge.
- To avoid electric arcing and hazards to personnel and electrical contacts, avoid connecting and disconnecting the EC-PX while the power source is on.
- When connecting the EC-PX to an approved isolated control supply, connect it through a line that is separated from hazardous live voltages using reinforced or double insulation, in accordance with approved safety standards.

The EC-PX is not intended for use in safety-critical applications (such as life supporting devices) where a failure of the EC-PX can lead to severe personal injury or death.

Perform the following instructions to ensure safe and proper wiring:

- Whenever possible, use shielded cables with braided shield of at least 80%-95% coverage.
- Proper wiring, grounding and shielding are essential for ensuring safe, immune and optimal servo performance. After completing the wiring, carefully inspect all wires to ensure tightness, good solder joints and general safety.
- "Wiring Guidelines" on the next page details the recommended wiring based on the current rating of the EC-PX.

Table 4-1. Wiring Guidelines

Item	Gauge	Twisted pair	Remarks
Control Power Supply	18AWG	No	Length should be as short as possible
EtherCAT	CAT5e		
Ethernet	CAT6	-	For 1GbE Ethernet host communication

4.1.1 General Safety Guidelines

WARNING In an emergency, disconnect the unit from the power supply.

WARNING Ensure that you comply with all electrical regulations.

4.2 Connecting the EC-PX

Connect the EC-PX as follows:

1. Ensure that all supplies are off when preparing the unit.
2. Connect the 24VDC control supply to J6.
3. Connect the PE ground to J6 pin 3.
4. Connect the EtherCAT primary cable from the input port of the first slave module in the EtherCAT network to J1.
5. If the EtherCAT network is configured for ring topology, connect the EtherCAT secondary cable from the output port of the last slave module in the EtherCAT network to J2. See Appendix A EtherCAT Topologies for the Dual EtherCAT network use case as well as other topologies.
6. Connect the Ethernet cable from the host computer to J3.
7. If required, connect RS-232 cables to J4 and J5.

4.3 Powering the Unit

1. Turn on the 24VDC control supply and verify communication with the EC-PX.

4.4 Recovering a non-functioning controller

If the EC-PX has stopped functioning, then the controller can be recovered through the Recovery Task of the SPiiPlus MMI Application Studio Upgrade and Recovery Wizard, see *SPiiPlus MMI Application Studio User Guide*.

4.5 J1, J2 EtherCAT

4.5.1 J1 EtherCAT Primary (A)

Label: J1

Connector name	EtherCAT primary (A)
Connector assignment	J1
Manufacturer part number or type	RJ45
Mating type	Ethernet plug

Table 4-2. EC-PX J1 EtherCAT Primary (A) Pinout

Pin	Signal	Description
1	TD+	Positive transmit signal
2	TD-	Negative transmit signal
3	RD+	Positive receive signal
4	NC	Not connected
5	NC	Not connected
6	RD-	Negative receive signal
7	NC	Not connected
8	NC	Not connected

4.5.2 J2 EtherCAT Secondary (B)

Connector name	EtherCAT secondary (B)
Connector assignment	J2

Manufacturer part number or type	RJ45
Mating type	Ethernet plug

Table 4-3. EC-PX J2 EtherCAT Secondary (B) Pinout

Pin	Signal	Description
1	TD+	Positive transmit signal
2	TD-	Negative transmit signal
3	RD+	Positive receive signal
4	NC	Not connected
5	NC	Not connected
6	RD-	Negative receive signal
7	NC	Not connected
8	NC	Not connected
9	NC	Not connected

The cable shield must be connected to the connector body.

4.6 J3 Ethernet

4.6.1 Connector Description

Connector name	Ethernet
Connector assignment	J3
Manufacturer part number or type	RJ45
Mating type	Ethernet plug

Table 4-4. EC-PX J3 Ethernet Pinout

Pin	Signal	Description
1	TX+_D1	Positive transmit signal
2	TX-_D1	Negative transmit signal
3	RX+_D2	Positive receive signal
4	BI+_D3	Bi-directional+ (for 1000Mb Ethernet only)
5	BI-_D3	Bi-directional- (for 1000Mb Ethernet only)
6	RX-_D2	Negative receive signal
7	BI+_D4	Bi-directional+ (for 1000Mb Ethernet only)
8	BI-_D4	Bi-directional- (for 1000Mb Ethernet only)

For 1000Mbps you must use CAT6 cable.

4.7 J4, J5, COM1, COM2

4.7.1 Connector Description

RS232 Serial Communications Ports

Connector name	COM1, COM2
Connector assignment	J4 - COM1 J5 - COM2
Manufacturer part number or type	D-type 9 pin male
Mating type	D-type 9 pin female

Table 4-5. EC-PX J4, J5, COM1, COM2 Pinout

Pin	Signal	Description
1	NC	Not connected
2	RXD	Receive signal for communication port
3	TXD	Transmit signal for communication port

Pin	Signal	Description
4	NC	Not connected
5	DGND	Digital ground
6	NC	Not connected
7	NC	Not connected
8	NC	Not connected

4.8 J6 Control Supply

4.8.1 Connector Description

Connector name	Control supply
Connector assignment	J6
Mating type	Phoenix MC 1,5/ 3-STF-3,81 - 1827716

Table 4-6. EC-PX J6 Control Supply Pinout

Pin	Signal	Description
1	24VDC	+24V dc control supply
2	24V_RTN	24V dc control supply return
3	SHIELD	SHIELD

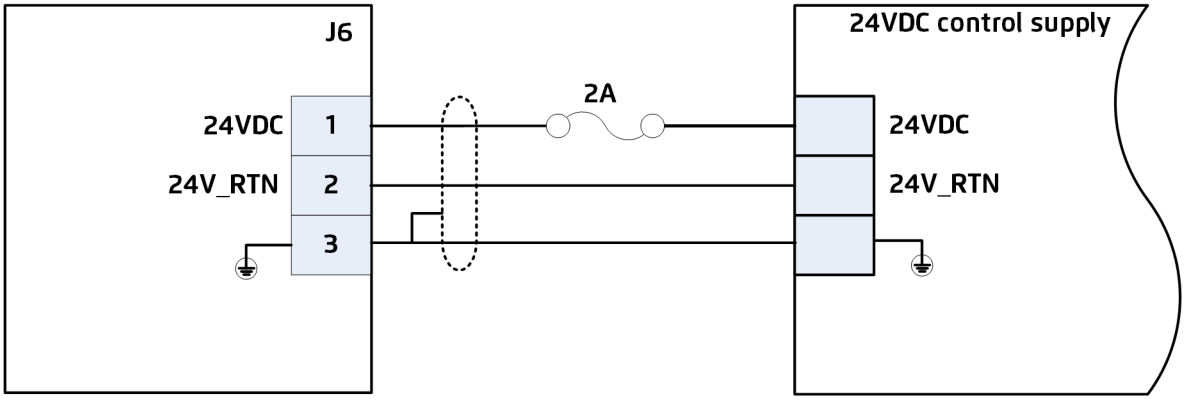


Figure 4-1. J6 Connections

5. Specifications

5.1 Control Supply Input

Table 5-1. EC-PX Control Supply Input

Item	Description	Remarks
Designation	24VDC 24VRTN.	Note: Connect the control supply via 2A fuse.
Input range	24VDC±10%	
Maximum Input current	0.8A @ 21.6V	
Protection	Reverse polarity	

5.2 Communication

5.2.1 EtherCAT Ports (Primary and Secondary)

Table 5-2. EC-PX EtherCAT Ports (Primary and Secondary)

Item	Description	Remarks
Designation	Transmit: ETH_TX± Receive: ETH_RX±	
Line Impedance	100Ω	
Quantity	2	EtherCAT input and output ports
Interface	TCP/IP 10/100Mbps or EtherCAT	
Speed	100Mbps	

5.2.2 Ethernet

Table 5-3. EC-PX Ethernet

Item	Description	Remarks
Designation	Transmit: ETH1_TX± Receive: ETH1_RX±	
Line Impedance	100Ω	

Item	Description	Remarks
Quantity	1	
Interface	Standard Ethernet LAN communication	
Speed	TCP/IP 10/100/1000Mbps	For 1000Mbps you must use CAT6 cable.

5.2.3 RS-232 Serial Communication

Table 5-4. RS-232 Serial Communication

Item	Description
Designation	> COM1 > RXD1 receive signal > TXD1 transmit signal > COM2 > RXD2 receive signal > TXD2 transmit signal
Quantity	2
Speed	Up to 115,200 baud

5.3 EtherCAT Cycle Rate

Table 5-5. Cycle Rates for Single Network Configuration

Single Network	
Number of Axes	**Maximum Cycle Rate**
2, 4 axes	10kHz[1]
8 axes	5kHz
16 axes	4kHz
32 axes	2kHz
64 axes	1kHz

[1] ACS drives supporting 10 kHz EtherCAT cycle rate: MDMst, UDMsa, UDMdx (single axis)

Table 5-6. Cycle Rates for Dual Network Configuration

Dual Network			
EtherCAT Network 1		**EtherCAT Network 2**	
Number of Axes	**Cycle Rate**	**Number of Axes**	**Cycle Rate**
Up to 4 axes	10kHz[1]	Up to 8	5kHz
		Up to 32	2kHz
		Up to 64	1kHz
Up to 8 axes	5kHz	Up to 8	5kHz
		Up to 64	1kHz
Up to 16 axes	4kHz	Up to 16	4kHz
		Up to 32	2kHz
		Up to 64	1kHz
Up to 32 axes	2kHz	Up to 32	2kHz
		Up to 64	1kHz
Up to 64 axes	1kHz	Up to 64	1kHz

[1] ACS drives supporting 10 kHz EtherCAT cycle rate: MDMst, UDMsa, UDMdx (single axis)

The cycle rates for each EtherCAT network are configured by setting the **CTIME** and **C2TIME** values. The CTIME/C2TIME values are 0.1, 0.2, 0.25, 0.5, 1 ms corresponding to the network rate of 10, 5, 4, 2, and 1 kHz, respectively.

See the *ACSPL+ Commands Variables Reference Guide* for details.

5.4 Dimensions

EC-PX has the following dimensions:

> 159.6 x 124.5 x 45.8 mm

5.5 Weight

> 476.6 grams

5.6 Compliance with Standards

5.6.1 Environmental

> Operating temperature: 0 to +50°C.

A 10 CFM velocity-controlled cooling automatically starts operating when the operating temperature exceeds 30°C.

> Storage temperature:-20°C to +85°C

> Humidity: 90%RH, non-condensing

5.6.2 RoHS

> Design complies with RoHS requirements.

Appendix A. EtherCAT Topologies

ACS controllers provide flexibility to control various types of EtherCAT topologies. The following figure shows the types of configurations.

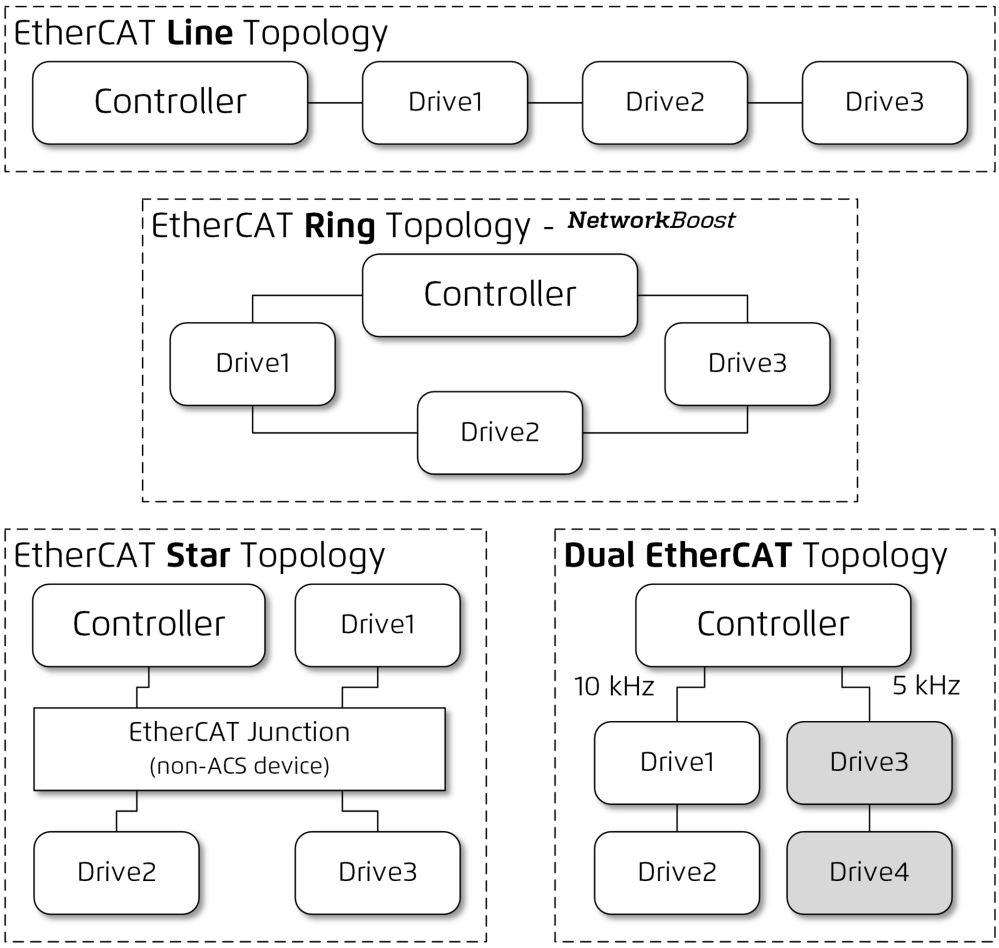
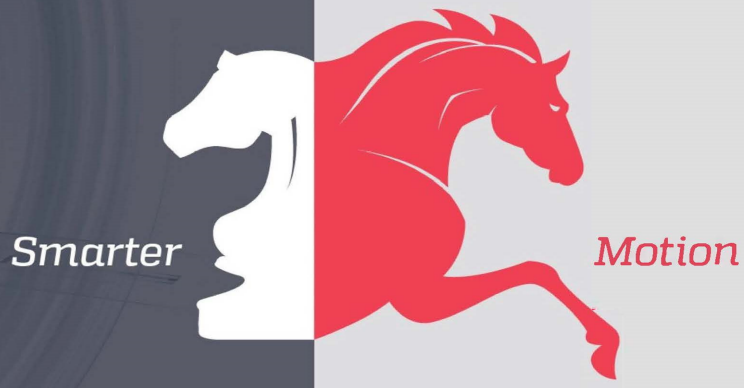


Figure 6-1. EtherCAT topologies

The topologies are:

- **Line** - all drives are connected sequentially.
- **Ring** - the drives are connected like the line configuration , but the last drive is connected back to the controller to a secondary EtherCAT port. If a problem occurs between any of the drives, the controller can use the secondary port to control the drives after the problematic connection.
- **Star** - all communication goes through an EtherCAT junction, much like a router in Ethernet.
- **Dual EtherCAT** - the controller has two EtherCAT ports that control two separate networks, potentially operating at two different frequencies. Axes count starts from the primary port (J1).



5 HaTnufa St.
Yokne'am Illit 2066717
Israel
Tel: (+972) (4) 654 6440 Fax: (+972) (4) 654 6443