FXE060-25-EM

FlexPro® Series
Product Status: Active

SPECIFICATIONS

Current Peak	**50 A**
Current Continuous	**25 A**
DC Supply Voltage	**10 – 55 VDC**
Network Communication	**EtherCAT**
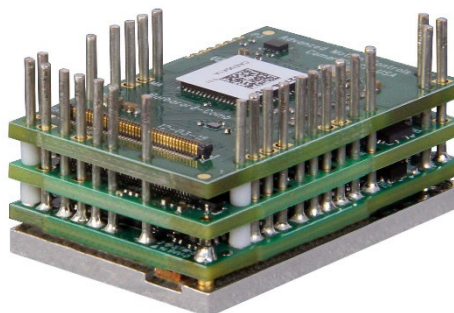
The **FXE060-25-EM** is a FlexPro® series Extended Environment servo drive with IMPACT™ architecture.

The **FXE060-25-EM** offers full tuning control of all servo loops and is designed to drive brushed and brushless servo motors, and closed loop stepper motors. The drive accepts a variety of external command signals, or can use the built-in Motion Engine, an internal motion controller used with Sequencing and Indexing commands. Programmable digital and analog I/O are included to enhance interfacing with external controllers and devices.

The **FXE060-25-EM** features an EtherCAT® interface for network communication using CANopen over EtherCAT (CoE) and USB connectivity for drive configuration and setup. All drive and motor parameters are stored in non-volatile memory.

IMPACT™ (**I**ntegrated **M**otion **P**latform **A**nd **C**ontrol **T**echnology) combines exceptional processing capability and high-current components to create powerful, compact, feature-loaded servo solutions. IMPACT™ is used in all FlexPro® drives and is available in custom products as well.

The **FXE060-25-EM** conforms to the following specifications and is designed to the Environmental Engineering Considerations as defined in MIL-STD-810F.
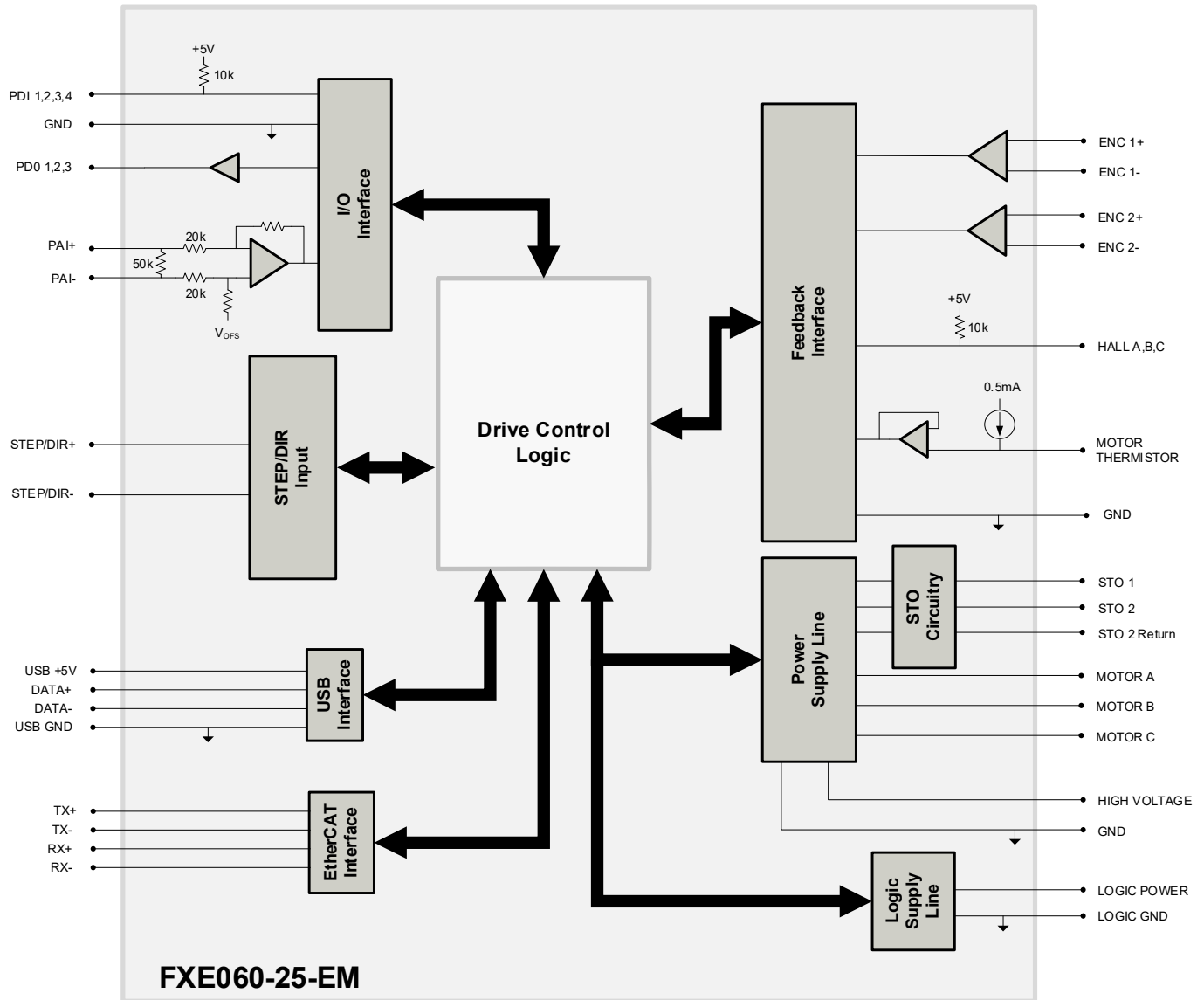
Extended Environment Performance

Ambient Operating Temperature Range	**-40°C to +95°C (-40°F to +203°F)**
Thermal Shock	**-40°C to +95°C (-40°F to +203°F) within 3 min.**
Relative Humidity	**0 to 95%, Non-Condensing**
Vibration	**25 Grms for 5 min. in 3 axes**
Altitude	**-400m to +25000m**
Contaminants	**Pollution Degree 2**

FEATURES

- CoE – Based on DSP-402 Device Profile for Drives and Motion Control
- Synchronization using Distributed Clocks
- Position Cycle Times down to 100µs
- Four Quadrant Regenerative Operation
- Programmable Gain Settings
- PIDF Velocity Loop

- Extended Environmental Ratings
- Compact Size, High Power Density
- On-the-Fly Mode Switching
- On-the-Fly Gain Set Switching
- Dedicated Safe Torque Off (STO) Inputs
- Space Vector Modulation (SVM) Technology

Feedback Supported	• Absolute Encoder
	  o BiSS C-Mode
	  o EnDat 2.2
	• Incremental Encoder
	• Hall Sensors
	• Aux Incremental Encoder
	• Tachometer (±10V)
		Motors Supported	• Three Phase
			• Single Phase
			• Stepper
				Modes of Operation	• Profile Modes
					• Cyclic Synchronous Modes
					• Current
					• Velocity
					• Position

Command Sources	• Over the Network • ±10V Analog • Sequencing • Indexing • Jogging • Step & Direction • Encoder Following	**Inputs / Outputs**	• 4 Programmable Digital Inputs • 3 Programmable Digital Outputs • 1 Programmable Analog Input	**Agency Approvals**	• RoHS • MIL-STD-810F (as stated) • MIL-STD-1275D (optional) • MIL-STD-461E (optional) • MIL-STD-704F (optional) • MIL-HDBK-217 (optional)

Release Date:
6/12/2024

ADVANCED Motion Controls · 3805 Calle Tecate, Camarillo, CA, 93012
ph# 805-389-1935 · fx# 805-389-1165 · www.a-m-c.com

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BLOCK DIAGRAM

FXE060-25-EM

INFORMATION ON APPROVALS AND COMPLIANCES

RoHS Compliant	The RoHS Directive restricts the use of certain substances including lead, mercury, cadmium, hexavalent chromium and halogenated flame retardants PBB and PBDE in electronic equipment.
MIL-STD-810F	Environmental Engineering Considerations and Laboratory Tests – (as stated)
MIL-STD-1275D	Characteristics of 28 Volt DC Electrical Systems in Military Vehicles – (optional)
MIL-STD-461E	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment – (optional)
MIL-STD-704F	Aircraft Electric Power Characteristics – (optional)
MIL-HDBK-217	Reliability Prediction of Electronic Equipment (MTBF) – (optional)

SPECIFICATIONS

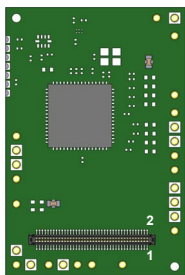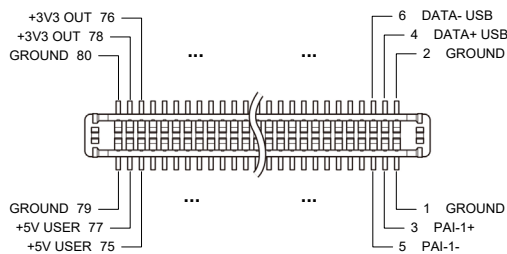| Electrical Specifications		
Description	Units	Value
Nominal DC Supply Input Range	VDC	12 – 48
DC Supply Input Range	VDC	10 – 55
DC Supply Undervoltage	VDC	8
DC Supply Overvoltage	VDC	58
Logic Supply Input Range (optional)	VDC	10 – 55
Safe Torque Off Voltage (Default)	VDC	5
Minimum Required External Bus Capacitance	µF	500
Maximum Peak Current Output[1]	A (Arms)	50 (35.3)
Maximum Continuous Current Output[2]	A (Arms)	25 (25)
Efficiency at Rated Power	%	99
Maximum Continuous Output Power	W	1361
Maximum Power Dissipation at Rated Power	W	14
Minimum Load Inductance (line-to-line)[3]	µH	150 (@ 48VDC supply); 75 (@24VDC supply); 40 (@12VDC supply)
Switching Frequency	kHz	20
Maximum Output PWM Duty Cycle	%	83
Control Specifications		
Description	Units	Value
Communication Interfaces[4]	-	EtherCAT® (USB for configuration)
Command Sources	-	±10 V Analog, Over the Network, Sequencing, Indexing, Jogging, Step & Direction, Encoder Following
Feedback Supported	-	Absolute Encoder (BiSS C-Mode, EnDat 2.2), Hall Sensors, Incremental Encoder, Auxiliary Incremental Encoder, Tachometer (±10V)
Commutation Methods	-	Sinusoidal, Trapezoidal
Modes of Operation	-	Profile Modes, Cyclic Synchronous Modes, Current, Velocity, Position
Motors Supported[5]	-	Three Phase (Brushless Servo), Single Phase (Brushed Servo, Voice Coil, Inductive Load), Stepper (2- or 3-Phase Closed Loop)
Hardware Protection	-	40+ Configurable Functions, Over Current, Over Temperature (Drive & Motor), Over Voltage, Short Circuit (Phase-Phase & Phase-Ground), Under Voltage
Programmable Digital Inputs/Outputs	-	4/3
Programmable Analog Inputs/Outputs	-	1/0
Primary I/O Logic Level	-	5 VDC, not isolated
Current Loop Sample Time	µs	50
Velocity Loop Sample Time	µs	100
Position Loop Sample Time	µs	100
Maximum Encoder Frequency	MHz	20 (5 pre-quadrature)
Mechanical Specifications		
Description	Units	Value
Size (H x W x D)	mm (in)	38.1 x 25.4 x 15.8 (1.50 x 1.00 x 0.60)
Weight	g (oz)	TBD
Ambient Operating Temperature Range[6]	°C (°F)	-40 – 95 (-40 – 203)
Storage Temperature Range	°C (°F)	-50 – 100 (-58 – 212)
Thermal Shock	°C (°F)	-40 – 95 (-40 – 203) within 3 min
Relative Humidity	-	0-95%, non-condensing
Vibration	Grms	25 for 5 minutes in 3 axes
Altitude	m	-400 – 25000
Contaminants	-	Pollution Degree 2
Form Factor	-	PCB Mounted
P1 SIGNAL CONNECTOR	-	80-pin 0.4mm spaced connector
TERMINAL PINS	-	26x Terminal Pins

Notes
1. Capable of supplying drive rated peak current for 2 seconds with 5 second foldback to continuous value. Longer times are possible with lower current limits.
2. Continuous Arms value attainable when RMS Charge-Based Limiting is used.
3. Lower inductance is acceptable for bus voltages well below maximum. Use external inductance to meet requirements.
4. EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.
5. Maximum motor speed for stepper motors is 600 RPM. Consult the hardware installation manual for 2-phase stepper wiring configuration.
6. Additional cooling and/or heatsink may be required to achieve rated performance.

PIN FUNCTIONS

Pin	Name	Description / Notes	I/O	Pin	Name	Description / Notes	I/O
**P1 – Signal Connector**
1	GROUND	Ground	GND	2	GROUND	Ground	GND
3	PAI-1+	Differential Programmable Analog Input or Reference Signal Input (12-bit Resolution)	I	4	DATA+ USB	USB Data Channel	I/O
5	PAI-1-		I	6	DATA- USB		I/O
7	THERMISTOR	Motor Thermal Protection.	I	8	GROUND	Ground	GND
9	GROUND	Ground	GND	10	SCLA	I²C Data Signals for Addressing, Network Error LED, and Bridge Status LED. See Hardware Manual for more info.	O
11	ENC 1 DATA+ / A+	Differential Data Line for Absolute Encoders (BiSS: SLO+/-) or Differential Incremental Encoder A.	I/O	12	SDAA		I/O
13	ENC 1 DATA- / A-		I/O	14	HALL A		I
15	ENC 1 CLK+ / B+	Differential Clock Line for Absolute Encoders (BiSS: MA+/-) or Differential Incremental Encoder B.	I/O	16	HALL B	Single-ended Commutation Sensor Inputs	I
17	ENC 1 CLK- / B-		I/O	18	HALL C		I
19	GROUND	Ground	GND	20	GROUND	Ground	GND
21	ENC 1 REF+ / I+	Differential Reference Mark for Absolute Encoders (Leave open for BiSS) or Differential Incremental Encoder Index.	I	22	ENC 2 A+	Differential Incremental Encoder A.	I
23	ENC 1 REF- / I-		I	24	ENC 2 A-		I
25	RESERVED	Reserved. Do not connect.	-	26	ENC 2 B+	Differential Incremental Encoder B.	I
27	RESERVED	Reserved. Do not connect.	-	28	ENC 2 B-		I
29	RESERVED	Reserved. Do not connect.	-	30	ENC 2 I+	Differential Incremental Encoder Index.	I
31	PDI-1	Programmable Digital Input	I	32	ENC 2 I-		I
33	PDI-2	Programmable Digital Input	I	34	PDO-1	Programmable Digital Output (TTL/8mA)	O
35	PDI-3	Programmable Digital Input	I	36	PDO-2	Programmable Digital Output (TTL/8mA)	O
37	PDI-4	Programmable Digital Input	I	38	PDO-3	Programmable Digital Output (TTL/8mA)	O
39	GROUND	Ground	GND	40	GROUND	Ground	GND
41	TX- IN	Transmit Line IN (100 Base TX)	I	42	TX- OUT	Transmit Line OUT (100 Base TX)	O
43	TX+ IN		I	44	TX+ OUT		O
45	RX- IN	Receive Line IN (100 Base TX)	I	46	RX- OUT	Receive Line OUT (100 Base TX)	O
47	RX+ IN		I	48	RX+ OUT		O
49	+3V BIAS IN	+3V Supply for Transformer/Magnetics Bias	O	50	+3V BIAS OUT	+3V Supply for Transformer/Magnetics Bias	O
51	LINK/ACT IN	Link and Activity Indicator for IN port. Function based on protocol specification. See Hardware Information below.	I/O	52	LINK/ACT OUT	Link and Activity Indicator for OUT port. Function based on protocol specification. See Hardware Information below.	I/O
53	STATUS	Run State Indicator for Network. Function based on protocol specification. See Hardware Information below.	I/O	54	RESERVED	Reserved. Do not connect.	-
55	RESERVED	Reserved. Do not connect.	-	56	RESERVED	Reserved. Do not connect.	-
57	RESERVED	Reserved. Do not connect.	-	58	RESERVED	Reserved. Do not connect.	-
59	GROUND	Ground	GND	60	GROUND	Ground	GND
61	RESERVED	Reserved. Do not connect.	-	62	RESERVED	Reserved. Do not connect.	-
63	RESERVED	Reserved. Do not connect.	-	64	RESERVED	Reserved. Do not connect.	-
65	RESERVED	Reserved. Do not connect.	-	66	RESERVED	Reserved. Do not connect.	-
67	RESERVED	Reserved. Do not connect.	-	68	STEP	Step Input.	I
69	RESERVED	Reserved. Do not connect.	-	70	DIR	Direction Input.	I
71	RESERVED	Reserved. Do not connect.	-	72	RESERVED	Reserved. Do not connect.	-
73	+5V_OUT	+5VDC unprotected supply (See Note 1)	O	74	RESERVED	Reserved. Do not connect.	-
75	+5V_USER	+5VDC User Supply for feedback and local logic (See Note 1)	O	76	+3V3 OUT	+3.3VDC Supply Output for local logic signals (100 mA max)	O
77	+5V_USER		O	78	+3V3 OUT		O
79	GROUND	Ground	GND	80	GROUND	Ground	GND

Connector Information	80-pin, 0.4mm spaced connector	
Mating Connector Details	PANASONIC: P/N AXT380224	
Mating Connector Included with Drive	No	

+3V3 OUT 76
+3V3 OUT 78
GROUND 80

6 DATA- USB
4 DATA+ USB
2 GROUND

GROUND 79
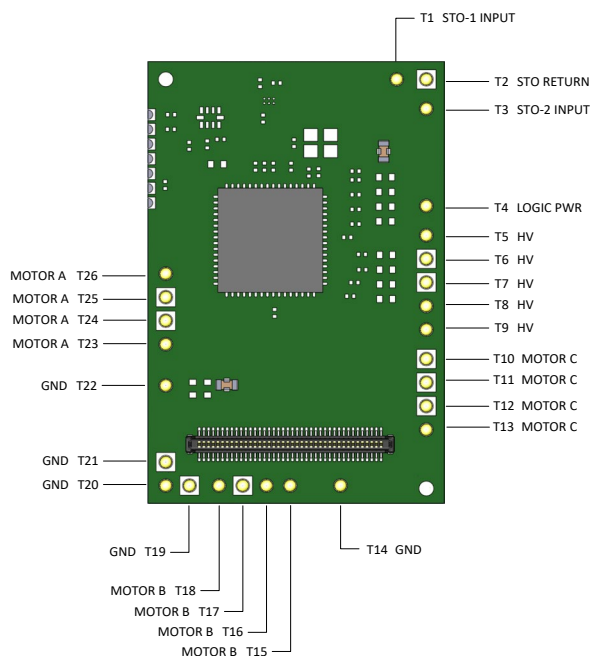+5V USER 77
+5V USER 75

1 GROUND
3 PAI-1+
5 PAI-1-

Notes
1. Total current through pins P1-73/75/77 should not exceed 300mA, while no single pin should be loaded more than 150mA.

TERMINAL PIN LOCATIONS

The 26 Terminal Pins provide connection to the high power drive signals. Terminal Pins must be soldered to an interface board.

Pin	Name	Description / Notes	I/O
T1	STO-1 INPUT	Safe Torque Off – Input 1	I
T2	STO RETURN	Safe Torque Off Return	STORET
T3	STO-2 INPUT	Safe Torque Off – Input 2	I
T4	LOGIC PWR	Logic Supply Input (10 – 55VDC) (optional). When using a separate logic power supply, turn on the logic supply first before turning on the main power supply	I
T5	HV		I
T6	HV		I
T7	HV	DC Supply Input (10-55VDC). Minimum 500μF external capacitance required between HV and POWER GND.	I
T8	HV		I
T9	HV		I
T10	MOTOR C		O
T11	MOTOR C	Motor Phase C. All provided motor phase output pins must be used.	O
T12	MOTOR C		O
T13	MOTOR C		O
T14	POWER GND	Ground.	GND
T15	MOTOR B		O
T16	MOTOR B	Motor Phase B. All provided motor phase output pins must be used.	O
T17	MOTOR B		O
T18	MOTOR B		O
T19	POWER GND		GND
T20	POWER GND	Ground.	GND
T21	POWER GND		GND
T22	POWER GND		GND
T23	MOTOR A		O
T24	MOTOR A	Motor Phase A. All provided motor phase output pins must be used.	O
T25	MOTOR A		O
T26	MOTOR A		O

Terminal Pin Details

Safe Torque Off (STO) Inputs
The Safe Torque Off (STO) inputs are dedicated +5VDC sinking single-ended inputs. For applications not using STO functionality, disabling of the STO feature is required for proper drive operation. STO may be disabled by following the STO Disable wiring instructions as given in the hardware installation manual. Consult the hardware installation manual for more information.

HARDWARE INFORMATION

LED Functionality

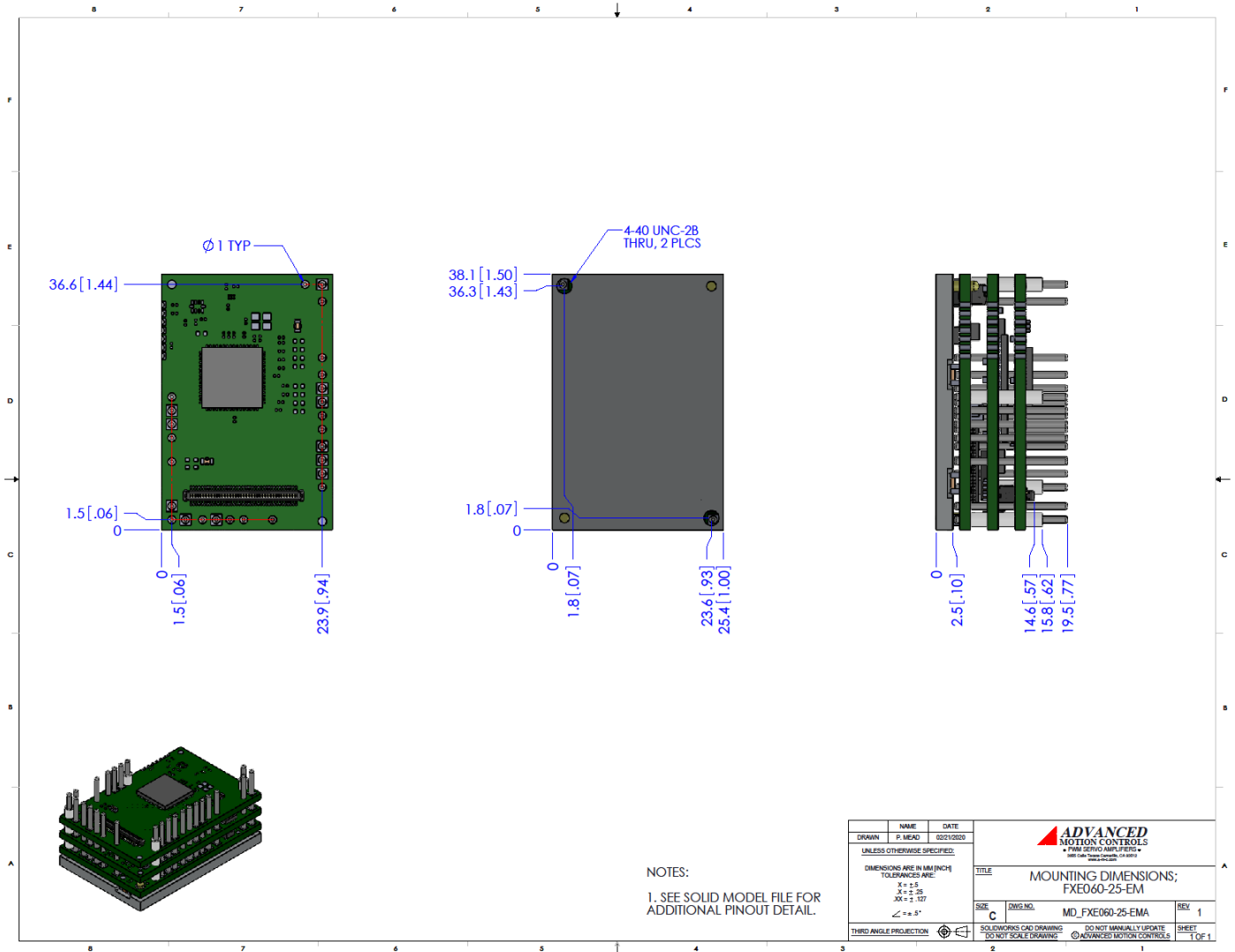*LINK/ACT IN (P1-51); LINK/ACT OUT (P1-52); STATUS (P1-53);*

The *LINK/ACT IN, LINK/ACT OUT,* and *STATUS* pins serve as EtherCAT network indicators. On a standard RJ-45 connector used with EtherCAT network topology, the typical EtherCAT network indicator LED locations are as shown in the below diagrams. **Note that the drive features signals for connection to LEDs on an RJ-45 connector, but the connector itself is not included on the drive. The Development Card assembly FD060-25-EM features a built-in RJ-45 connector with LEDs for this purpose**.
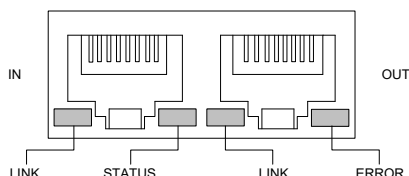
LINK/ACT IN and *LINK/ACT OUT* are used to drive the corresponding LINK IN and LINK OUT LEDs on a typical RJ-45 connector. The STATUS pin is used to drive the Status LED. The ERROR LED is driven by the I²C Data signals (P1-10/12). Consult the hardware installation manual for recommended wiring connections. The LED Function Protocol tables below describe typical LED functionality.
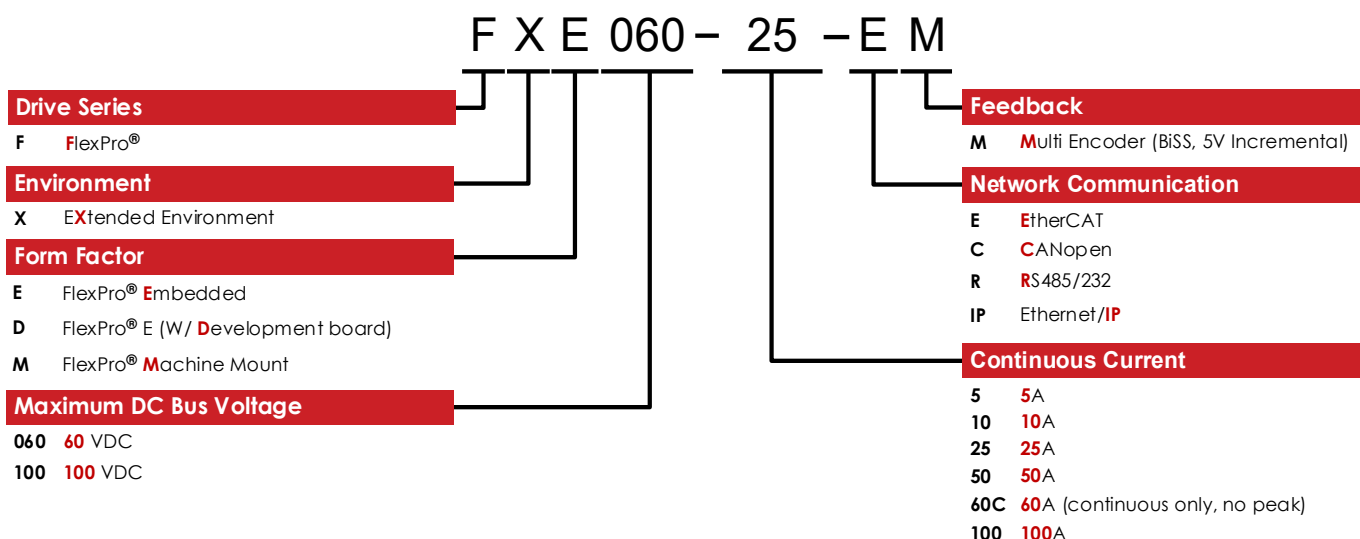
LINK/ACT LEDS	
LED State	**Description**
Green – On	Valid Link - No Activity
Green – Flickering	Valid Link - Network Activity
Off	Invalid Link

STATUS LED	
LED State	**Description**
Green – On	The device is in the state OPERATIONAL
Green – Blinking (2.5Hz – 200ms on and 200ms off)	The device is in the state PRE-OPERATIONAL
Green – Single Flash (200ms flash followed by 1000ms off)	The device is in state SAFE-OPERATIONAL
Green – Flickering (10Hz – 50ms on and 50ms off)	The device is booting and has not yet entered the INIT state, or The device is in state BOOTSTRAP, or Firmware download operation in progress
Off	The device is in state INIT

ERROR LED		
LED State	**Description**	**Example**
Red – On	A PDI Watchdog timeout has occurred.	Application controller is not responding anymore.
Red – Blinking (2.5Hz – 200ms on and 200ms off)	General Configuration Error.	State change commanded by master is impossible due to register or object settings.
Red – Flickering (10Hz – 50ms on and 50ms off)	Booting Error was detected. INIT state reached, but parameter "Change" in the AL status register is set to 0x01:change/error	Checksum Error in Flash Memory.
Red – Single Flash (200ms flash followed by 1000ms off)	The slave device application has changed the EtherCAT state autonomously: Parameter "Change" in the AL status register is set to 0x01:change/error.	Synchronization error; device enters SAFE-OPERATIONAL automatically
Red – Double Flash (Two 200ms flashes separated by 200ms off, followed by 1000ms off)	An application Watchdog timeout has occurred.	Sync Manager Watchdog timeout.

MOUNTING DIMENSIONS

Ø 1 TYP

36.6 [1.44]

1.5 [.06]
0

1.5 [.06]

23.9 [.94]

4-40 UNC-2B
THRU, 2 PLCS

38.1 [1.50]
36.3 [1.43]

1.8 [.07]
0

0

1.8 [.07]

23.6 [.93]
25.4 [1.00]

0

2.5 [.10]

14.6 [.57]
15.8 [.62]
19.5 [.77]

NOTES:

1. SEE SOLID MODEL FILE FOR
ADDITIONAL PINOUT DETAIL.

	NAME	DATE	
DRAWN	P. MEAD	02/21/2020	

UNLESS OTHERWISE SPECIFIED:

DIMENSIONS ARE IN MM [INCH]
TOLERANCES ARE:
X = ± .5
.X = ± .25
.XX = ± .127
∠ = ± .5°

THIRD ANGLE PROJECTION

ADVANCED
MOTION CONTROLS
■ PWM SERVO AMPLIFIERS ■
3805 Calle Tecate Camarillo, CA 93012
www.a-m-c.com

TITLE: MOUNTING DIMENSIONS;
FXE060-25-EM

SIZE	DWG NO.	REV
C	MD_FXE060-25-EMA	1

SOLIDWORKS CAD DRAWING
DO NOT SCALE DRAWING

DO NOT MANUALLY UPDATE
© ADVANCED MOTION CONTROLS

SHEET 1 OF 1

PART NUMBERING AND CUSTOMIZATION INFORMATION

F X E 060 – 25 – E M

Drive Series

F **F**lexPro®

Environment

X E**X**tended Environment

Form Factor

E FlexPro® **E**mbedded
D FlexPro® E (W/ **D**evelopment board)
M FlexPro® **M**achine Mount

Maximum DC Bus Voltage

060 **60** VDC
100 **100** VDC

Feedback

M **M**ulti Encoder (BiSS, 5V Incremental)

Network Communication

E **E**therCAT
C **C**ANopen
R **R**S485/232
IP Ethernet/**IP**

Continuous Current

5 **5**A
10 **10**A
25 **25**A
50 **50**A
60C **60**A (continuous only, no peak)
100 **100**A

ADVANCED Motion Controls also has the capability to promptly develop and deliver specified products for OEMs with volume requests. Our Applications and Engineering Departments will work closely with your design team through all stages of development in order to provide the best servo drive solution for your system. Equipped with on-site manufacturing for quick-turn customs capabilities, *ADVANCED* Motion Controls utilizes our years of engineering and manufacturing expertise to decrease your costs and time-to-market while increasing system quality and reliability.

Examples of Customized Products

- Optimized Footprint
- Private Label Software
- OEM Specified Connectors
- No Outer Case
- Increased Current Resolution
- Increased Temperature Range
- Custom Control Interface
- Integrated System I/O
- Tailored Project File
- Silkscreen Branding
- Optimized Base Plate
- Increased Current Limits
- Increased Voltage Range
- Conformal Coating
- Multi-Axis Configurations
- Reduced Profile Size and Weight

Feel free to contact us for further information and details!

Available Accessories

ADVANCED Motion Controls offers a variety of accessories designed to facilitate drive integration into a servo system. Visit www.a-m-c.com to see which accessories will assist with your application design and implementation.