Description

The DigiFlex® Performance™ (DP) Series digital servo drives are designed to drive brushed and brushless servomotors. These fully digital drives operate in torque, velocity, or position mode and employ Space Vector Modulation (SVM), which results in higher bus voltage utilization and reduced heat dissipation compared to traditional PWM. The command source can be generated internally or can be supplied externally. In addition to motor control, these drives feature dedicated and programmable digital and analog inputs and outputs to enhance interfacing with external controllers and devices.

This DP Series drive features an EtherCAT® interface for network communication using CANopen over EtherCAT (CoE), and a USB port for drive configuration and setup. Drive commissioning is accomplished using DriveWare® 7, available for download at www.a-m-c.com.

All drive and motor parameters are stored in non-volatile memory. The DPE Series Hardware Installation Manual is available for download at www.a-m-c.com.

Power Range

Peak Current	15 A (10.6 A_{RMS})
Continuous Current	7.5 A (7.5 A_{RMS})
Supply Voltage	100 - 240 VAC

EtherCAT®

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
- Space Vector Modulation (SVM) Technology
- Fully Digital State-of-the-art Design
- Programmable Gain Settings
- Fully Configurable Current, Voltage, Velocity and Position Limits
- PIDF Velocity Loop
- PID + FF Position Loop
- Compact size, high power density
- 16-bit Analog to Digital Hardware
- Built-in brake/shunt regulator
- On-the-Fly Mode Switching
- On-the-Fly Gain Set Switching
- Dedicated Safe Torque Off (STO) Inputs

MODES OF OPERATION
- Profile Current
- Profile Velocity
- Profile Position
- Cyclic Synchronous Current Mode
- Cyclic Synchronous Velocity Mode
- Cyclic Synchronous Position Mode

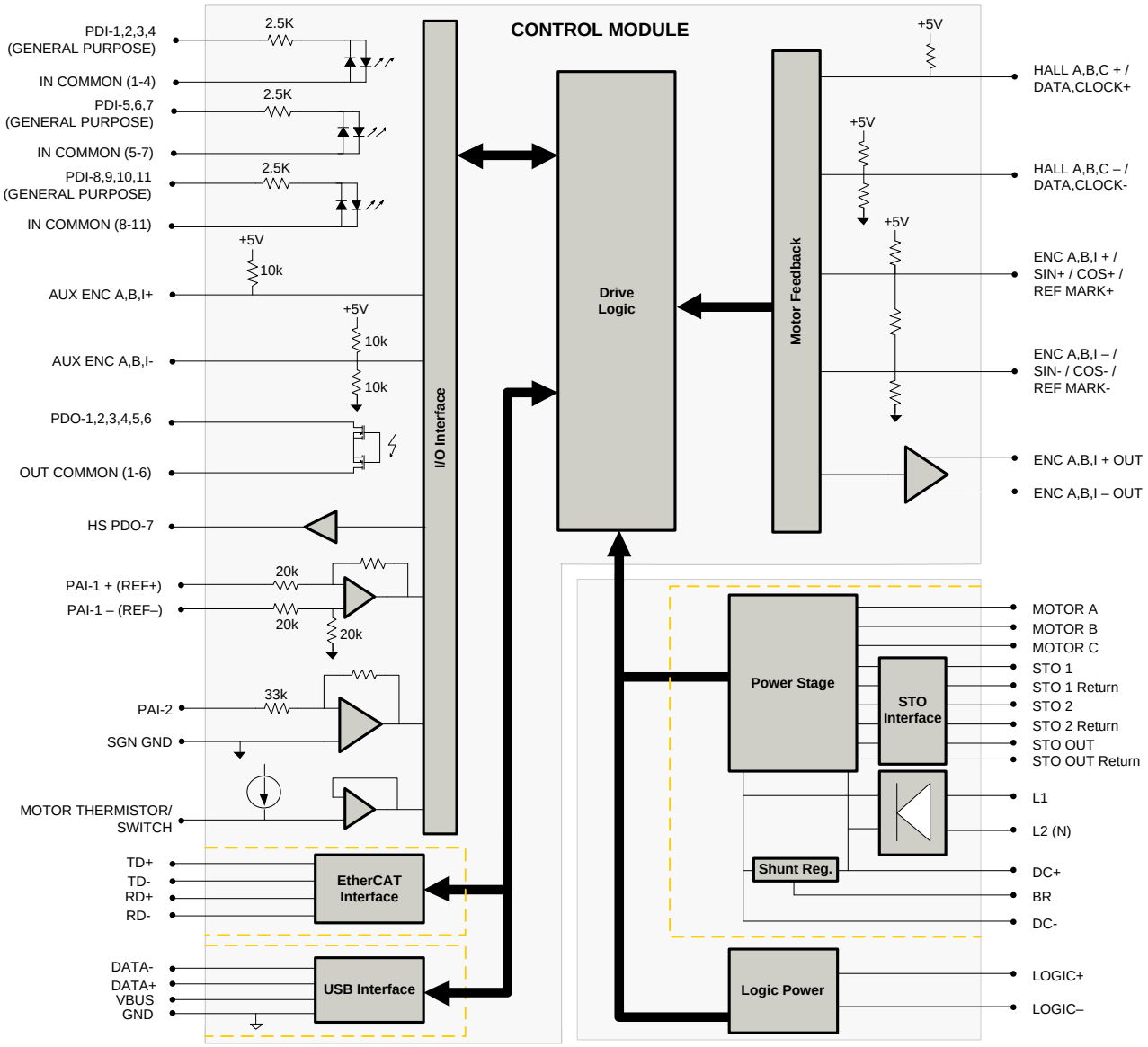
COMMAND SOURCE
- ±10 V Analog
- Encoder Following
- Over the Network
- Sequencing
- Indexing
- Jogging

FEEDBACK SUPPORTED (FIRMWARE DEPENDENT)
- Halls
- Incremental Encoder
- Absolute Encoder (EnDat® 2.1/2.2, Hiperface®, or BiSS C-Mode)
- 1Vp-p Sine/Cosine Encoder (see notes on page 3)
- Auxiliary Incremental Encoder
- Tachometer (±10 VDC)

INPUTS/OUTPUTS
- 1 Motor Thermistor/Switch Input
- 11 General Purpose Programmable Digital Inputs
- 1 High Speed Programmable Digital Output
- 6 General Purpose Programmable Digital Outputs
- 2 Programmable Analog Inputs

COMPLIANCES & AGENCY APPROVALS
- UL
- cUL
- CE Class A (LVD)
- CE Class A (EMC
- RoHS
- TÜV Rheinland® (STO)

BLOCK DIAGRAM



Information on Approvals and Compliances	
cULus	US and Canadian safety compliance with UL 508c, the industrial standard for power conversion electronics. UL registered under file number E140173. Note that machine components compliant with UL are considered UL registered as opposed to UL listed as would be the case for commercial products.
CE	Compliant with European EMC Directive 2004/108/EC on Electromagnetic Compatibility (specifically EN 61000-6-4:2007 for Emissions, Class A and EN 61000-6-2:2005 for Immunity, Performance Criteria A). LVD requirements of Directive 2006/95/EC (specifically, EN 60204-1:2004, a Low Voltage Directive to protect users from electrical shock).
RoHS COMPLIANCE	RoHS (Reduction of Hazardous Substances) is intended to prevent hazardous substances such as lead from being manufactured in electrical and electronic equipment.
TÜVRheinland CERTIFIED Functional Safety Type Approved	Functional Safety STO is TÜV Rheinland® certified and meets requirements of the following standards: • EN ISO 13849-1 Category 4 / PL e • EN IEC 61800-5-2 STO (SIL 3) • EN62061 SIL CL3 • IEC 61508 SIL 3

SPECIFICATIONS

Power Specifications		
Description	Units	Value
Rated Voltage	VAC (VDC)	240 (339)
AC Supply Voltage Range	VAC	100 – 240
AC Supply Minimum	VAC	90
AC Supply Maximum	VAC	264
AC Input Phases	-	1
AC Supply Frequency	Hz	50 – 60
DC Supply Voltage Range[1]	VDC	127 – 373
DC Bus Over Voltage Limit	VDC	394
DC Bus Under Voltage Limit	VDC	55
Logic Supply Voltage	VDC	20 – 30 (@ 850 mA)
Safe Torque Off Voltage	VDC	24 (±6)
Maximum Peak Output Current[2]	A (A_{RMS})	15 (10.6)
Maximum Continuous Output Current[3]	A (A_{RMS})	7.5 (7.5)
Maximum Continuous Power @ Rated Voltage[4]	W	2415
Maximum Continuous Power Dissipation @ Rated Voltage	W	127
Internal Bus Capacitance	µF	540
External Shunt Resistor Minimum Resistance[5]	Ω	25
Minimum Load Inductance (Line-To-Line)[6]	µH	600
Switching Frequency	kHz	20
Low Voltage Supply Outputs	-	+5 VDC (250 mA)
Control Specifications		
Description	Units	Value
Communication Interfaces[7]	-	EtherCAT® (USB for Configuration)
Command Sources	-	±10 V Analog, Encoder Following, Over the Network, Sequencing, Indexing, Jogging
Feedback Supported[8]	-	Halls, Incremental Encoder, Absolute Encoder (EnDat® 2.1/2.2, Hiperface®, or BiSS C-Mode), 1Vp-p Sine/Cosine Encoder, Auxiliary Incremental Encoder, Tachometer (±10 VDC)
Commutation Methods	-	Sinusoidal, Trapezoidal
Modes of Operation	-	Profile Current, Profile Velocity, Profile Position, Cyclic Synchronous Current, Cyclic Synchronous Velocity, Cyclic Synchronous Position
Motors Supported	-	Closed Loop Vector, Single Phase (Brushed, Voice Coil, Inductive Load), Three Phase (Brushless)
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 (PDIs/PDOs)	-	11/7
Programmable Analog Inputs/Outputs (PAIs/PAOs)	-	2/0
Primary I/O Logic Level	-	24 VDC
Current Loop Sample Time	µs	50
Velocity Loop Sample Time	µs	100
Position Loop Sample Time	µs	100
Maximum Sin/Cos Encoder Frequency	kHz	200
Maximum Sin/Cos Interpolation	-	2048 counts per sin/cos cycle
Internal Shunt Regulator	-	Yes
Internal Shunt Resistor	-	No
Mechanical Specifications		
Description	Units	Value
Agency Approvals	-	CE Class A (EMC), CE Class A (LVD), cUL, RoHS, TÜV Rheinland® (STO), UL
Size (H x W x D)	mm (in)	177.495 x 123.393 x 44.450 (6.988 x 4.858 x 1.750)
Weight	g (oz)	894 (31.5)
Heatsink (Base) Temperature Range[9]	°C (°F)	0 - 75 (32 - 167)
Storage Temperature Range	°C (°F)	-40 - 85 (-40 - 185)
Cooling System	-	Natural Convection
Form Factor	-	Panel Mount
AUX. COMM Connector	-	5-pin, Mini USB B Type port
COMM Connector	-	Shielded, dual RJ-45 socket with LEDs
FEEDBACK Connector	-	15-pin, high-density, female D-sub
AUX. ENCODER Connector	-	15-pin, high-density, male D-sub
I/O Connector	-	26-pin, high-density, female D-sub
+24V LOGIC Connector	-	2-port, 3.5 mm spaced insert connector
POWER Connector	-	10-port, 5.08 mm spaced, enclosed, friction lock header
STO Connector	-	8-port, 2.0 mm spaced, enclosed, friction lock header

Notes

1. Large inrush current may occur upon initial DC supply connection to DC Bus.
2. Capable of supplying drive rated peak current for 2 seconds with 10 second foldback to continuous value. Longer times are possible with lower current limits.
3. Continuous A_{rms} value attainable when RMS Charge-Based Limiting is used.
4. P = (DC Rated Voltage) * (Cont. RMS Current) * 0.95
5. *ADVANCED* Motion Controls recommends using an external fuse in series with the shunt resistor. A 3 amp motor delay fuse is typical.
6. Lower inductance is acceptable for bus voltages well below maximum. Use external inductance to meet requirements.
7. EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.
8. Contact *ADVANCED* Motion Controls for 1Vp-p Sine/Cosine Encoder feedback availability.
9. Additional cooling and/or heatsink may be required to achieve rated performance.

PIN FUNCTIONS

COMM – EtherCAT Communication Connector			
Pin	Name	Description / Notes	I/O
1	RD+	Receiver + (100Base-TX)	I
2	RD-	Receiver - (100Base-TX)	I
3	TD+	Transmitter + (100Base-TX)	O
4	RESERVED	-	-
5	RESERVED	-	-
6	TD-	Transmitter - (100Base-TX)	O
7	RESERVED	-	-
8	RESERVED	-	-
9	RESERVED	-	-

I/O – Signal Connector			
Pin	Name	Description / Notes	I/O
1	PDO-1	General Purpose Programmable Digital Output (120 mA maximum)	O
2	PDO-2	General Purpose Programmable Digital Output (120 mA maximum)	O
3	PDO-3	General Purpose Programmable Digital Output (120 mA maximum)	O
4	OUT COMMON	Digital Output Common (1-6)	OCOM
5	GROUND	Ground	GND
6	PDO-4	General Purpose Programmable Digital Output (120 mA maximum)	O
7	PDO-5	General Purpose Programmable Digital Output (120 mA maximum)	O
8	HS PDO-7	High Speed Programmable Digital Output	O
9	PDO-6	General Purpose Programmable Digital Output (120 mA maximum)	O
10	PDI-1	General Purpose Programmable Digital Input	I
11	PDI-2	General Purpose Programmable Digital Input	I
12	PDI-3	General Purpose Programmable Digital Input	I
13	PDI-4	General Purpose Programmable Digital Input	I
14	IN COMMON	Digital Input Common (1-4)	ICOM
15	IN COMMON	Digital Input Common (5-7)	ICOM
16	PDI-5	General Purpose Programmable Digital Input	I
17	PDI-6	General Purpose Programmable Digital Input	I
18	PDI-7	General Purpose Programmable Digital Input	I
19	PDI-8	General Purpose Programmable Digital Input	I
20	PDI-9	General Purpose Programmable Digital Input	I
21	PDI-10	General Purpose Programmable Digital Input	I
22	PDI-11	General Purpose Programmable Digital Input	I
23	IN COMMON	Digital Input Common (8-11)	ICOM
24	PAI-1+	General Purpose Differential Programmable Analog Input	I
25	PAI-1-		I
26	GROUND	Ground	GND

FEEDBACK – Feedback Connector – C3*					
Pin	Incremental Encoder	Absolute Encoder	1Vp-p Sin/Cos Encoder	Description / Notes	I/O
1	HALL A+	DATA-	HALL A+	Differential Hall A+/ Differential Data Line (BiSS: SLO-)	I
2	HALL B+	CLOCK+	HALL B+	Differential Hall B+ / Differential Clock Line (BiSS: MA+)	I
3	HALL C+	N/C	HALL C+	Differential Hall C+	I
4	ENC A+	SIN +	SIN +	Differential Encoder A / Differential Sine Input (Leave open for BiSS and EnDat 2.2)	I
5	ENC A-	SIN -	SIN -		I
6	ENC B+	COS +	COS +	Differential Encoder B/ Differential Cosine Input (Leave open for BiSS and EnDat 2.2)	I
7	ENC B-	COS -	COS -		I
8	ENC I+	REF MARK+	REF MARK +	Differential Encoder Index / Differential Reference Mark (Leave open for BiSS and EnDat 2.2)	I
9	ENC I-	REF MARK-	REF MARK -		I
10	HALL A-	DATA+	HALL A-	Differential Hall A- / Differential Data Line (BiSS: SLO+)	I
11	HALL B-	CLOCK-	HALL B-	Differential Hall B- / Differential Clock Line (BiSS: MA-)	I
12	SGND	SGND	SGND	5V Return (Signal Ground)	SGND
13	+5V OUT	+5V OUT	+5V OUT	+5V Encoder Supply Output. Short-circuit protected. (250mA)	O
14	THERMISTOR	THERMISTOR	THERMISTOR	Motor Thermal Protection	I
15	HALL C-	N/C	HALL C-	Differential Hall C-.	I

*Note: Feedback supported (Incremental Encoder, Absolute Sin/Cos Encoder, or 1Vp-p Sin/Cos Encoder) will be dependent on firmware. Contact *ADVANCED* Motion Controls for 1Vp-p Sin/Cos Encoder feedback availability.

AUX. ENCODER – Auxiliary Encoder Connector

Pin	Name	Description / Notes	I/O
1	ENC A+ OUT / RESERVED	Buffered Encoder Channel A Output* or Reserved.	O
2	ENC A- OUT / RESERVED		O
3	ENC B+ OUT / RESERVED	Buffered Encoder Channel B Output* or Reserved.	O
4	AUX ENC A+	Auxiliary Encoder Input (For single ended signal leave negative terminal open)	I
5	AUX ENC A-		I
6	AUX ENC B+	Auxiliary Encoder Input (For single ended signal leave negative terminal open)	I
7	AUX ENC B-		I
8	AUX ENC I+	Auxiliary Encoder Index Input (For single ended signal leave negative terminal open)	I
9	AUX ENC I-		I
10	ENC B- OUT / RESERVED	Buffered Encoder Channel B Output* or Reserved.	O
11	ENC I+ OUT / RESERVED	Buffered Encoder Index Output* or Reserved.	O
12	SGND	Signal Ground	SGND
13	+5V OUT	+5 VDC User Supply	O
14	PAI-2	Programmable Analog Input (12-bit Resolution)	I
15	ENC I- OUT / RESERVED	Buffered Encoder Index Output* or Reserved.	O

*Buffered encoder output only available with incremental encoder or 1Vp-p sin/cos encoder feedbacks. 1:1 input-to-output ratio, 5V square wave output. Reserved pins for all other feedbacks.

AUX. COMM - USB Communication Connector – C5

Pin	Name	Description / Notes	I/O
1	VBUS	Supply Voltage	O
2	DATA -	Data -	I/O
3	DATA +	Data +	I/O
4	RESERVED	-	-
5	USB GND	USB Ground	UGND

POWER - Power Connector

Pin	Name	Description / Notes	I/O
1	MOTOR A	Motor Phase A	O
2	MOTOR B	Motor Phase B	O
3	MOTOR C	Motor Phase C	O
4	SHIELD	Motor feedback cable shield. Internally connected to protective earth ground.	-
5	PE	Protective Earth Ground	-
6	L1	AC Supply Input (Single Phase)	I
7	L2 (N)		I
8	DC+	Internal DC Bus Voltage (Can be used to connect external shunt regulator)	I/O
9	BR	External Brake Resistor Connection	-
10	DC-	Internal DC Bus Voltage (Can be used to connect external shunt regulator)	I/O

+24V LOGIC - Logic Power Connector

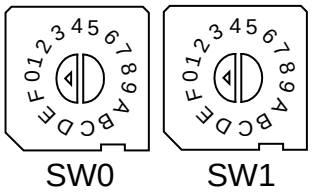
Pin	Name	Description / Notes	I/O
1	LOGIC GND	Logic Supply Ground	GND
2	LOGIC PWR	Logic Supply Input	I

STO – Safe Torque Off Connector

Pin	Name	Description / Notes	I/O
1	STO OUTPUT	Safe Torque Off Output	O
2	STO 24V DISABLE	24V Supply Output for STO Disable. Internal use only.	O
3	STO-1 RETURN	Safe Torque Off 1 Return	STORET1
4	STO-1	Safe Torque Off – Input 1	I
5	STO-2 RETURN	Safe Torque Off 2 Return	STORET2
6	STO-2	Safe Torque Off – Input 2	I
7	STO GND DISABLE	Ground for STO Disable. Internal use only.	GND
8	STO OUT RETURN	Safe Torque Off Output Return	STORETO

HARDWARE SETTINGS

EtherCAT Station Alias Selector Switches

Switch Diagram	Description
	Hexadecimal switch settings correspond to the drive Station Alias. Note that drives on an EtherCAT network will be given an address automatically based on proximity to the host. Setting the switches manually is optional, and only necessary if a fixed address is required.

SW1	SW0	Node ID
0	0	Address stored in NVM
0	1	001
0	2	002
…	…	…
F	D	253
F	E	254
F	F	255

LED Functions (on RJ-45 Communication Connectors)

LINK LED	
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

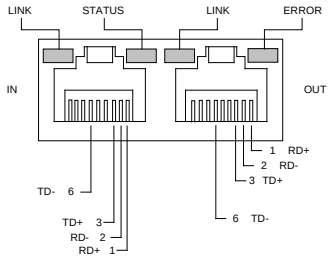
ERROR LED		
LED State	**Description**	**Example**
Red – On	A PDI Watchdog timeout has occurred.	Application controller is not responding anymore.
Red – Blinking (2.5Hz – 200ms on and 200ms off)	General Configuration Error.	State change commanded by master is impossible due to register or object settings.
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.

Safe Torque Off (STO) Inputs

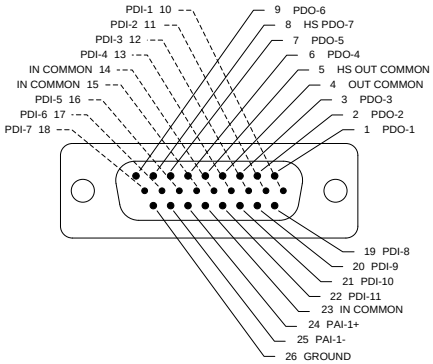
The Safe Torque Off (STO) Inputs are dedicated +24VDC max sinking single-ended inputs. A dedicated STO Disable Key connector is included and should be installed for applications where STO is not required.

MECHANICAL INFORMATION

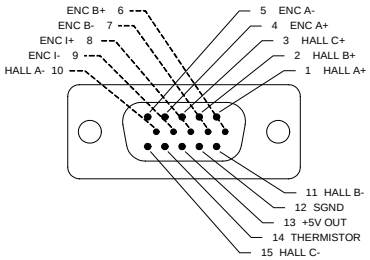
COMM - EtherCAT Communication Connector – C1		
Connector Information		Shielded, dual RJ-45 socket with LEDs
Mating Connector	Details	Standard CAT 5e or CAT 6 ethernet cable
	Included with Drive	No



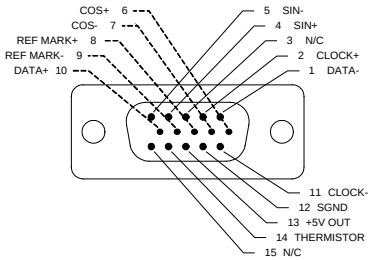
I/O - Signal Connector – C2		
Connector Information		26-pin, high-density, female D-sub
Mating Connector	Details	TYCO: Plug P/N 1658671-1; Housing P/N 5748677-3; Terminals P/N 1658670-2 (loose) or 1658670-1 (strip)
	Included with Drive	No



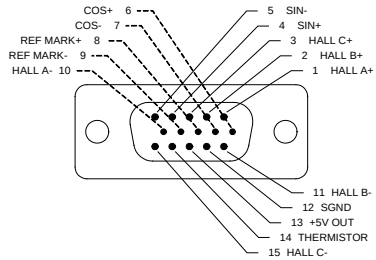
FEEDBACK - Feedback Connector – C3		
Connector Information		15-pin, high-density, female D-sub
Mating Connector	Details	TYCO: Plug P/N 748364-1; Housing P/N 5748677-2; Terminals P/N 1658670-2 (loose) or 1658670-1 (strip)
	Included with Drive	No



Incremental Encoder

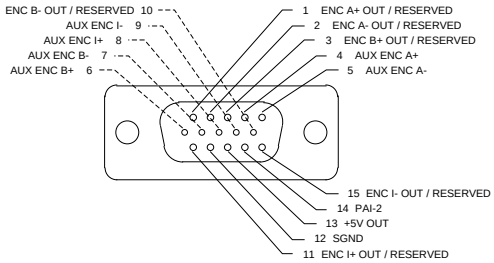


Absolute Encoder

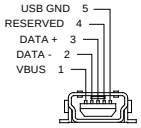


1Vp-p Sin/Cos Encoder

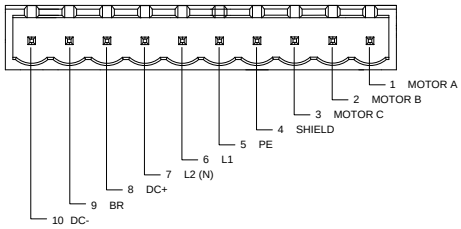
AUX. ENCODER - Auxiliary Feedback Connector – C4		
Connector Information		15-pin, high-density, male D-sub
Mating Connector	Details	TYCO: Plug P/N 1658681-1; Housing P/N 5748677-2; Terminals P/N 1658686-2 (loose) or 1658686-1 (strip)
	Included with Drive	No



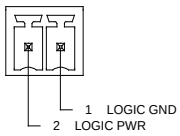
AUX. COMM – USB Communication Connector – C5		
Connector Information		5-pin, Mini USB B Type port
Suggested Mating Cable	Details	TYCO: 1496476-3 (2-meter STD-A to MINI-B ASSY)
	Included with Drive	No



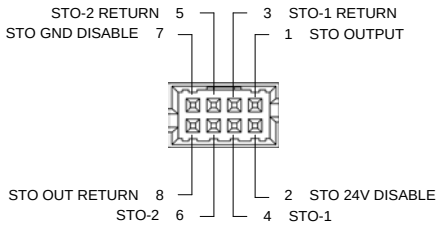
POWER - Power Connector		
Connector Information		10-port, 5.08 mm spaced, enclosed, friction lock header
Mating Connector	Details	Phoenix Contact: P/N 1781069
	Included with Drive	Yes



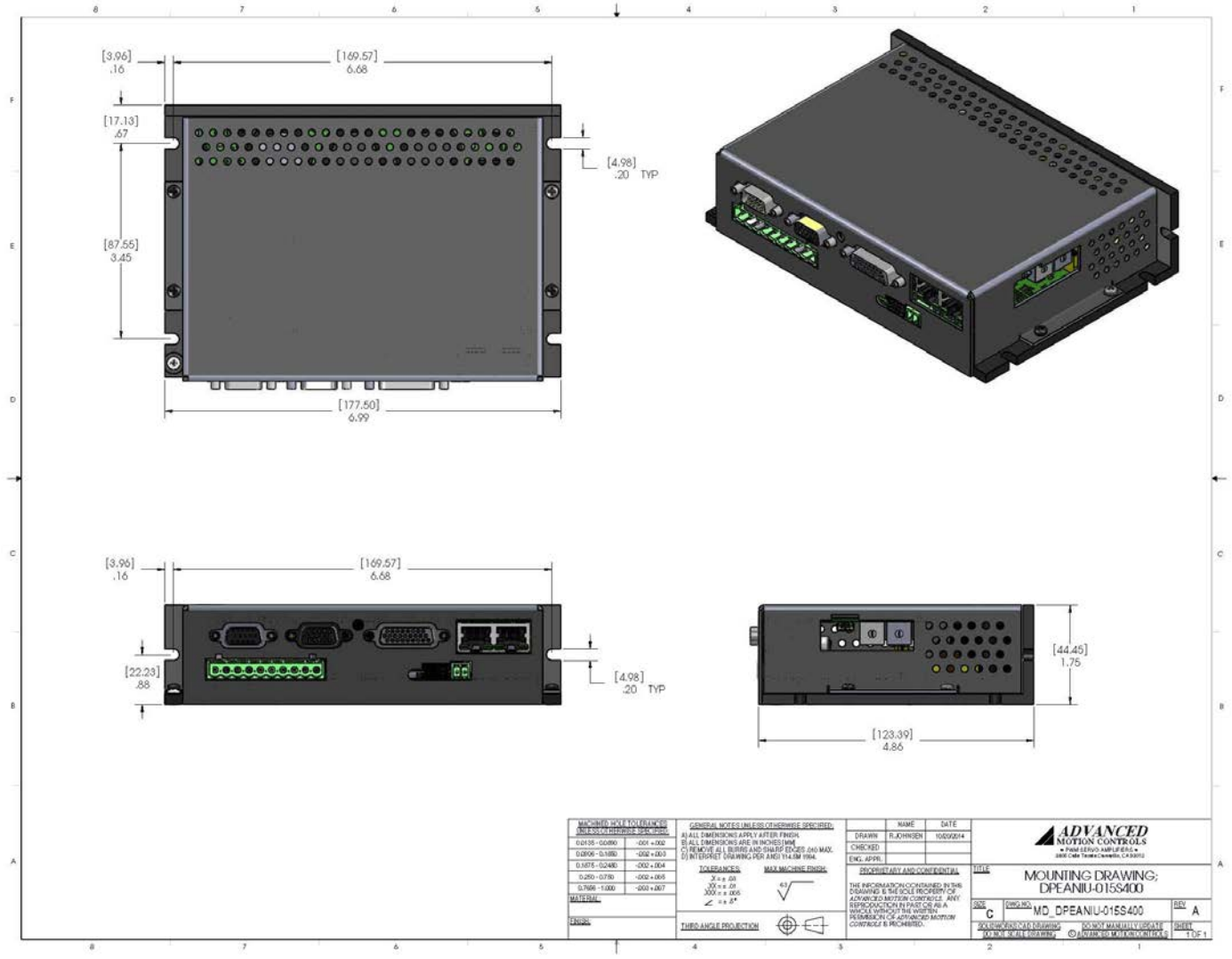
+24V LOGIC - Logic Power Connector		
Connector Information		2-port, 3.5 mm spaced insert connector
Mating Connector	Details	Phoenix Contact: P/N 1840366
	Included with Drive	Yes



STO – Safe Torque Off Connector		
Connector Information		8-port, 2.00 mm spaced, enclosed, friction lock header
Mating Connector	Details	Molex: P/N 51110-0860 (housing); 50394-8051 (pins)
	Included with Drive	No



MOUNTING DIMENSIONS



PART NUMBERING INFORMATION

Example: D P E A N I U - 0 1 5 S 4 0 0 -

Drive Series	
DP	DigiFlex® Performance™ Panel Mount

Communication	
R	RS232/RS485
C	CANopen or RS232
E	EtherCAT
P	POWERLINK / Modbus TCP / Ethernet

Command Inputs	
AN	Analog (±10V) No Step & Direction
AL	Analog (±10V) Low Voltage Step & Direction (5V)
AH	Analog (±10V) High Voltage Step & Direction (24V)

Digital I/O	
I	Isolated (24V)
T	TTL (5V) Non-Isolated

Motor Feedback	
E	Incremental Encoder and/or Halls
R	Resolver
A	Absolute Encoder
U	Universal (Halls, Inc. Enc., Abs. Enc., 1Vp-p Sin/Cos Enc.)

Customer Special
Code used to identify customer specials

Max DC Bus Voltage (V_{DC})	
080	80
200	200
400	400
800	800

Power and Logic Supply	
A	AC Input +24V_{DC} User Logic Supply Required
S	AC Input Single Phase Only +24V_{DC} User Logic Supply Required
B	DC Input Both Logic Supply Options (Internal or User)
L	DC Input Logic Supply Required

Peak Current ($A_{0\ to\ Peak}$)	
015	15
016	16
020	20
025	25
030	30
040	40
060	60
C060	60
C100	100

DigiFlex® Performance™ series of products are available in many configurations. All models listed in the selection tables of the website are readily available, standard product offerings.

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. Feel free to contact Applications Engineering for further information and details.

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

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.

Shunt Regulators

Drive(s)

Filter Cards

To Motor

All specifications in this document are subject to change without written notice. Actual product may differ from pictures provided in this document.