

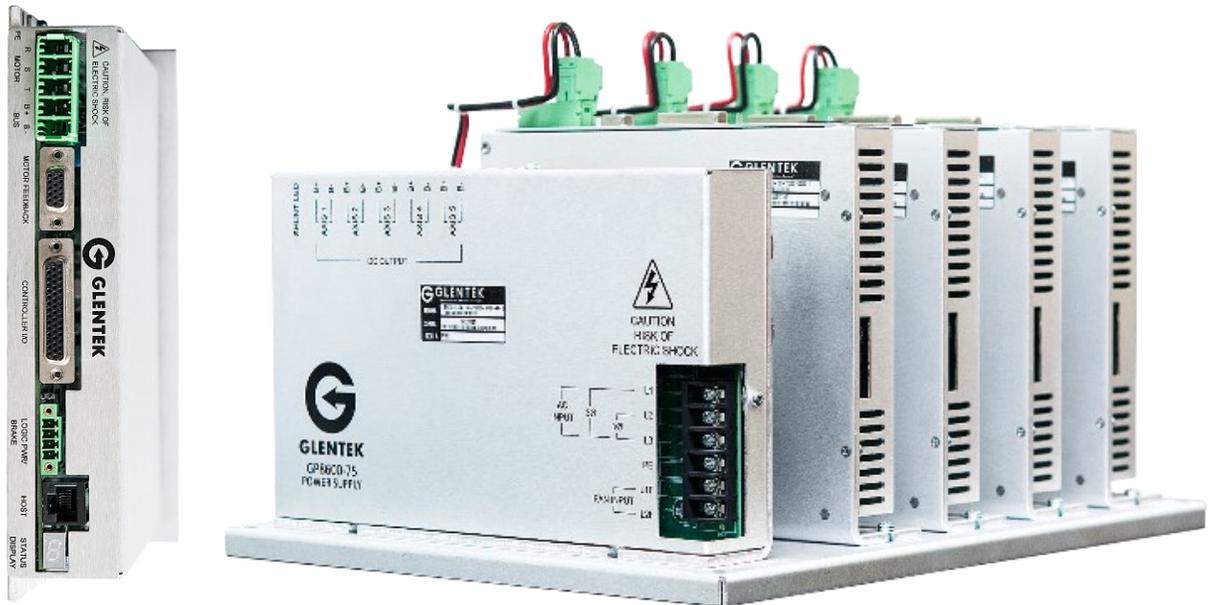
INSTALLATION & OPERATION MANUAL

Gamma Series Digital - High Bandwidth PWM Brush and Brushless Servo Drives



GLENTEK

SMB/SMC 9G16



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***Manual Revision Date:
11 July 2023***

Revision History

Page	Rev	Description	ECO	Date	Changes	APPD
	A	Initial Release	4295	5NOV20	D.C.R.	L.P.
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TABLE OF CONTENTS

TABLE OF CONTENTS	3
TABLES	6
FIGURES	7
1. OVERVIEW	8
2. PRODUCT DESCRIPTION	9
2.1 FEATURES	11
2.1.1 Performance	11
2.1.2 Regulatory	13
2.1.3 Connectivity	13
2.1.4 Feedback	13
2.1.5 I/O	13
2.1.6 Input	13
2.1.7 Build	14
2.2 ENVIRONMENTAL CONDITIONS	15
2.3 SMx9G16 RATINGS, SPECIFICATIONS AND NUMBERING	16
2.4 PACKAGE CONFIGURATIONS AND DIMENSIONS	19
2.5 SMx9G16 STAND ALONE MODEL NUMBERING	21
2.6 SMx9G16 MODULE MODEL NUMBERING	22
2.7 SMx9G16 MULTI-AXIS MODEL NUMBERING	23
3. DRIVE INTERFACE AND WIRING	24
3.1 CONTROLLER I/O	24
3.1.1 Programmable Digital Inputs	26
3.1.2 Programmable Digital Outputs	31
3.1.3 Analog Inputs	34
3.1.4 Analog Outputs	36
3.1.5 Encoder Outputs	38
3.1.6 Programmable Digital Input Functions	39
3.1.7 Programmable Digital Output Functions	40
3.2 BRAKE/STO CONNECTOR	42
3.2.1 Logic Power Inputs	43
3.2.2 Brake Output	44
3.2.3 STO Inputs	45
3.3 COMMUNICATION INTERFACE	46
3.3.1 Servo Drive Serial Communications Connector	46
3.3.2 RS-232	47
3.3.3 CANopen Interface	48
3.4 MOTOR FEEDBACK CONNECTOR AND WIRING	50
3.4.1 Tachometer	53
3.4.2 Resolver	54
3.4.3 Sin/Cos Encoder	55
3.5 SERVO DRIVE MOTOR AND POWER CONNECTORS	56
4. DRIVE SETUP	61
4.1 USING MOTIONMAESTRO TO SETUP A BRUSHLESS MOTOR	61
4.2 CURRENT (TORQUE) MODE	64
4.2.1 Signal Gain	64
4.2.2 Tach. Reverse	64
4.2.3 Signal Offset	65
4.2.4 Dead Band	66
4.2.5 Current Mode Brake Operation	67
4.3 VELOCITY (RPM) MODE TUNING	68
4.3.1 GVS (Gain Velocity Scale) Setting	68
4.3.2 Velocity Loop PID Setting	68
4.3.3 Velocity Mode Brake Operation	70

4.4 POSITION MODE	73
4.4.1 Pulse Follower Position Mode Tuning	73
4.4.2 Configure Pulse and Direction Follower Mode	75
4.4.3 Configure Encoder Quadrature A/B (Encoder Follower) Mode	77
4.4.4 Configure CW and CCW Pulse Follower Mode	79
4.5 TWO PHASE CURRENT MODE TUNING	80
4.5.1 Preliminary Setup	80
4.5.2 Setup Motor	80
4.5.3 Configure Command Signal Inputs	81
4.5.4 Drive Running	81
4.6 TACHOMETER FEEDBACK DEDICATED DRIVE	82
4.7 FINE TUNING (MANUAL TUNING)	83
5. MOTIONMAESTRO®	84
5.1 IMPORTANT INFORMATION BEFORE STARTING	84
5.2 INSTALLING MOTIONMAESTRO	84
5.3 CONVENTIONS USED IN THIS MANUAL	85
5.4 MOTIONMAESTRO OVERVIEW	86
5.4.1 Main Menu and Toolbar	86
5.5 COMMUNICATIONS	89
5.6 MOTOR PARAMETERS	91
5.7 MOTOR SAFETY	92
5.8 COMMUTATION	94
5.9 COMMUTATION CONFIG TAB	96
5.9.1 Initialization Method (Visible for all motor and feedback types)	96
5.9.2 Selection of a Commutation Initialization Method	97
5.9.3 Brushless Configuration	97
5.9.4 Phase Lead	97
5.9.5 Correction Method	98
5.9.6 Smart Commutation	98
5.9.7 Simulated Hall	99
5.9.8 Auto-Phase	99
5.10 DRIVE MODE	100
5.11 FEEDBACK CONFIG TAB	101
5.11.1 Encoder Data	101
5.11.2 Sin/Cos Interpolation	101
5.11.3 Analog Motor Feedback Calibration	102
5.11.4 Tachometer Data	102
5.12 SETUP DIGITAL INPUTS	103
5.13 SETUP DIGITAL OUTPUTS	104
5.14 FILTERS	106
5.15 PROFILE GENERATOR	108
5.16 OSCILLOSCOPE	112
5.16.1 Adding Scope Channels	113
5.16.2 Oscilloscope Channels Settings	114
5.16.3 Channel List	115
5.16.4 Channel Source Section	116
6. REFERENCE INFORMATION	117
6.1 ON BOARD STATUS DISPLAY	118
6.2 MATCHING BRUSHLESS MOTOR PHASE LEADS TO MOTOR FEEDBACK	119
6.2.1 Verify Motor Phasing and Alignment	120
6.2.2 Adjusting Alignment	123
6.2.3 Manual Phasing Procedure	124
6.2.4 Auto Phasing Procedure	128
6.3 DETERMINING ENCODER SPECS AND NUMBER OF MOTOR POLES	131
6.3.1 Encoder Resolution	131
6.3.2 Encoder Reverse	131
6.3.3 Encoder Outputs	131
6.3.4 Number of Poles (Note: Requires Hall sensors)	132

6.4 REPLACEMENT FOR ALPHA SERIES DRIVES.....	133
6.5 DRIVE TERMS AND TECHNOLOGY	134
6.5.1 Terms	134
6.5.2 Technology.....	136
6.6 CONTROL BLOCK DIAGRAMS	138
6.6.1 Position Mode Control Diagram	139
6.6.2 Command Input Control Diagram	140
6.6.3 Velocity Control Loop Diagram	141
6.6.4 Current Control Loop Diagram	142
6.7 DIMENSIONS.....	143
6.7.1 (Non-UL) SMB/SMC9G16-1A/1B Standalone Short Fin.....	144
6.7.2 (UL) SMB/SMC9G16-1A/1B Standalone Short Fin	145
6.7.3 (Non-UL) SMB/SMC9G16 Standalone Long Fin	146
6.7.4 (UL) SMB/SMC9G16 Standalone Long Fin	147
6.7.5 (Non-UL) SMB/SMC9G16-1 Module L-Bracket	148
6.7.6 (UL) SMB/SMC9G16-1 Module L-Bracket.....	149
6.7.7 (Non-UL) SMB/SMC9G16-1 Module Short Fin.....	150
6.7.8 (UL) SMB/SMC9G16-1 Module Short Fin.....	151
6.7.9 (Non-UL) SMB/SMC9G16-1 Module Long Fin	152
6.7.10 (UL) SMB/SMC9G16-1 Module Long Fin	153
6.7.11 (Non-UL) SMB/SMC9G16 2-Axis Package: L-Bracket or Short Fin Modules	154
6.7.12 (UL) SMB/SMC9G16 2-Axis Package: L-Bracket or Short Fin Modules	155
6.7.13 (Non-UL) SMB/SMC9G16 2-Axis Package: Long Fin Fin Modules.....	156
6.7.14 (UL) SMB/SMC9G16 2-Axis Package: Long Fin Modules.....	157
6.7.15 (Non-UL) SMB/SMC9G16 4-Axis Package: L-Bracket or Short Fin Modules	158
6.7.16 (UL) SMB/SMC9G16 4-Axis Package: L-Bracket or Short Fin Modules	159
6.7.17 (Non-UL) SMB/SMC9G16 5-Axis Package: L-Bracket or Short Fin Modules	160
6.7.18 (UL) SMB/SMC9G16 5-Axis Package: L-Bracket or Short Fin Modules	161
6.8 FACTORY REPAIR, MAINTENANCE AND WARRANTY.....	162
6.8.1 Factory Repair.....	162
6.8.2 Maintenance.....	162
6.8.3 Warranty.....	163
6.9 UL REGISTERED COMPONENT.....	164
6.9.1 Standards	164
6.9.2 File Number	164
6.9.3 Conditions of Acceptability	164
6.10 EUROPEAN UNION EMC DIRECTIVES.....	166
6.10.1 Electromagnetic Compatibility Guidelines For Machine Design	166
6.10.2 Filtering	167
6.10.3 AC Line Filter Selection.....	167
6.10.4 Grounding	169
6.10.5 Shielding and Segregation.....	170
6.10.6 European Union Declaration of Incorporation Motion Control Systems	172

Tables

Table 2-1 – Product Features	10
Table 2-2 – Environmental Conditions	15
Table 2-3 – Electrical Ratings	17
Table 2-4 – Stand Alone Dimensions	19
Table 2-5 – Module Dimensions	20
Table 2-6 – Multi-Axis Dimensions	20
Table 3-1 – Controller I/O Configuration	25
Table 3-2 – Optically Isolated Input Specs	26
Table 3-3 – Schmitt Trigger Input Specs	27
Table 3-4 – Differential Digital Input Specs	28
Table 3-5 – MOSFET Output Specs	31
Table 3-6 – Optically Isolated Output Specs	32
Table 3-7 – Relay Output Specs	33
Table 3-8 – Analog Input Specs	34
Table 3-9 – Analog Output Specs	36
Table 3-10 – Analog Output Function List	37
Table 3-11 – Programmable Digital Input Functions	39
Table 3-12 – Programmable Digital Output Functions (Faults)	40
Table 3-13 – Programmable Digital Output Functions (Status)	41
Table 3-14 – Brake/STO Connector Pin Function	43
Table 3-15 – Logic Power Specs	43
Table 3-16 – Brake Output Specs	44
Table 3-17 – STO Inputs	45
Table 3-18 – RJ45 Mating Connector	46
Table 3-19 – RJ45 (RS-232 Communication Designations)	46
Table 3-20 – Serial Speed over Distance	48
Table 3-21 – RJ45 (CANopen) Communication Designations	48
Table 3-22 – Motor Feedback Designations: TTL Encoder/Hall Communication	50
Table 3-23 – Motor Feedback Specs	51
Table 3-24 – Digital Hall Sensor Specs	51
Table 3-25 – Tachometer Sensor Specs	53
Table 3-26 – Motor Feedback Designations: Resolver	54
Table 3-27 – Motor Feedback Designations: Sin/Cos & Absolute Encoder	55
Table 3-28 – UL and Non-UL Stand Alone Motor Output Designations – 3 Pin	56
Table 3-29 – UL and Non-UL Stand Alone AC Power Input Designation – 4 Pin	57
Table 3-30 – UL and Non-UL Module DC Power Input and Motor Output Designation – 5 Pin	59
Table 5-1 – MotionMaestro Menu Options	87
Table 5-2 – Motor Parameter Field Information	91
Table 5-3 – Motor Safety	93
Table 5-4 – Commutation Initialization Methods	96
Table 5-5 – Filter Parameters	107
Table 5-6 Control Type/Mode	109
Table 5-7 – Actions	109
Table 5-8 – Action Triggers	110
Table 5-9 – Truth Table for Profile Address Selector (PAS) Pins	111
Table 6-1 – Status Display Codes	118

Figures

Figure 3-1 44-Pin I/O connector.....	24
Figure 3-2 Optically Isolated Programmable Digital Input.....	26
Figure 3-3 Schmitt Trigger Digital Input	27
Figure 3-4 Differential Digital Input	28
Figure 3-5 Differential Digital Input Single Ended	29
Figure 3-6 Motor Over Temperature Input	30
Figure 3-7 MOSFET output.....	31
Figure 3-8 Optically Isolated Programmable Digital Output.....	32
Figure 3-9 Relay Output.....	33
Figure 3-10 Differential Analog Input	34
Figure 3-11 Single Ended Analog Input	35
Figure 3-12 Analog Outputs.....	36
Figure 3-13 Encoder Outputs.....	38
Figure 3-14 Logic Power/Brake Connector (Standard).....	42
Figure 3-15 Logic Power/Brake/STO Connector (Optional).....	42
Figure 3-16 Brake/Stop Sequence Internal Circuit	44
Figure 3-17 STO Input Circuit	45
Figure 3-18 RJ45 Mating Connector	46
Figure 3-19 RS-232 Chip Information	47
Figure 3-20 RJ45 Double Mating Connector	49
Figure 3-21 CANopen Connection Diagram	49
Figure 3-22 Motor Feedback Connector	50
Figure 3-23 Digital Hall Circuit (Differential).....	51
Figure 3-24 Digital Hall Circuit (Single Ended)	52
Figure 3-25 Tachometer Circuit	53
Figure 3-26 Resolver Circuit	54
Figure 3-27 Sin/Cos Encoder Circuit	55
Figure 3-28 UL Stand Alone Motor Output Connector.....	56
Figure 3-29 Non-UL Stand Alone Motor Output Connector	56
Figure 3-30 UL and Non-UL Stand Alone Motor Output Brushless	57
Figure 3-31 UL and Non-UL Stand Alone Motor Output Brush Type.....	57
Figure 3-32 UL Stand Alone AC Power Input Connector.....	58
Figure 3-33 Non-UL Stand Alone AC Power Input Connector.....	58
Figure 3-34 UL and Non-UL Stand Alone AC Power Input.....	59
Figure 3-35 UL Module DC Power Input and Motor Output Connector	59
Figure 3-36 Non-UL Module DC Power Input and Motor Output Connector.....	60
Figure 3-37 UL and Non-UL Module DC Power Input and Motor Output.....	60
Figure 4-1 Oscilloscope Waveforms	69
Figure 4-2 Brake/Stop Sequence If Zero Speed Window is Reached	72
Figure 4-3 Brake/Stop Sequence If Maximum Deceleration Time is Reached	72
Figure 6-1 Glentek Standard Commutated Encoder Signals.....	131
Figure 6-2 EMI Source-Victim Model	166
Figure 6-3 Single Point Ground Types.....	169

1. Overview

This manual guides you through the steps necessary for the installation of Gamma Series Digital PWM Servo Drives.

In this manual, all the features of the Gamma Series are explained. Also, it covers the procedures for installation and tuning. The following sections are presented in an order that will make installation easy for first time users of Gamma Series Drives.

The *Product Description* and *Features* sections provide you with the necessary information for system integration of Gamma Series Drives.

You are then guided through a step by step procedure for the setup and tuning of a digital servo system.

Next, Glentek's MotionMaestro software is introduced. Enough material is given here to familiarize you with the software tools to setup, install, and run a motor using a Gamma Series Drives. For additional information, refer to the MotionMaestro Software Guide at www.glentek.com. As always, Glentek application engineers are available to help you with your specific application goals. If you have any questions at all, please contact us and we will help in any way we can.

Again, thank you and we look forward to providing you with a product that will make your system perform at its very best.

2. Product Description

The Gamma Series is Glentek's latest offering of higher performance multi-core DSP control of brushless (standard servo and high-speed spindle), brush type, rotary, linear, voice coil, and AC induction motors. This drive offers expanded command and control modes including CANopen and indexing/point-to-point. Gamma Series Drives also accept feedback from a wider range of devices and protocols, namely absolute serial encoders (BiSS, EnDat and SSI) and analog Sin/Cos encoders. Additional programmable I/O includes 5 optically isolated inputs, 6 Schmitt triggers, 2 differential inputs, 3 MOSFETS outputs, 2 optically isolated programmable outputs, and a general-purpose relay. AC powered (stand alone and multi-axis) and DC powered (module) packages are available. These drives incorporate Field Oriented Control (FOC) and Space Vector Modulation (SVM) algorithms, which provide optimum control that enable motors to run cooler and at higher velocities. Set-up, tuning, and system diagnostics are accomplished using MotionMaestro (Glentek's Windows-based software).

Glentek can customize a serial port digital interface to adapt to your controller as required to meet your protocols, such as Ethernet, CAN, RS485, etc.

The following table is a list of general specifications.

Table 2-1 – Product Features

Command/Control Modes	
+/-10 VDC for current (torque) or velocity (RPM)	
Pulse (step) and direction	
Encoder follower	
CW/CCW (up/down mode)	
External sine commutation (2-phase current mode)	
RS-232 & RS-485	
PWM for current (torque) or velocity (RPM) in 50% duty cycle format (one-wire) or 100% duty cycle format (two-wire)	
Indexer/Point-to-Point	
Camming/Gearing	
CANopen	
Ethernet	
Feedback	
Incremental quadrature encoder	
Digital Hall sensors or commutation tracks from encoder	
Absolute serial encoder (Biss, EnDat and SSI)	
Analog Sin/Cos encoder	
Resolver	
Analog tachometer	
I/O	
Dedicated Digital I/O	Inputs: 2 STO optically isolated Outputs: STO optically isolated indicator, brake (max 2 A @ 24 VDC)
Programmable Digital I/O	Inputs: 5 optically isolated, 6 Schmitt trigger, 2 differential Outputs: 3 MOSFETS (max 1.5 A, 24 VDC), 2 optically isolated (max 10 mA, 24 VDC), relay (max 2 A, 30 VDC)
Analog I/O	Inputs: 2 differential (16-bit A/D) Outputs: 2 Single Ended, Programmable (12-bit A/D)
Safety Disable	
Safe Torque Off (STO) in accordance with IEC61800-5-2	

2.1 Features

2.1.1 Performance

Field Oriented Control:	All Gamma Series Drives employ a Field Oriented Control (FOC) method, which allows accurate control in both steady state or transient operation and optimal orientation of the magnetic field in a motor.
Space Vector Modulation:	Glentek's advanced algorithms allow for maximum utilization of the DC BUS voltage while generating minimum harmonic distortion of the currents in the winding of 3-phase AC motor.
Digital Current Loops:	The current loop bandwidths are programmable up to 5 KHz.
Digitally Tuned:	All parameters are set digitally. There are no potentiometers to adjust. DSP control for the ultimate in high performance.
Parametric Filtering:	All Gamma Series Drive provide control engineers advanced filtering to eliminate un-wanted system mechanical resonance.
Smart-Comm Initialization:	The use of Smart-Comm initialization, which is one of the initialization options, eliminates the need for Hall sensors or commutation tracks for many applications.
Auto Phase Finding:	The Gamma Series Drives provide a Plug and Play ability for all types of three phase brushless motors. They also provide control engineers the ability to connect any motor leads to any drive motor outputs. The drive's smart algorithm will automatically find and align the motor phases to allow for optimized smoothness and efficient commutation.
Auto Phase Advance:	The advanced algorithms incorporated into the Gamma Series Drives automatically provide phase advance, ensuring that the current is delivered at the appropriate time. It also provides the most efficient operation.
Sinusoidal Commutation:	Sinusoidal commutation provides the ultimate in efficiency and smoothness of motion. Gamma Series Drives can commute from almost any resolution, linear or rotary encoder, or Hall sensors.
Fault Protection:	For fault protection, Gamma Series Drives detects shorts from output to output, shorts from output to ground, drive RMS over current, drive under/over voltage, drive over temperature, and motor over temperature.
On-the-Fly Mode Switching:	This feature allows the drive to switch between any operating mode on the fly. That is, the drive can switch modes from current to velocity (or velocity to current), current to position (or position to current), and velocity to position (or position to velocity) while the drive is engaged and the motor is in motion. This feature is available upon request. Please contact Glentek application engineers for assistance.
Software Configurable:	Glentek's Windows based MotionMaestro software provides ease of set-up, monitoring, and tuning with no previous programming experience required. This software is compatible with Windows XP, Vista, and 7/8/10.
Silent Operation:	The Gamma Series Drives operates at a 25 KHz PWM standard.

Command/Control Modes: The control modes are +/-10 VDC for current (torque) or velocity (RPM), pulse (step) and direction, encoder follower, and external sine commutation (2-phase current mode). The command modes are RS-232, RS-485, Ethernet, PWM for current (torque) or velocity (RPM), camming/gearing, Indexer/Point-to-Point, and CANopen.

2.1.2 Regulatory

CE compliant:	All drives are CE marked
RoHS compliant:	All drives are RoHS compliant
UL Recognized Component:	US and Canada (optional)
Safe Torque Off (STO):	The Gamma Series can provide two optically isolated inputs to directly control the gate drivers without involving control software. Implemented in accordance with EC61800-5-2.

Note: The STO feature is available upon request only.

2.1.3 Connectivity

CANopen:	The Gamma drives can maintain high speed (up to 1 Mb/s) serial communication interface for communications between nodes in real-time control applications. The drive device profile is based on IEC61800-7-201/301 (CiA 402).
RS-232 or RS-485:	The Gamma drive also provides the ability of high speed (115.2K baud) serial communication interface for setup and tuning.

2.1.4 Feedback

Encoder Feedback:	The Gamma Series accepts feedback from quadrature encoders (up to 5 MHz signal frequency is standard, maximum frequency of up to 10 MHz is possible, but is system dependent), feedback from absolute serial encoders (Bliss, EnDat, and SSI), and feedback from analog Sin/Cos encoders.
Encoder Output Divider:	The encoder input signal can be divided by a user selectable integer 1-8 for the encoder output signal.

Note: The encoder output divider ability is available upon request only.

Tachometer Feedback:	The Gamma Series accepts analog signals from all types of tachometer feedback.
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2.1.5 I/O

Programmable Functions:	All Gamma Series drives are equipped with an I/O port to command or view the following functions: analog signal command, +/- limits, inhibit/enable, fault, reset, motor temperature, encoder, step, and direction.
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2.1.6 Input

Wide Operating Voltage:	Most Gamma Series drive modules can operate at 24-710 VDC. All stand-alone and multi axis versions can be ordered for operation from either 110-130 VAC, 208-240 VAC, 360-400 VAC, and 460-500 VAC main lines (single or 3-phase, 50/60 Hz).
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Note: Non-standard voltages can be ordered on request.

Direct AC Operation:	The stand-alone units and multi-axis chassis include DC BUS power supplies, cooling fans, and a regen clamp with a dumping resistor.
External Logic Supply:	Some Gamma drives come equipped with an external logic supply of 24 – 48 VDC, 600 mA min @ 24 VDC to power all drive logic and encoder logic. This works as a “keep alive” for the SMC9G16 drives.

2.1.7 Build

Complete Isolation:	The Gamma drives provide complete optical isolation between the signal and power stage.
Non-Volatile Memory:	All parameters are stored in non-volatile memory for reliable start up. In addition, up to two different configurations can be stored in the drive’s non-volatile memory.
Relay Outputs:	Two programmable pins provide an interface for the relay. They turn on when a desired condition occurs. Note: Relay outputs are available upon request only.
Status indicator:	The 7-segment display indicates drive status and diagnostics.
SMT construction:	Glentek provides ultra-compact size, cost competitive packaging, and high reliability.

2.2 Environmental Conditions

Table 2-2 – Environmental Conditions

Storage Temperature	-40°C to 80°C
Operating Temperature	Refer to the Electrical Ratings Table (see pg. 17)
Humidity Range	5 – 95% relative humidity, non-condensing.
Altitude	Up to 1000m without derating, derate current 10% per 1000m above 1000m
Atmospheric Pollutants	Operate within pollution degree 2.
Ventilation	Clearance of 75mm (minimum) above the drive for proper ventilation. Ensure the drive's air vents are not obstructed.

Warnings:

Shock: Do not expose the drive to sudden shock (dropping, shaking, etc...). Do not install the drive in an area prone to constant vibration.

Water: Keep the drive away from all water hazards, including pipes that may accumulate condensation and areas that can become excessively humid.

2.3 SMx9G16 Ratings, Specifications and Numbering

This section explains the model numbering system for Glentek's Gamma Series Digital PWM Servo Drives. The model numbering system is designed so that you, our customer, will be able to quickly and accurately create the model number for the drive that best suits your needs. This manual contains complete model numbering information for the following drive types:

SMB/SMC 9G16

To accurately select a complete part number, please follow the steps below:

1. Select the drive type which meets your power requirements (i.e. SMB9G16, SMC9G16), and then select a model that meets your input voltage and output current requirements from the Electrical Ratings table (see [p. 17](#)).
2. Select the industry standard mounting configuration which meets your needs (i.e. Module, Stand Alone, or Multi-Axis).
3. Utilize the model number key in conjunction with the tables at the beginning of each section to select the complete model number for your requirements.

Note: A complete model number example follows the model number key and includes a full description of the individual codes which make up the complete model number.

The difference between SMB9G16 and SMC9G16

1. SMB9G16 uses BUS input to power the logic board.
 - Advantage: Only requires one input power source to operate the drive.
 - Disadvantage: In case of input power failure, the drive will shut down completely.
 - Bus power logic is not available for input voltages of 370-565 VDC (Module) / 360-400 VAC (Stand Alone and Multi-Axis) or greater.
2. SMC9G16 requires external 24 VDC "Keep Alive" input to power the logic board.
 - Advantage: The logic board power will stay alive due to the external 24 VDC source even if the BUS input shuts down.
 - Disadvantage: The drive needs two separate input power sources (external 24 VDC & BUS input) to operate.

Table 2-3 – Electrical Ratings

Input Voltage			Output Current ⁽¹⁾			Heatsink Type ⁽²⁾		Available Package Configurations			UL ⁽⁴⁾
VDC	VAC	Model Code ⁽³⁾	Cont. A (A _{RMS})	Peak A (A _{RMS})	Model Code ⁽³⁾	Module	Stand Alone	Module	Stand Alone	Multi-Axis	
24-60	N/A	0	5 (3.5)	10 (7.1)	1	L-Bracket ¹	N/A	•			•
24-60	N/A	0	10 (7.1)	20 (14.1)	3	L-Bracket ¹	N/A	•			•
24-60	N/A	0	15 (10.6)	30 (21.2)	4	L-Bracket ¹	N/A	•			•
24-60	N/A	0	20 (14.1)	40 (28.3)	5	Short Fin ¹	N/A	•			•
24-60	N/A	0	25 (17.7)	50 (35.4)	6	Short Fin ¹	N/A	•			•
24-60	N/A	0	30 (21.2)	60 (42.4)	7	Short Fin ¹	N/A	•			•
24-60	N/A	0	45 (31.8)	80 (56.6)	8	Short Fin ²	N/A	•			•
60-190	110-130	1	5 (3.5)	10 (7.1)	1	L-Bracket ¹	Short Fin ¹	•	•	•	•
60-190	110-130	1	10 (7.1)	20 (14.1)	3	L-Bracket ¹	Short Fin ¹	•	•	•	•
60-190	110-130	1	15 (10.6)	30 (21.2)	4	L-Bracket ²	Short Fin ¹	•	•	•	•
60-190	110-130	1	20 (14.1)	40 (28.3)	5	Short Fin ¹	Short Fin ¹	•	•	•	•
60-190	110-130	1	25 (17.7)	50 (35.4)	6	Short Fin ²	Short Fin ²	•	•	•	•
60-190	110-130	1	30 (21.2)	60 (42.4)	7	Long Fin ¹	Long Fin ¹	•	•	•	•
60-190	110-130	1	45 (31.8)	80 (56.6)	8	Long Fin ²	Long Fin ²	•	•	•	•
190-370	208-240	2	5 (3.5)	10 (7.1)	1	L-Bracket ¹	Short Fin ¹	•	•	•	•
190-370	208-240	2	10 (7.1)	20 (14.1)	3	L-Bracket ²	Short Fin ¹	•	•	•	•
190-370	208-240	2	15 (10.6)	30 (21.2)	4	L-Bracket ³	Short Fin ²	•	•	•	•
190-370	208-240	2	20 (14.1)	40 (28.3)	5	Short Fin ²	Short Fin ²	•	•	•	•
190-370	208-240	2	25 (17.7)	50 (35.4)	6	Short Fin ³	Short Fin ³	•	•	•	•
190-370	208-240	2	30 (21.2)	60 (42.4)	7	Long Fin ²	Long Fin ²	•	•	•	•
190-370	208-240	2	45 (31.8)	80 (56.6)	8	Long Fin ³	Long Fin ³	•	•	•	•
370-565	360-400	3	5 (3.5)	10 (7.1)	1	L-Bracket ²	Short Fin ¹	•	•	•	•
370-565	360-400	3	10 (7.1)	20 (14.1)	3	Short Fin ²	Short Fin ²	•	•	•	•
370-565	360-400	3	15 (10.6)	30 (21.2)	4	Short Fin ³	Short Fin ³	•	•	•	•
370-565	360-400	3	20 (14.1)	40 (28.3)	5	Long Fin ²	Long Fin ²	•	•	•	•
370-565	360-400	3	25 (17.7)	50 (35.4)	6	Long Fin ³	Long Fin ³	•	•	•	•
370-565	360-400	3	30 (21.2)	60 (42.4)	7	Long Fin ⁴	Long Fin ⁴	•	•	•	•
565-710	460-500	4	5 (3.5)	10 (7.1)	1	L-Bracket ³	Short Fin ²	•	•	•	•
565-710	460-500	4	10 (7.1)	20 (14.1)	3	Short Fin ³	Short Fin ³	•	•	•	•
565-710	460-500	4	15 (10.6)	30 (21.2)	4	Long Fin ³	Long Fin ³	•	•	•	•
565-710	460-500	4	20 (14.1)	40 (28.3)	5	Long Fin ⁴	Long Fin ⁴	•	•	•	•

Notes:

- (1) The column Cont. Output Current is the continuous current and the column Peak Output Current is the intermittent peak current. For output current ratings in brushless mode, ratings for each model are listed as peak of the sine wave phase current values followed by the equivalent RMS phase current values (in parentheses). In brush or voicecoil mode, A is the current, and the RMS values (in parentheses) can be ignored. All output current ratings are for three-phase VAC inputs or VDC inputs. If a single-phase VAC input is used, the total output current for all axes is limited to a maximum of 15 A cont. / 30 A peak.
- (2) Three heatsink types (L-Bracket, Short Fin, and Long Fin) are available depending on the input voltage and output current. For dimensions see [pg 19](#). There are 4 standard categories for ambient operating temperature and current derating denoted by the number following the heatsink type. All categories require forced air cooling.

Category 1: 0 to 60 °C without derating. Derate current 10% per °C over 60 °C.

Category 2: 0 to 50 °C without derating. Derate current 5% per °C over 50 °C.

Category 3: 0 to 40 °C without derating. Derate current 3% per °C over 40 °C.

Category 4: 0 to 30 °C without derating. Derate current 2.5% per °C over 30 °C.

Special: Contact Glentek for models with a lower operating temperature limit of -40 °C.

- (3) Model Codes are used on [pg. 21](#) for model numbering
- (4) Models that are UL Registered Components are available as an option for the selected drives.
- (5) Bus power logic (SMB models) not available for input voltages of greater than 370 VDC (Module) or 360 VAC (Stand Alone and Multi-Axis).

2.4 Package Configurations and Dimensions

Stand Alone

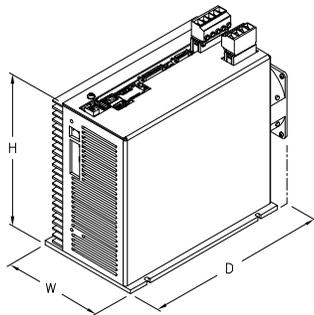
This package consists of a drive, DC bus power supply, optional regen clamp with dumping resistor, in-rush current limiting protection at power-on, and one or more cooling fans. This type of package is typically used for one or multi-axis applications. Models with regen option code 1A feature a built in regen clamp, while models with a code of 1B do not.

Stand Alone models come in one of two sizes, based upon the input voltage and the output current. They are short fin heatsink and long fin heatsink. Refer to section [6.7 Dimensions](#) for more detailed dimensions.

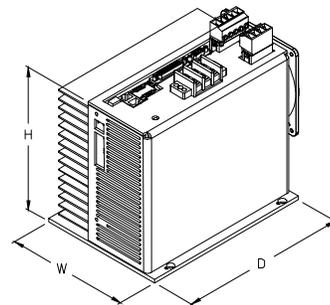
Table 2-4 – Stand Alone Dimensions

Heatsink Type	Dimensions, Inches (mm)			Weight lbs. (kg)	Fan
	Width	Height	Depth		
Short Fin	5.2 (132)	8.2 (208)	10.9 (276)	9.0 (4.1)	Yes
Long Fin	6.6 (168)	8.2 (208)	10.9 (276)	9.5 (4.3)	Yes

Short Fin Stand Alone



Long Fin Stand Alone



Module

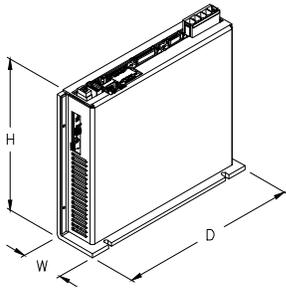
This package consists of a drive module, without a DC bus power supply. This type of package is typically used for cost sensitive applications where the customer provides DC bus power supply, forced-air cooling, and regen clamp.

Modules come in one of three sizes, based upon the input voltage and the output current. They are L-bracket heatsink, short fin heatsink, and long fin heatsink. Refer to section [6.7 Dimensions](#) for more detailed dimensions.

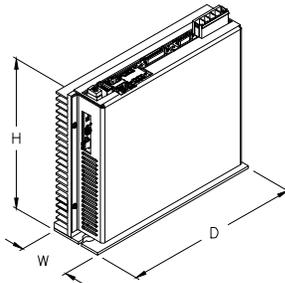
Table 2-5 – Module Dimensions

Heatsink Type	Dimensions, Inches (mm)			Weight lbs. (kg)
	Width	Height	Depth	
L-Bracket	2.0 (51)	7.6 (193)	8.8 (224)	2.6 (1.2)
Short Fin	2.5 (64)	7.6 (193)	8.8 (224)	4.0 (1.8)
Long Fin	3.8 (95)	7.6 (193)	8.8 (224)	4.5 (2.0)

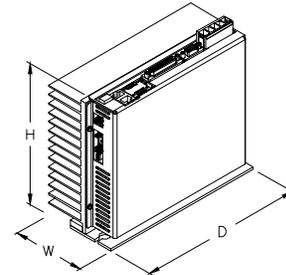
L-Bracket Module



Short Fin Module



Long Fin Module



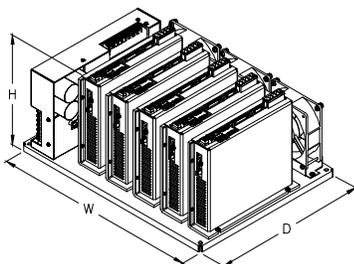
Multi-Axis

This package consists of an open frame base plate chassis with DC bus power supply, optional regen clamp with dumping resistor, in-rush current limiting protection at power-on, fuses, and cooling fans. Available in a 2, 4, and 5 axis package. Refer to section [6.7 Dimensions](#) for more detailed dimensions.

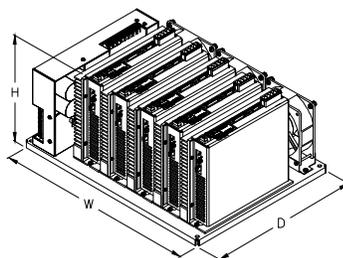
Table 2-6 – Multi-Axis Dimensions

Axes	Heatsink Type	Dimensions, Inches (mm)			Weight lbs. (kg)
		Width	Height	Depth	
2	L-Bracket	9.8 (248)	8.1 (205)	11.8 (298)	13.0 (5.9)
2	Small Fin	9.8 (248)	8.1 (205)	11.8 (298)	16.0 (7.3)
2	Long Fin	14.9 (378)	8.1 (205)	11.8 (298)	18.5 (8.4)
4	L-Bracket	14.9 (378)	8.1 (205)	11.8 (298)	20.0 (9.1)
4	Small Fin	14.9 (378)	8.1 (205)	11.8 (298)	24.0 (10.9)
5	L-Bracket	18.8 (476)	8.1 (205)	11.8 (298)	23.0 (10.4)
5	Small Fin	18.8 (476)	8.1 (205)	11.8 (298)	30.0 (13.6)

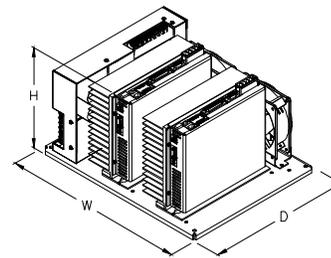
L-Bracket Multi-Axis



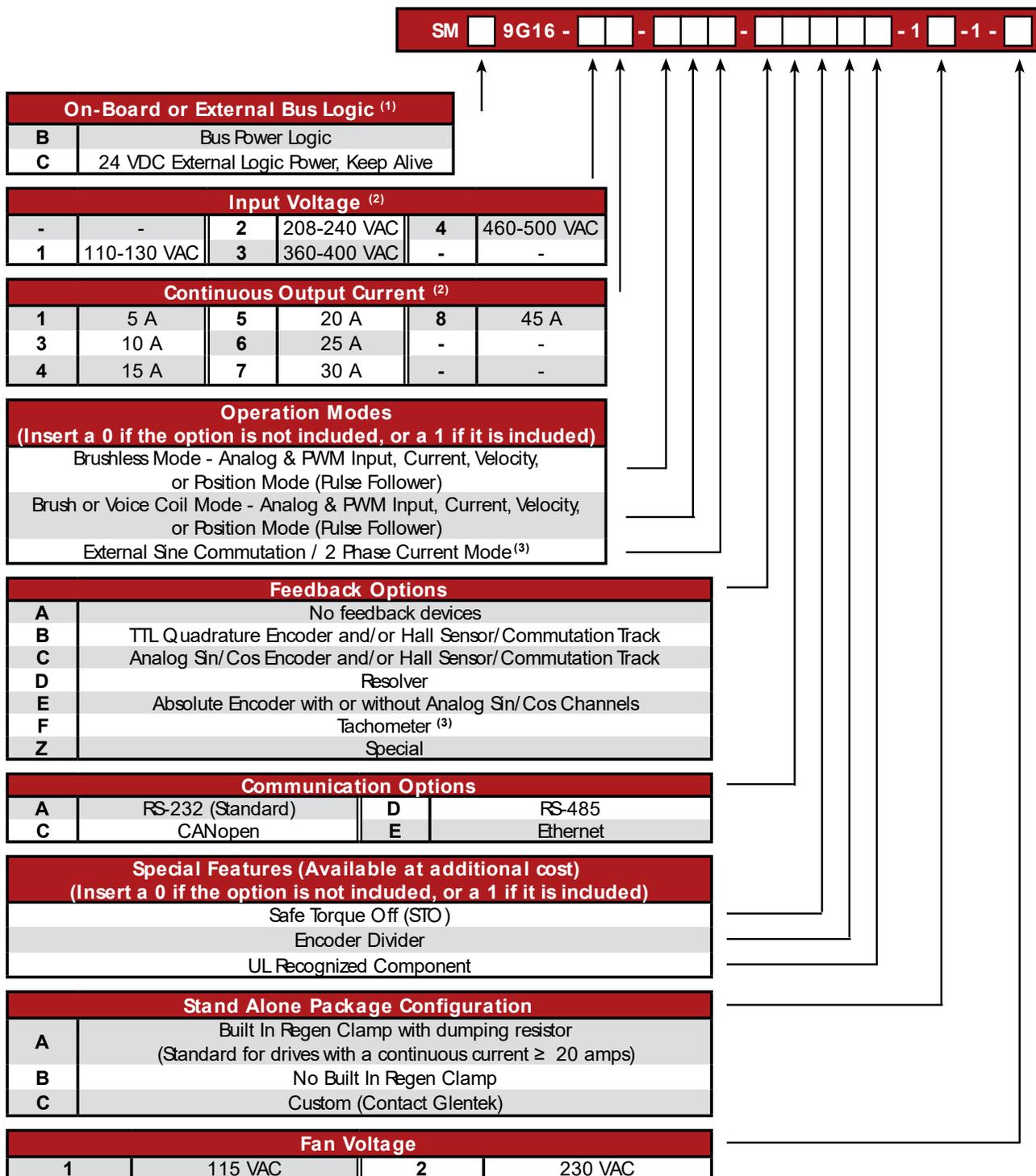
Short Fin Multi-Axis



Long Fin Multi-Axis



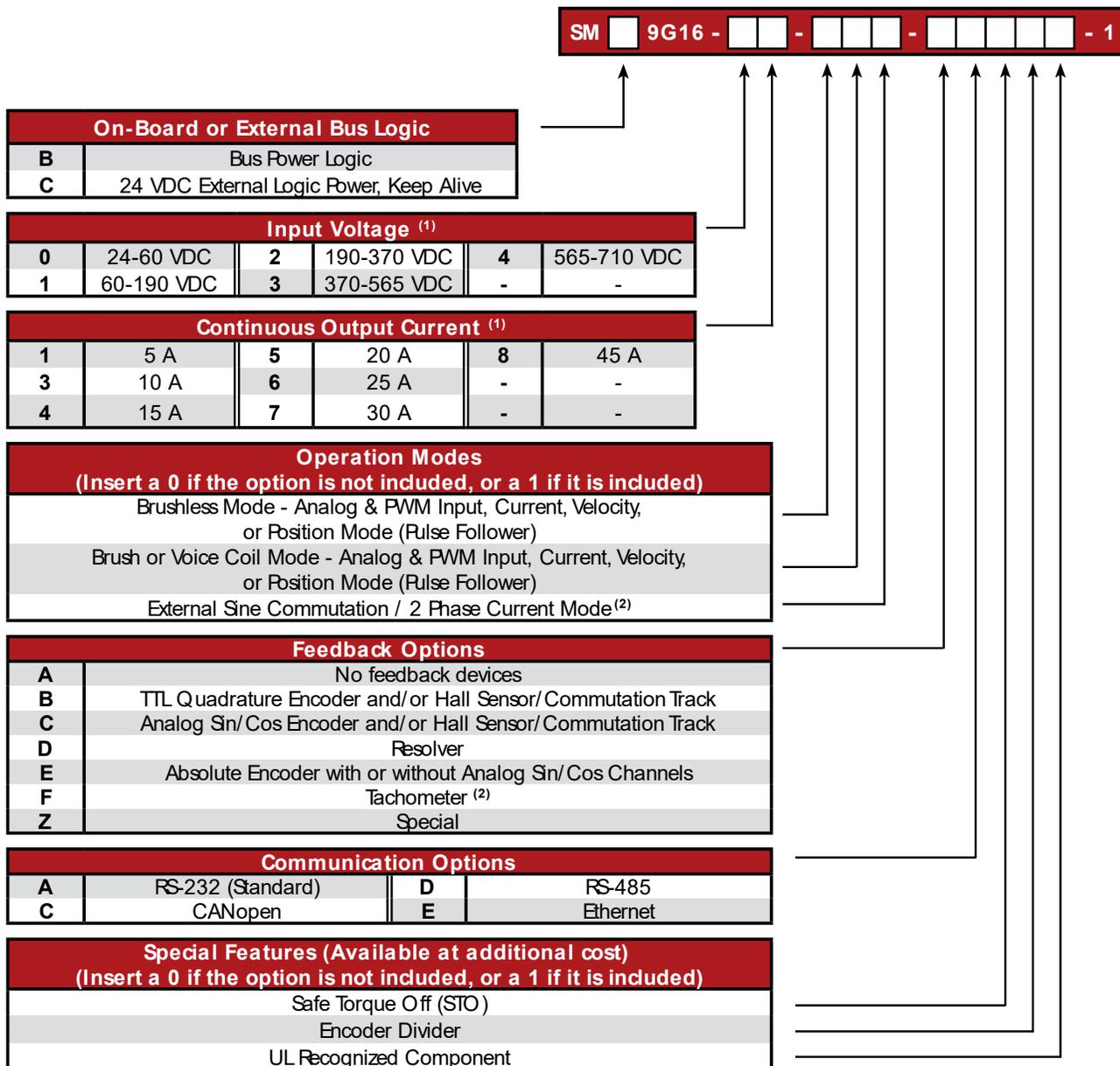
2.5 SMx9G16 Stand Alone Model Numbering



Notes:

- (1) Bus power logic (SMB models) not available for input voltages greater than 360 VAC.
- (2) Refer to the [Table 2-3 – Electrical Ratings](#) for available combinations of input voltage and output current.
- (3) External sine commutation and tachometer may not both be selected.

2.6 SMx9G16 Module Model Numbering



Notes (For Module and Multi-Axis):

(1) Bus power logic (SMB models) not available for input voltages greater than 370 VDC (Module) or 360 VAC (Multi-Axis).

(2) Refer to [Table 2-3 – Electrical Ratings](#) for available combinations of input voltage and output current.

(3) External sine commutation and tachometer may not both be selected.

3. Drive Interface and Wiring

This section describes the drive connections and pin specific functions. Refer to the drive's installation drawings in the Appendix to locate the connectors on the drives.

[Table 3-1](#) describes each pin of the I/O connector, whether they are programmable or dedicated, input or output, optical, differential, MOSFET, encoder, etc.

The connector pin numbering and assignment shown are per Glentek designation. It may be different than the pin numbering from the manufacturer of the connector being used.

3.1 Controller I/O

The 44-pin I/O connector allows you to connect additional hardware to the drive. The table on the next page highlights the function and type of each pin and whether the pin is dedicated for a specific purpose or is programmable. Each type of programmable pin has certain functions which can be assigned. These functions are listed within this chapter as well.

For the I/O mating connector, the recommended wire size is 28 AWG, but the crimp pins can accommodate wire sizes from 22 to 28 AWG.

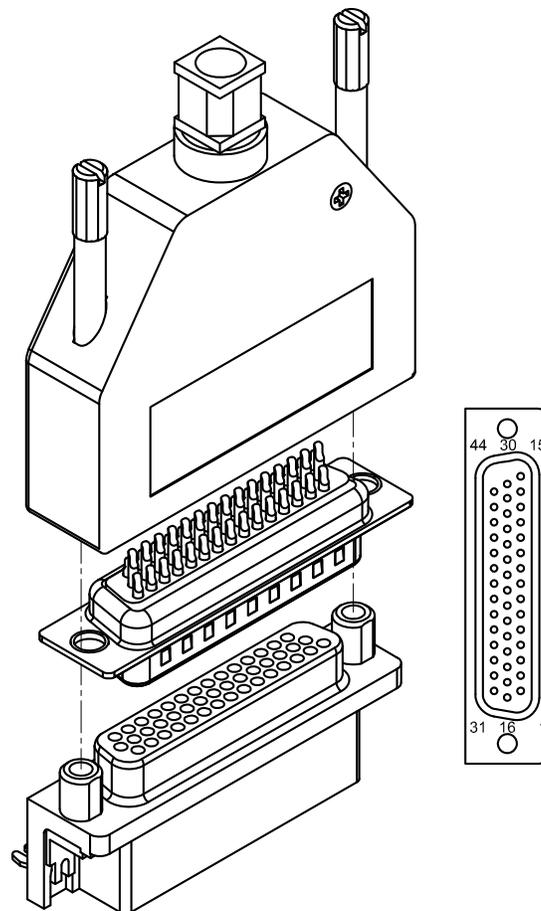


Figure 3-1 44-Pin I/O connector

Table 3-1 – Controller I/O Configuration

Pin #	Pin Name	Pin Function	Ded./PGM	Pin Type	Group #'s
1	Signal 1-	Analog Command Signal 1-	Ded.	Input	N/A
2	Signal 1+	Analog Command Signal 1+	Ded.	Input	N/A
3	Signal 2-	Analog Command Signal 2-	Ded.	Input	N/A
4	Signal 2+	Analog Command Signal 2+	Ded.	Input	N/A
5	Analog Out 1	Analog Output 1	PGM	Output	N/A
6	MOSFET Out 2	MOSFET Output 2	PGM	Output	1,2
7	Schmitt In 2	Schmitt Trigger Input 2	PGM	Input	1,2
8	Schmitt In 4	Schmitt Trigger Input 4	PGM	Input	1,2,3
9	MOSFET Out 1	MOSFET Output 1	PGM	Output	1,2
10*	+5 V	+5 Volt Output	Ded.	Output	N/A
11	Common Digital	Common (Digital)	Ded.	Common	N/A
12	Differential In 2-	Differential Input 2-	PGM	Input	1,2,3
13	Differential In 2+	Differential Input 2+	PGM	Input	1,2,3
14	Enc A Out-	Encoder Output A-	Ded.	Output	3
15	Enc A Out+	Encoder Output A+	Ded.	Output	3
16	Reserved	Reserved	Ded.	Reserved	N/A
17	MOSFET Out 3	MOSFET Output 3	PGM	Output	1,2
18	Common Analog	Common (Analog)	Ded.	Common	N/A
19	Analog Out 2	Analog Output 2	PGM	Output	N/A
20	Motor Temp	Motor Temperature Sensor	Ded.	Input	3
21	Schmitt In 6	Schmitt Trigger Input 6	PGM	Input	1,2,3
22	Schmitt In 3	Schmitt Trigger Input 3	PGM	Input	1,2
23	Schmitt In 5	Schmitt Trigger Input 5	PGM	Input	1,2,3
24	Schmitt In 1	Schmitt Trigger Input 1	PGM	Input	1,2
25*	+5 V	+5 Volt Output	Ded.	Output	N/A
26	Common Digital	Common (Digital)	Ded.	Common	N/A
27	Differential In 1-	Differential Input 1- (digital)	PGM	Input	1,2,3
28	Differential In 1+	Differential Input 1+ (digital)	PGM	Input	1,2,3
29	Enc B Out-	Encoder Output B-	Ded.	Output	3
30	Enc B Out+	Encoder Output B+	Ded.	Output	3
31	Relay Out 1	Relay Output 1	PGM	Output	1,2
32	Relay Out 2	Relay Output 2	PGM	Output	1,2
33	Opto In 5	Optical Input 5	PGM	Input	1,2,3
34	Opto In 4	Optical Input 4	PGM	Input	1,2,3
35	Opto In 2	Optical Input 2	PGM	Input	1,2,3
36	Opto In 1	Optical Input 1	PGM	Input	1,2,3
37	Opto In 3	Optical Input 3	PGM	Input	1,2,3
38	Opto In Common	Optical Input COM	PGM	Input	N/A
39	Opto Out 1 C	Optical Output 1 Collector	PGM	Input	1,2
40	Opto Out 1 E	Optical Output 1 Emitter	PGM	Input	1,2
41	Opto Out 2 C	Optical Output 2 Collector	PGM	Input	1,2
42	Opto Out 2 E	Optical Output 2 Emitter	PGM	Output	1,2
43	Enc Z Out -	Encoder Output Z-	Ded.	Output	3
44	Enc Z Out +	Encoder Output Z+	Ded.	Output	3

Notes:

1. Pins 10* and 25* are 5 V default outputs. 5 V as an input is optional.
2. The “Ded./PGM” column denotes if a pin is “Dedicated” or “Programmable”.
3. More information on the *Group #'s* is found on [Table 3-11](#) on page [39](#).

3.1.1 Programmable Digital Inputs

3.1.1.1 Optically Isolated Programmable Digital Input

There are five optically isolated inputs available which share the same opto-common. These inputs are electrically isolated from the drive, allowing signals from devices that are not connected to the drive common to be received. Most drive functions may be assigned to these inputs.

Table 3-2 – Optically Isolated Input Specs

Input Voltage	Opto On	5 V to 24 V
	Opto Off	< 1.5 V
	Max Reverse	-5 V
Cut off Frequency	100 KHz	
Input Current Max	7 mA	

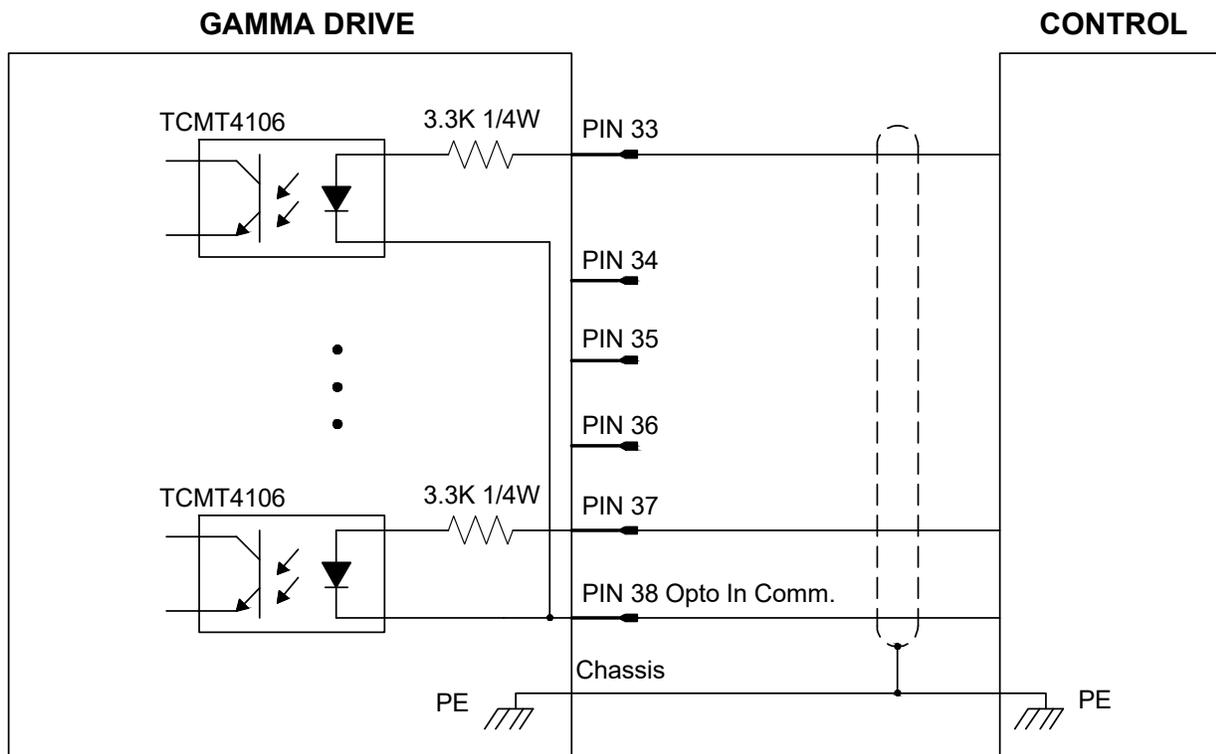


Figure 3-2 Optically Isolated Programmable Digital Input

3.1.1.2 Schmitt Trigger Programmable Digital Input

There are six Schmitt trigger inverter logic inputs. These inputs may be programmed as a group to be pulled up to 5V or pulled down to common. Most functions may be assigned to these inputs.

Table 3-3 – Schmitt Trigger Input Specs

Input Voltage	Logic High	2.5 VDC to 24 VDC
	Logic Low	< 0.9 V
Cut off Frequency	2 MHz	

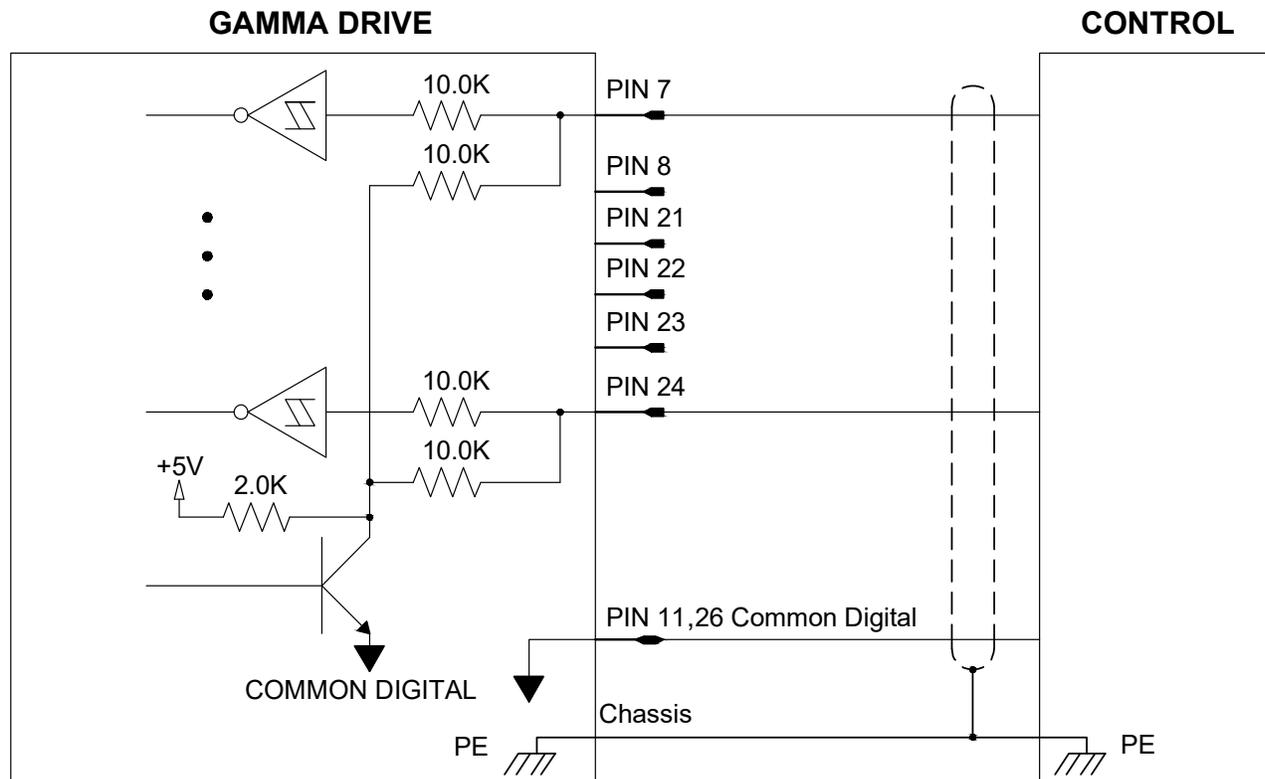


Figure 3-3 Schmitt Trigger Digital Input

3.1.1.3 Differential Digital Input

Differential digital inputs are used to overcome line noise introduced in a system by distance or proximity with other signals. If the noise is large enough, it will cause the signal to be interpreted in error leading to physical errors and possibly even system failure. If your control system provides differential output, these outputs are preferable to a standard signal vs ground comparison. However, if you need additional inputs and are not able to provide a differential output these inputs can also be used as a single ended input compared to the differential minus 2.5 VDC.

Table 3-4 – Differential Digital Input Specs

Input Voltage	Logic High	Differential > 200 mV
	Logic Low	Differential < -200 mV
	Common Range	-7 V to 12 V
Cut off Frequency	5 MHz	

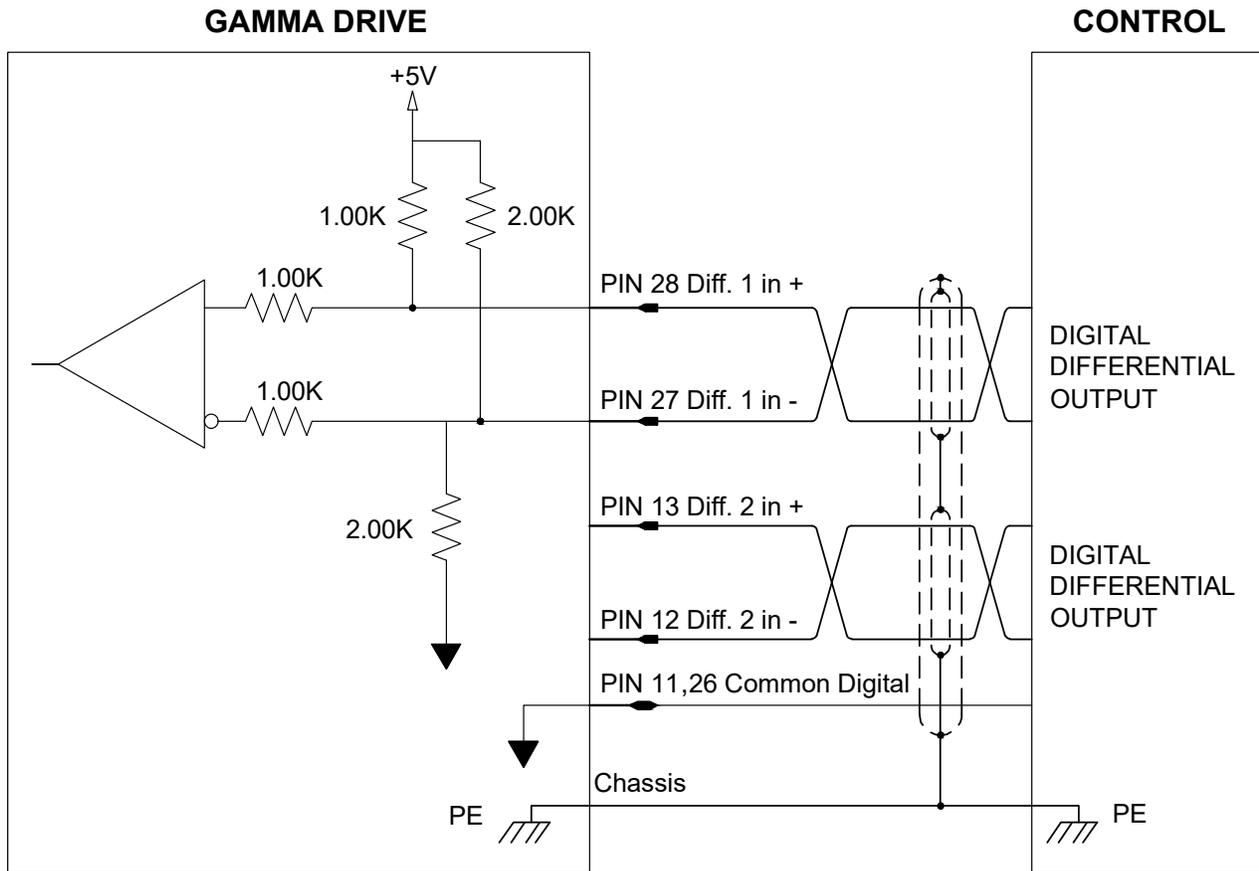


Figure 3-4 Differential Digital Input

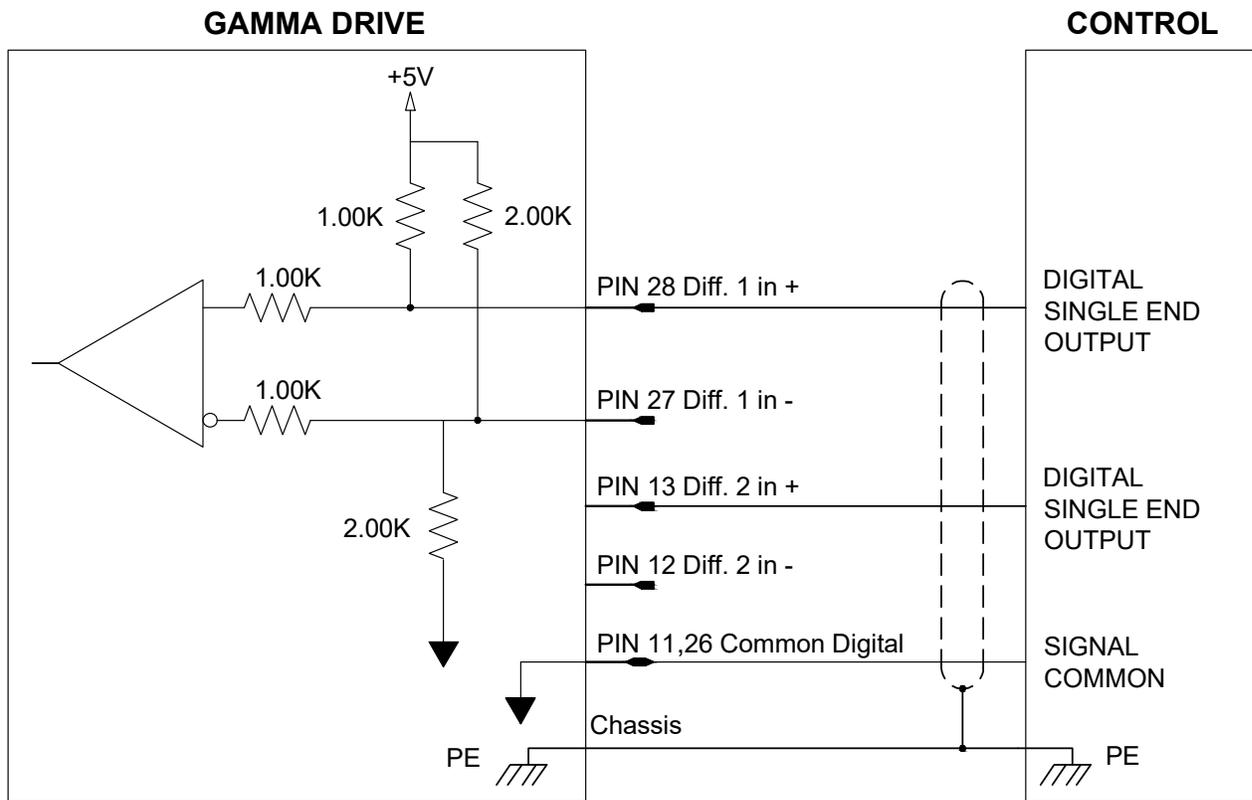
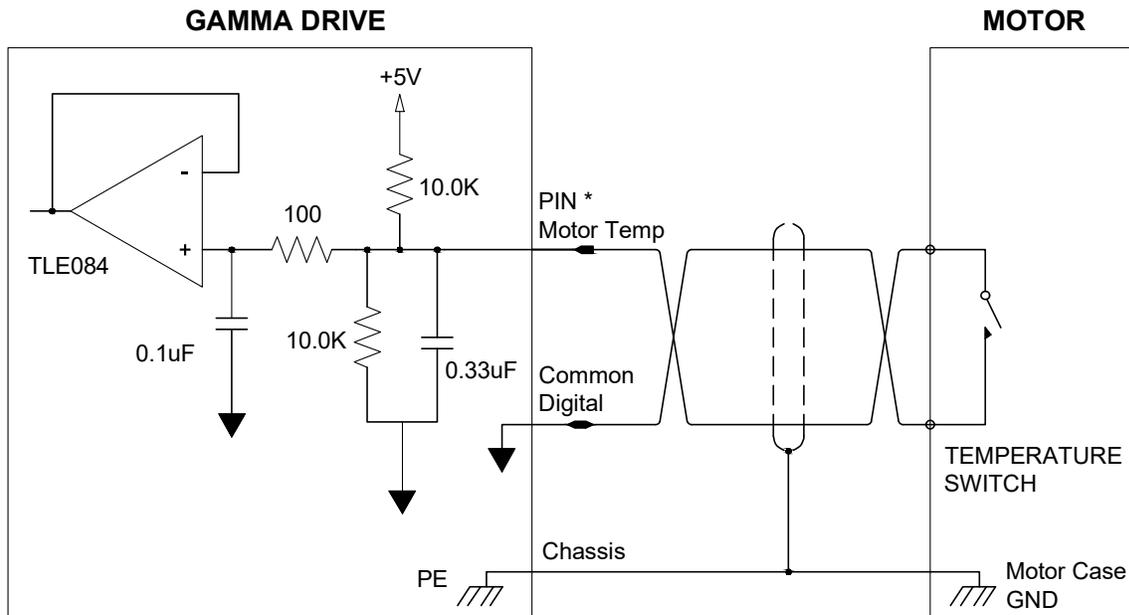


Figure 3-5 Differential Digital Input Single Ended

3.1.1.4 Motor Over Temperature Input

Pin 20 is dedicated as a motor over temp input. This pin can be configured as active high or low. When this signal is active, the drive displays a lower case "h", latches the fault, and disables the drive.



Controller I/O: PIN 20 pair with PIN 11 or 26 - Common Digital
 Motor Feed Back: PIN 11 - pair with Pin 6 - Common

Figure 3-6 Motor Over Temperature Input

3.1.2 Programmable Digital Outputs

3.1.2.1 MOSFET Programmable Output

There are three general purpose programmable MOSFET outputs. The outputs have a pull-up resistor in series with a diode connected to the drive's internal +5 VDC supply. The diode prevents current flow from an externally supplied DC voltage source. Most functions may be assigned to these outputs.

Table 3-5 – MOSFET Output Specs

Sink Current (Max)	1.5 A @ 25°C
Max External Voltage (Pull Up)	24 VDC

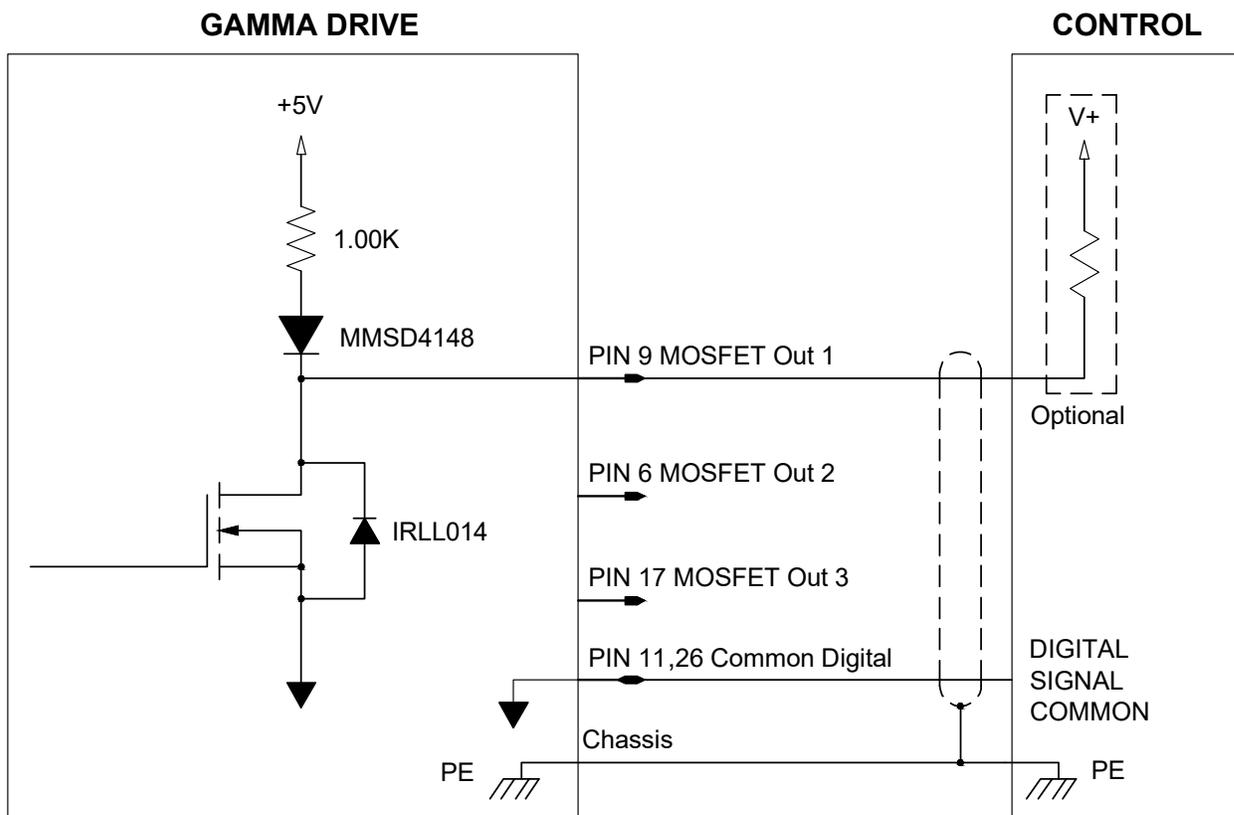


Figure 3-7 MOSFET output

Note: When the external pull up is used (see Setup Digital Outputs, p. [104](#)), ensure current is limited to 1.5 A or less.

3.1.2.2 Optically Isolated Programmable Digital Outputs

There are two independent optical outputs.

Table 3-6 – Optically Isolated Output Specs

Output Sink Current (Max)	10 mA
Output Voltage Saturation	.3 V
Max External Voltage (Pull Up)	24 V

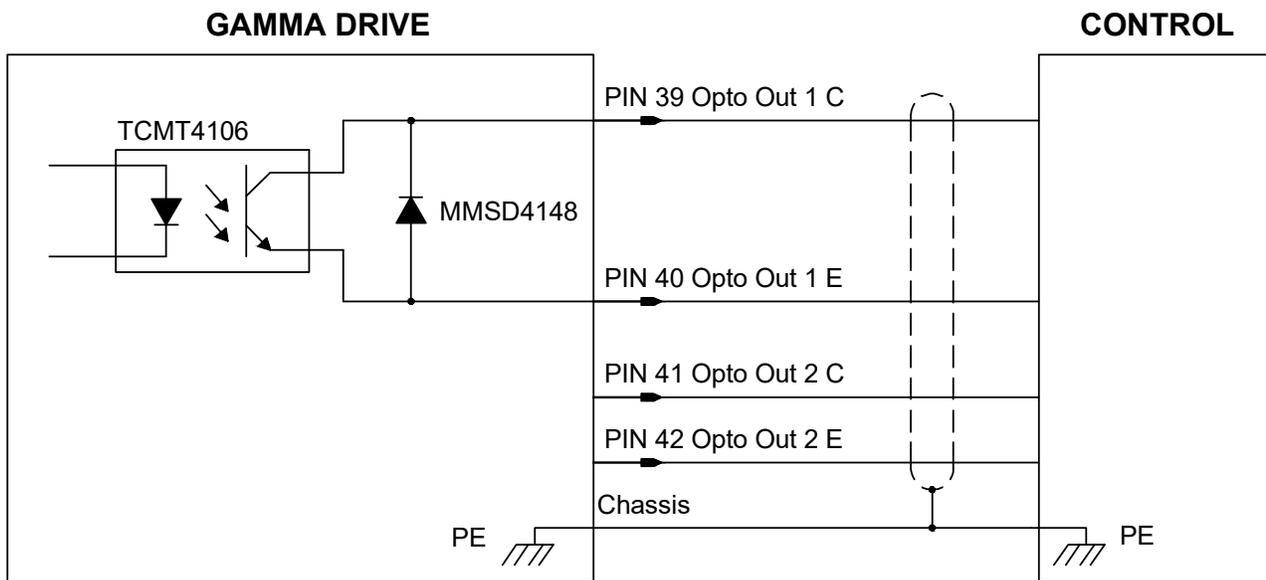


Figure 3-8 Optically Isolated Programmable Digital Output

3.1.2.3 Relay Output

A relay output is available on request. Consult a Glentek application engineer for more information.

Table 3-7 – Relay Output Specs

Relay Current	2 A
Relay Voltage	30 VDC

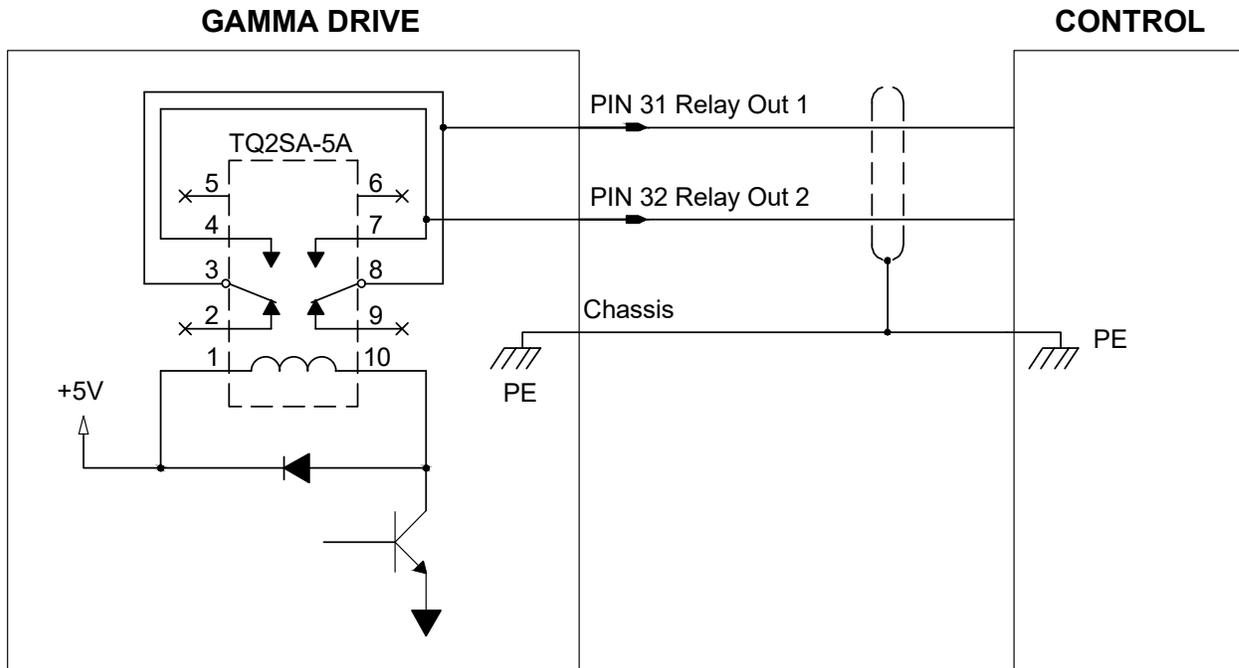


Figure 3-9 Relay Output

3.1.3 Analog Inputs

There are two differential analog inputs. A 16-bit analog to digital converter digitizes the signal for processing by the DSP. If a single-ended input is desired, then Signal (-) should be connected to Signal common, and the command input should be connected to Signal (+). This will maintain the proper input gain for a +/-10 V input range. If the signal polarity is incorrect, the signal gain may be inverted in the software setup using MotionMaestro (change "Signal Gain" to -300 RPM/Volt instead of +300 RPM/Volt).

Table 3-8 – Analog Input Specs

Input Voltage Range *	-10 VDC < Signal Total < 10 VDC
Resolution	16-bit
Cut off Frequency *	5 KHz
Input Impedance *	10 KΩ

* Other configurations can be ordered per request

Note: Signal Total = Signal + – Signal -

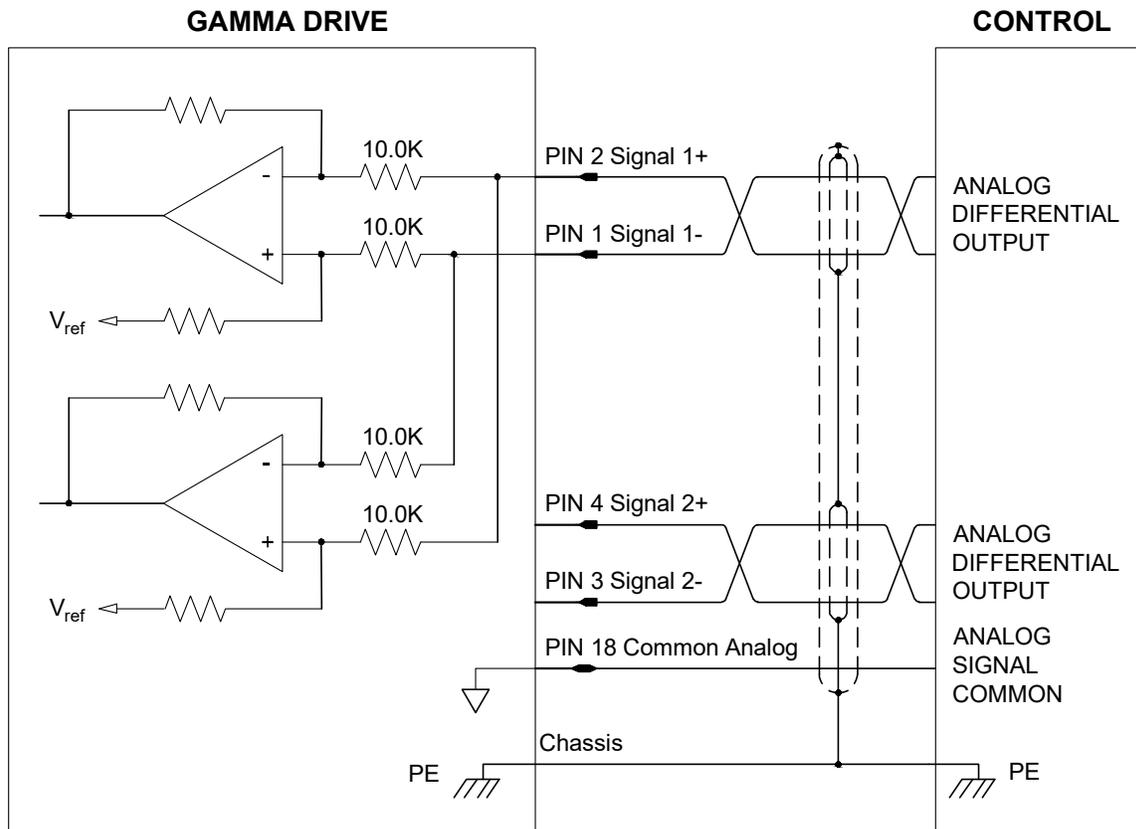


Figure 3-10 Differential Analog Input

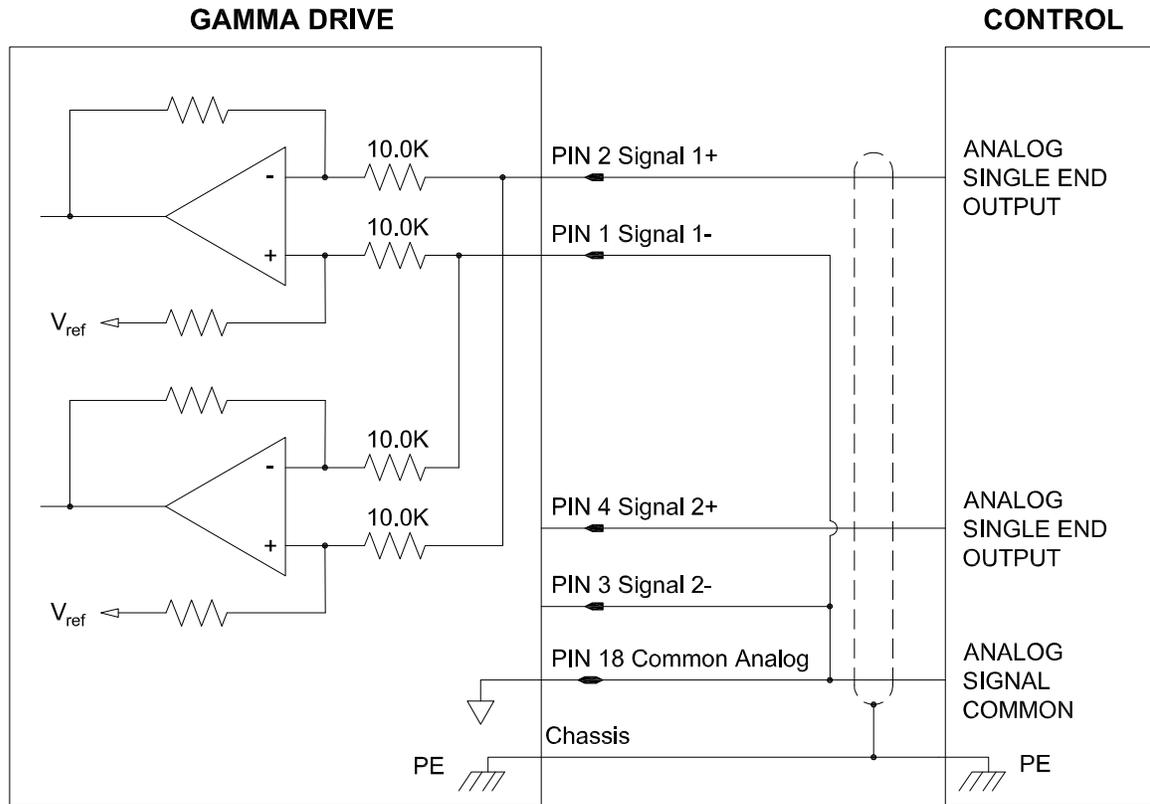


Figure 3-11 Single Ended Analog Input

3.1.4 Analog Outputs

There are two programmable analog output channels (see Table 3-1). The digital to analog converter has 12-bit resolution. The output range is -10 V to +10 V with 12-bit resolution. The analog output can be used to monitor drive signals at the servo update frequency. By doing so, the application engineer can determine the drive's true response to commanded signals. The analog output is for reference use only and is not intended for control purposes. At power on, its value is undetermined until the power-on reset is completed. During some drive functions the output is temporarily disabled. These functions include saving and recalling parameters from non-volatile memory. The output is filtered to minimize the switching noise from the PWM drive.

Table 3-9 – Analog Output Specs

Analog Output Voltage (Single Ended)	-10 V to 10 V
Resolution (D/A)	12-bit
Function	See Function Table (p. 37)

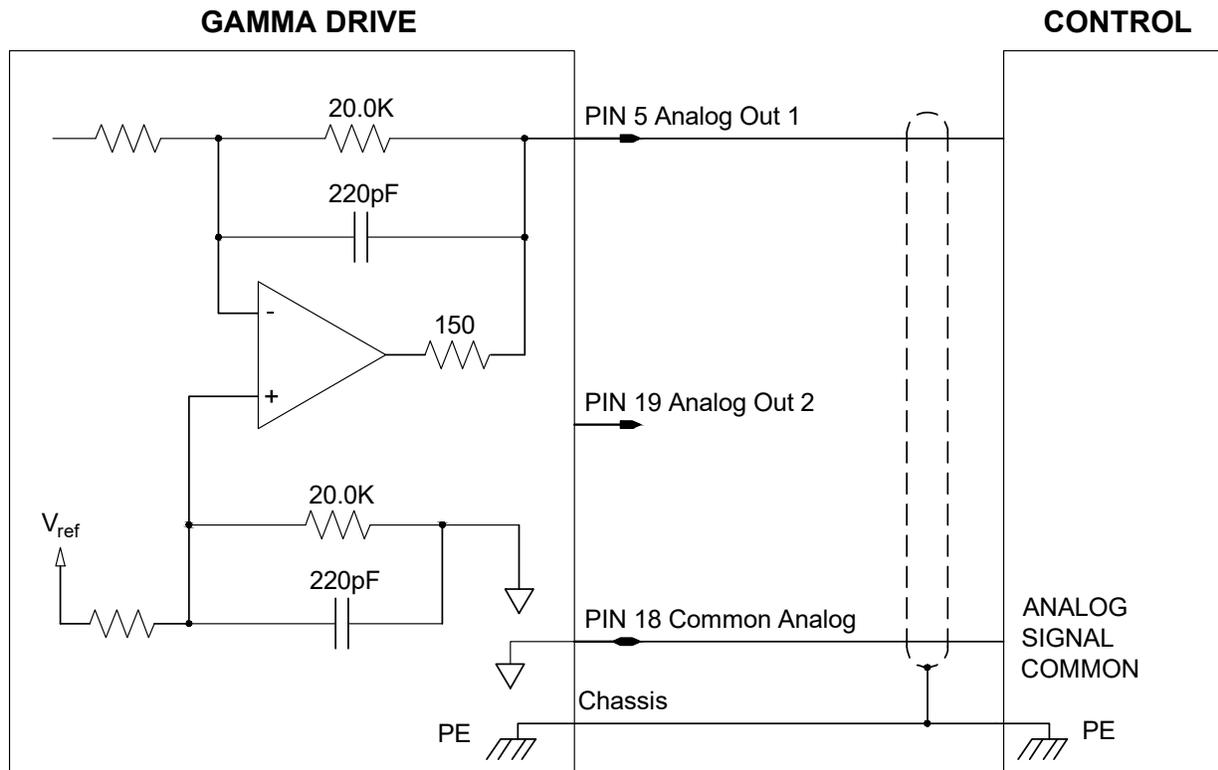


Figure 3-12 Analog Outputs

Table 3-10 – Analog Output Function List

Analog Output Function List	
Test Voltage	S Current Measured
Current Measured	T Current Measured
Velocity Measured	R Voltage Command
Velocity Command	S Voltage Command
Current Command	T Voltage Command
Primary Command	Auxiliary Command
Q Current Command	DC Bus Voltage Measured
D Current Command	Commutation Angle
Q Current Measured	Current Limit
R Current Measured	D Voltage Command

3.1.5 Encoder Outputs

Figure 3-13 shows the encoder output channels on the I/O connector. The drive is capable of dividing a TTL encoder count to a lower count (1,2,4,8) as well as creating different output counts from a resolver or sin/cos encoder. The 26C31 Differential Line Driver receives input signals directly from a TTL encoder, or from simulated encoder signals when a resolver or sin/cos encoder is used.

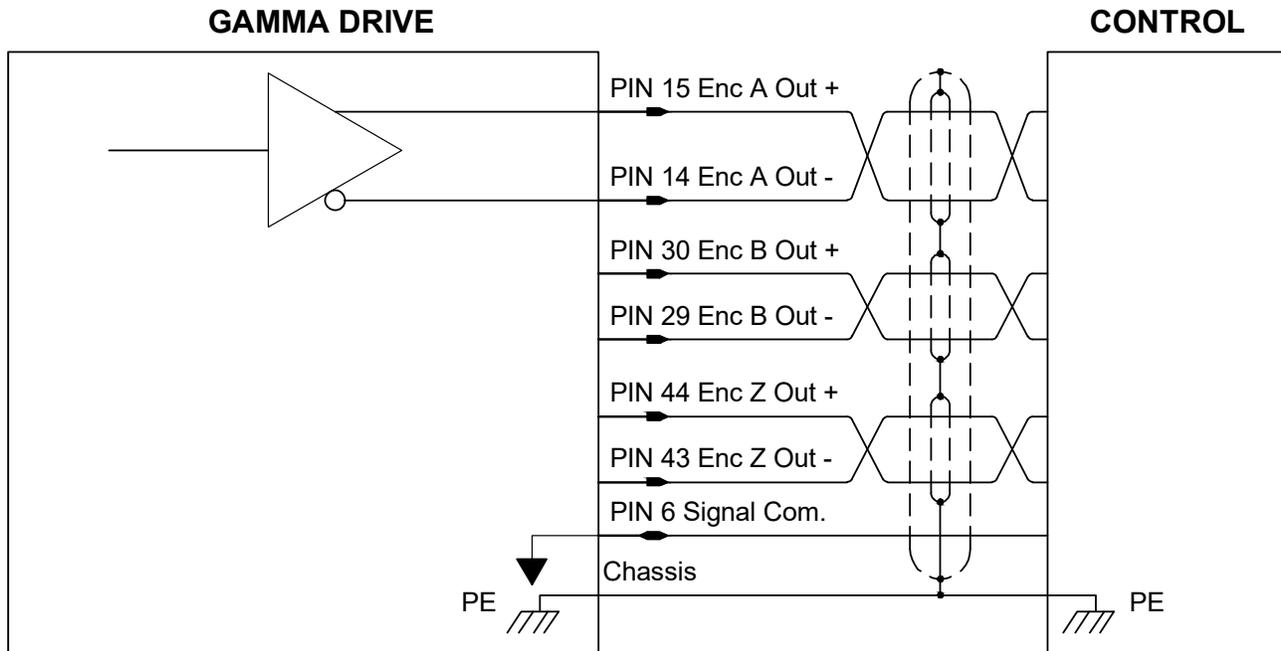


Figure 3-13 Encoder Outputs

3.1.6 Programmable Digital Input Functions

Drive functions are assignable to the digital inputs. There are different function types which segregate the drive functions into 3 groups: multiple inputs, one input only, and specific inputs. See Section [5.12](#) for more information about setting up digital inputs in MotionMaestro.

Table 3-11 – Programmable Digital Input Functions

Function Group	Function Name	Description
1: Function is assignable to multiple inputs.	External Inhibit	The drive is disabled, no current is being delivered to the motor.
	External Reset	Clears all faults, resets the DSP, and initializes the drive.
	Positive Limit	Stops motor rotation in the positive direction.
	Negative Limit	Stops motor rotation in the negative direction.
	Fault Input	Disables the drive by a hardware command.
	Stop/Go Control	The motor decelerates to a specific speed
	E-Stop	The drive commands the motor to zero speed
	Aux Encoder Fault	An input which indicates an encoder fault.
2: Function is assignable to only one input at a time.	Drive Operation Control	Selects mode of operation (current, velocity, position).
	Profile Start Trigger	Executes the profile as defined by the <i>Profile Address</i> pins (see 5.15 Profile Generator for more detail).
	Profile Step Stop	Used in conjunction with <i>Digital Input</i> action trigger from the profile generator.
	Set Home	Sets encoder count to zero. Can be used in conjunction with <i>Profile Step Stop</i> to set a home position and for absolute position moves in the profile generator.
	Profile Address0	Up to 16 profiles may be stored in NVM. This is bit 0 of the address of the profile.
	Profile Address1	This is bit 1 of the address of the profile.
	Profile Address2	This is bit 2 of the address of the profile.
3: Function is assignable to only specific inputs.	Profile Address3	This is bit 3 of the address of the profile.
	Pulse Direction1- Position Mode	For pulse mode only (see p. 75 for more detail). Paired with Pulse Direction2
	Pulse Direction2- Position Mode	For pulse mode only (see p. 75 for more detail). Paired with Pulse Direction1
	Up Counting - Position Mode	Counting up. Position Mode Only. Paired with Down Counting
	Down Counting - Position Mode	Counting down. Position Mode Only. Paired with Up Counting
	PWM Direction Command *	Selects clockwise or counterclockwise rotation. Paired with PWM duty cycle
	PWM Duty Cycle Command *	PWM duty cycle. Paired with PWM Direction
	PWM Sync Pulse Input *	Enables individual drives to sync together to share frequency.
Home Pulse *	Signals to drive the home position has been reached.	

* Available soon

3.1.7 Programmable Digital Output Functions

The drive functions in these tables can be assigned to the programmable digital outputs. See Section [5.13](#) for more information about setting up digital outputs in MotionMaestro.

Table 3-12 – Programmable Digital Output Functions (Faults)

Function	Description
Bus Under volt	The Input Bus Voltage is below the minimum required
Commutation Init	Hall angles do not match encoder counter angle. No Halls: Phase finding routine failed
Internal Fault	An Internal Fault has occurred
EEPROM	EEPROM checksum fault – Contact a Glentek application engineer
Hall	The drive has detected an invalid Hall state on the Hall inputs from the motor
Motor Over Temp	The drive has detected a motor over temp signal on the <i>Motor Overtemp</i> Input or on the I/O Connector
RX Overflow	Software overflow
Position Following Error	Position Mode Only – Difference between commanded position and actual position is excessive
Over Speed	The Motor speed has exceeded the specified threshold
Encoder	The drive has detected a fault on one or more of the encoder inputs
Drive Over Temp	The drive has exceeded the drive maximum allowed temperature
Bus Over Volt	The Input Bus Voltage to drive has exceeded the allowed max voltage
LSECB	The drive output current has exceeded the time + current constraints programmed into the drive
HSECB	The drive has detected a short circuit on one or more of the output terminals

Table 3-13 – Programmable Digital Output Functions (Status)

Status	Description
STO Active	STO (Safe Torque Off) input activated
Drive Fault	One or more of the internal drive faults has occurred
Commutation Init	The drive is finding the encoder commutation Tracks/Hall signals and calculating the rotor angle
Software Inhibit	The drive is disabled from within MotionMaestro software (see Hardware Inhibit below)
At Zero	The motor is at zero rpm
At Speed	The motor is at a specified rpm (configurable see Section 4.3)
Drive Commutated	Commutation Initialization was successful
Encoder Index Sensed	The drive has detected the encoder index signal
Drive Enabled	The drive is not inhibited and no faults are present
Hardware Inhibit	An inhibit signal has been received at one of the I/O terminals
Current Fold back	The fold back function has occurred, motor current has been reduced to the configured level
Balancing	The drive is in the process of balancing the motor phase currents
Stopping	The drive is decelerating the motor
External Reset	The reset terminal of the I/O has been activated from an external source

3.2 Brake/STO Connector

For the brake/STO mating connector, the recommended wire size is 24 AWG, but the mating connector can accommodate wire sizes from 16 to 28 AWG.

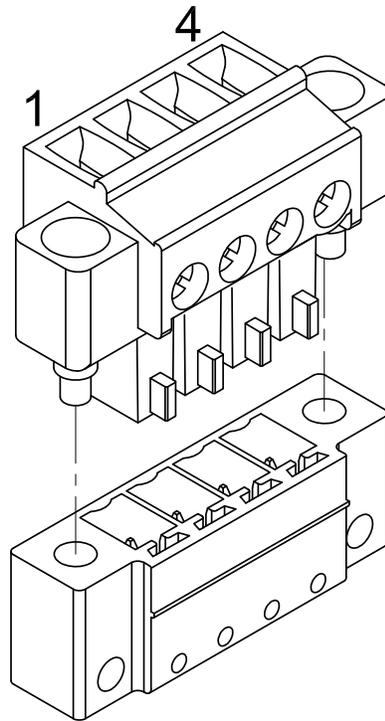


Figure 3-14 Logic Power/Brake Connector (Standard)

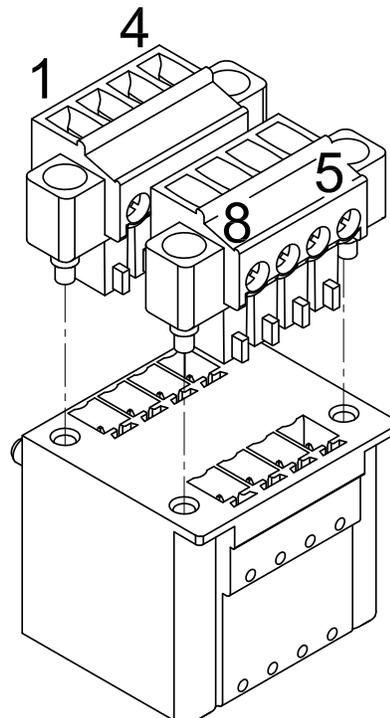


Figure 3-15 Logic Power/Brake/STO Connector (Optional)

Table 3-14 – Brake/STO Connector Pin Function

Pin #	Pin Name	Pin Function	Pin Type
1	Ext +24 VDC Rtn	+24 VDC Return	Input
2	Brake	Drive Brake	Output
3	Ext +24 VDC In	+24 VDC Input	Input
4	Reserved	Reserved	Reserved
5*	STO A+	Safe Torque Off Input A+	Input
6*	STO A-	Safe Torque Off Input A-	Input
7*	STO B+	Safe Torque Off Input B+	Input
8*	STO B-	Safe Torque Off Input B-	Input

Note: Pins 5-8* are optional functions available by special order.

3.2.1 Logic Power Inputs

Powers all logic, brake, and feedback devices.

Table 3-15 – Logic Power Specs

Input Voltage	24-48 VDC
Input Current	600 mA minimum @ 24 VDC

3.2.2 Brake Output

There is one optically isolated output available for the brake output. It is internally connected to the +24 VDC input by a flyback diode. Refer to Figure 3-16 for the circuitry.

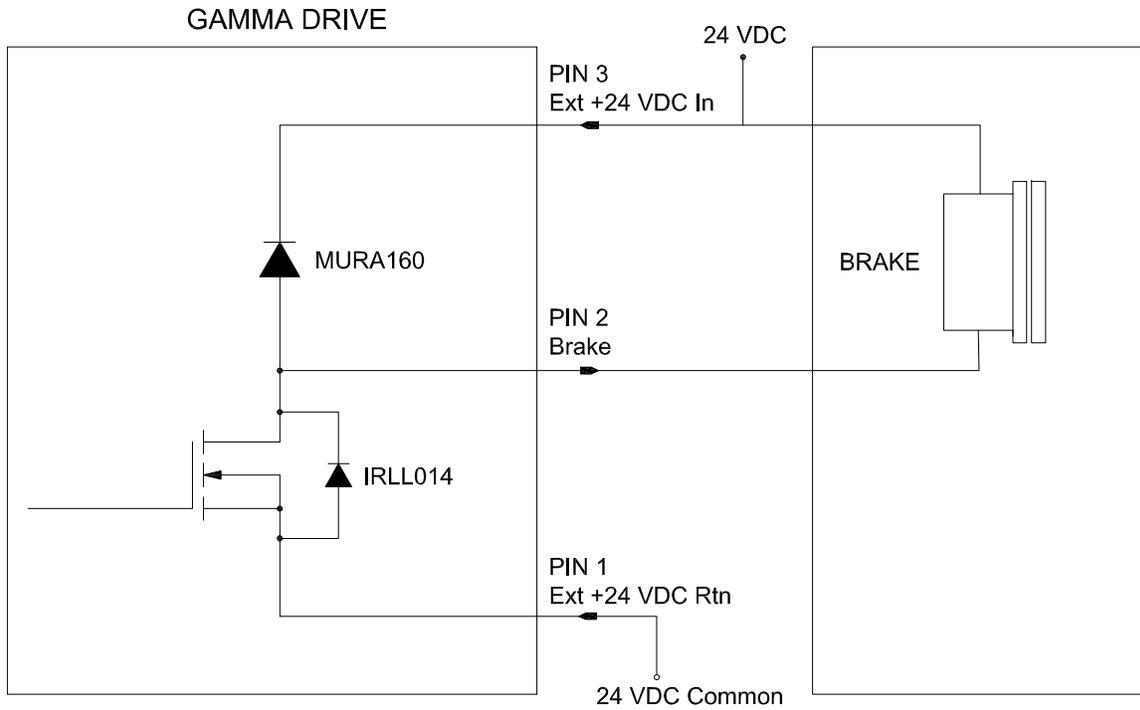


Figure 3-16 Brake/Stop Sequence Internal Circuit

Table 3-3-16 – Brake Output Specs

Output Current	1.5 A @ 25°C
Max External Voltage (Pull Up)	24 VDC

3.2.3 STO Inputs

STO (Safe Torque Off) is an optional safety feature that has a dedicated optically isolated physical pathway to the drive output devices allowing these devices to be de-energized to a safe condition independent of all drive control software. (Implemented in accordance with IEC61800-5-2). STO A and STO B are independently operating inputs. Drives with the STO option must have hot STO A and STO B inputs energized in order for the drive to operate (failsafe).

Table 3-17 – STO Inputs

Input Voltage	STO (Inactive)	5 V to 24 V
	STO (Active)	< 1 V
Max Reverse	-5 V	
Input Current (Max)	10 mA	

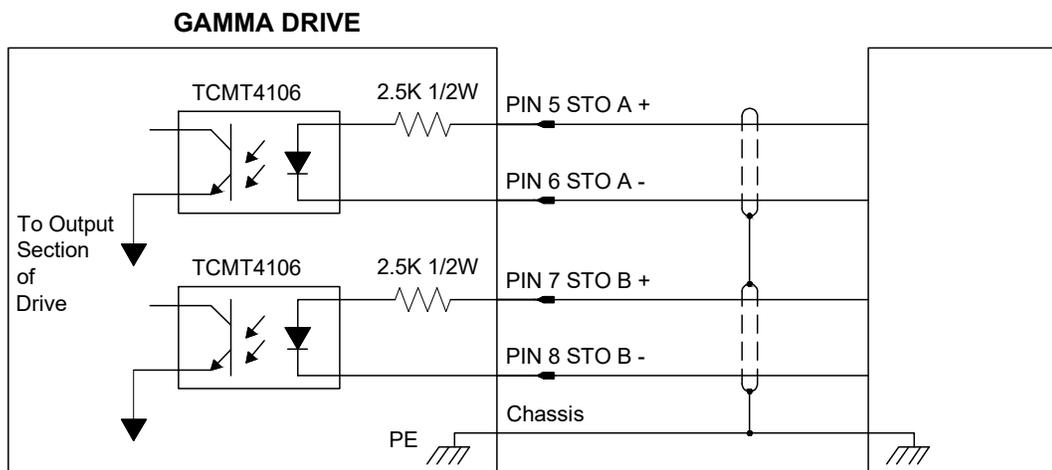


Figure 3-17 STO Input Circuit

3.3 Communication Interface

3.3.1 Servo Drive Serial Communications Connector

The following tables are pin directories for the connector that contains circuits involved with communication interface content.

Table 3-18 – RJ45 Mating Connector

Description/Type	8-Pin Mating Connector
Single RJ-45	EJ018083
Double RJ-45	EJ018083

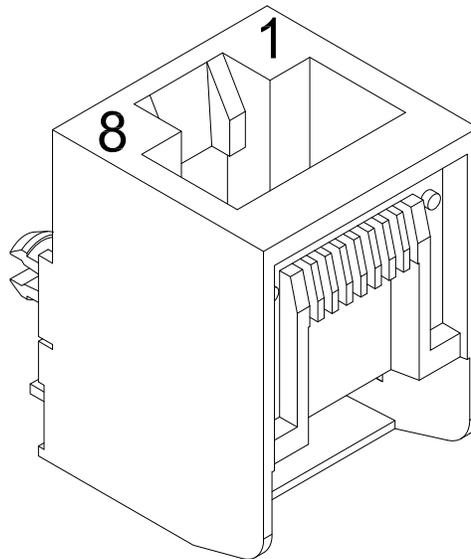


Figure 3-18 RJ45 Mating Connector

Table 3-19 – RJ45 (RS-232 Communication Designations)

Pin #	Pin Type	Pin Name	Pin Function
1	Input	RX+	RS-485 Receive+
2	Input	RX-	RS-485 Receive-
3	Reserved	Reserved	Reserved
4	Common	Common Digital	Common (Digital)
5	Output	TX 232	RS-232 Transmit
6	Input	RX 232	RS-232 Receive
7	Output	TX+	RS-485 Transmit+
8	Output	TX-	RS-485 Transmit-

3.3.2 RS-232

The PC interface can be found at the HOST connector. A RS-232 interface is on the outside of the drive. This port is the primary means of communication with the drive for setup and control. The port utilizes an RJ-45 type connector.

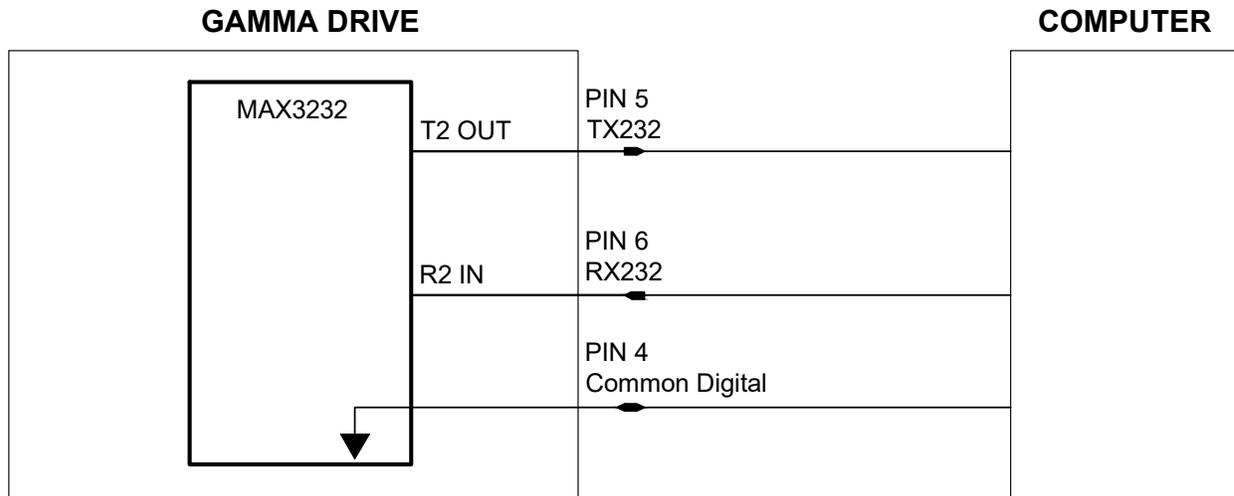


Figure 3-19 RS-232 Chip Information

3.3.3 CANopen Interface

The CANopen interface can be used via the HOST, COM1, or COM2 connector. Glentek Gamma Series Drives employ the CANopen protocol that is based on the CAN Physical Layer as described in the CAN in Automation (CiA) standard DS-301 V4.02. This port is the primary means of communication with the CANopen network for real-time control. The port utilizes an RJ45 type connector. The rate of data transmission (bit rate) depends on the total overall length of the bus and the delays associated with the transceivers. Under normal conditions, all the devices in a system transfer at uniform and fixed bit-rates. The CANopen BUS must be terminated at both ends so that reflections of signals are avoided. A 120 Ω termination resistor is required at the last drive node in the CANopen network. This resistor is provided inside the drive for convenience. The drive is terminated by placing a two-pin micro-shunt jumper across the termination jumper connector. The following bit rate is capable of being achieved by matching the indicated total system bus length:

Table 3-20 – Serial Speed over Distance

Bits/second	Length (meters)
1 M	25 (82 ft)
800 K	50 (164 ft)
500 K	100 (328 ft)
250 K	250 (820 ft)
125 K	500 (1640 ft)
50 K	1000 (3280 ft)
20 K	2500 (8200 ft)

Table 3-21 – RJ45 (CANopen) Communication Designations

Pin #	Pin Type	Pin Name	Pin Function (Isolated Version)	Pin Function (Non-Isolated Version)
1	Input/output	CAN H	Dominant High	Dominant High
2	Input/output	CAN L	Dominant Low	Dominant Low
3	Common	CAN GND	Ground	Common (Digital)
4	Reserved	Reserved	Reserved	Reserved
5	Reserved	Reserved	Reserved	Reserved
6	Reserved	Reserved	Reserved	Reserved
7	Common	CAN GND	Ground	Common (Digital)
8	Reserved	Reserved	Reserved	Reserved

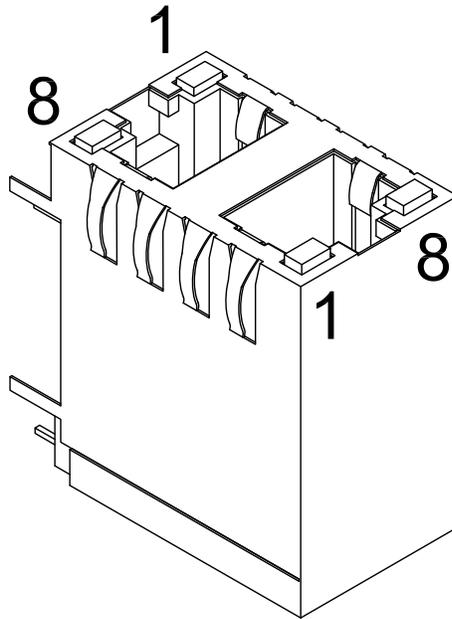


Figure 3-20 RJ45 Double Mating Connector

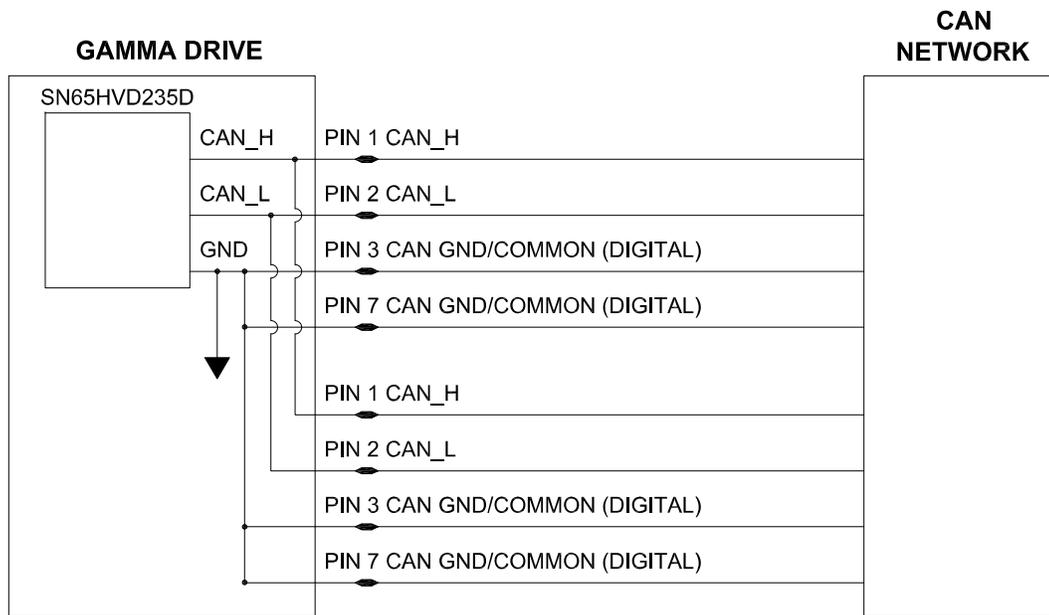


Figure 3-21 CANopen Connection Diagram

3.4 Motor Feedback Connector and Wiring

For the motor feedback mating connector, the recommended wire size is 28 AWG, but the crimp pins can accommodate wire sizes from 22 to 28 AWG.

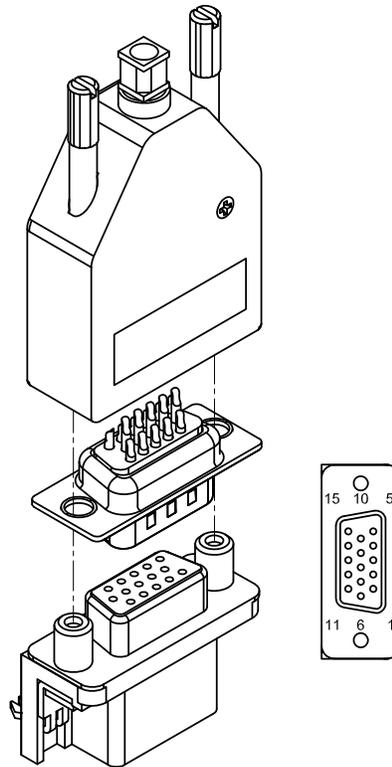


Figure 3-22 Motor Feedback Connector

Table 3-22 – Motor Feedback Designations: TTL Encoder/Hall Communication

Pin #	Pin Name	Pin Function
1	+5 VDC	Encoder +5 VDC Power Out
2	Enc A In-	Encoder A Input-
3	Enc B In-	Encoder B Input-
4	Enc Z In-	Encoder Z Input-
5	W In- / Tach-	Hall 3 Input- / Tachometer Signal-
6	+5 VDC Com	Common (Digital)
7	Enc A In+	Encoder A Input+
8	Enc B In+	Encoder B Input+
9	Enc Z In+	Encoder Z Input+
10	W In+ / Tach+	Hall 3 Input+ / Tachometer Signal+
11	Motor Temp	Motor Temperature Sensor Input
12	U In-	Hall 1 Input-
13	U In+	Hall 1 Input+
14	V In-	Hall 2 Input-
15	V In+	Hall 2 Input+

* Tachometer requires special order Motor Feedback Specs (TTL Encoder)

Table 3-23 – Motor Feedback Specs

Output Voltage	Voltage	+5 V
	Maximum Current	150 mA
Input Voltage	Logic High	Differential > 200 mV
	Logic Low	Differential < -200 mV
	Common Range	-7 V to 12 V
Cut off Frequency	5 MHz	

The drive can supply +5 V of encoder/Hall power. It is accessible at the +5 V pin. The Hall input uses a MAX3096 differential line receiver input. Compatible with differential or single-ended commutation tracks or Hall sensors.

Table 3-24 – Digital Hall Sensor Specs

Output Voltage	Voltage	+5 V
	Maximum Current	150 mA
Input Voltage (Differential)	Logic High	Differential > 200 mV
	Logic Low	Differential < -200 mV
	Common Range	-7 V to 12 V
Input Voltage (Single Ended)	Logic High	> 3.0 V
	Logic Low	< 2.0 V
Cut off Frequency	100 KHz	

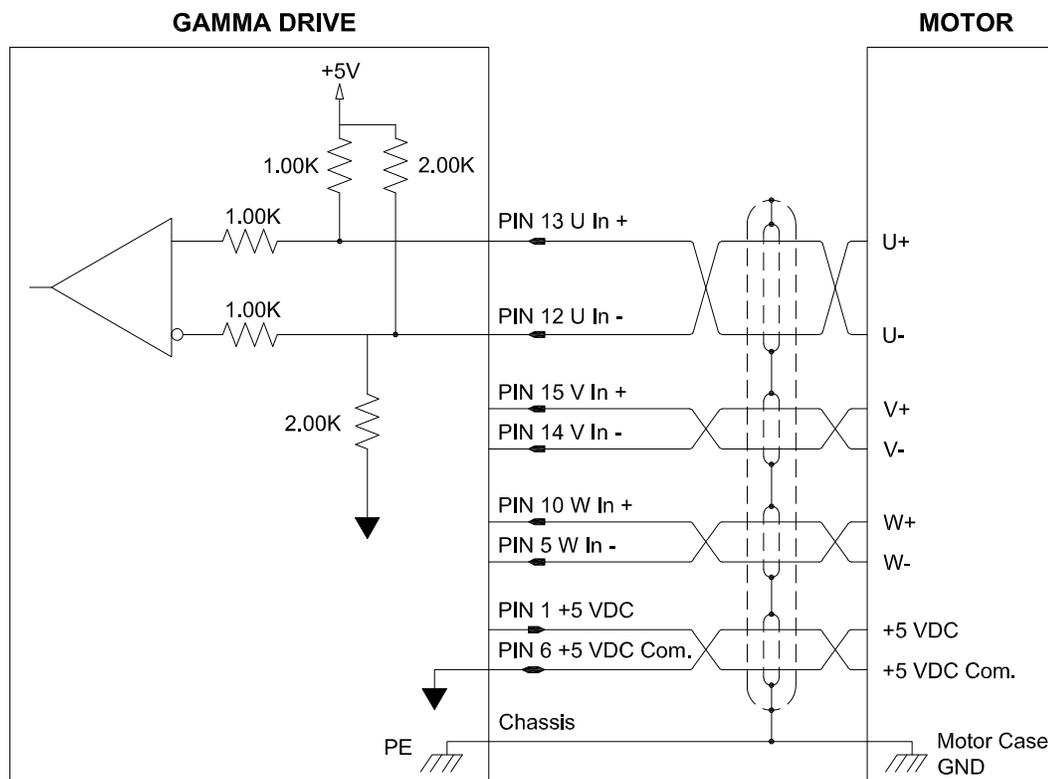


Figure 3-23 Digital Hall Circuit (Differential)

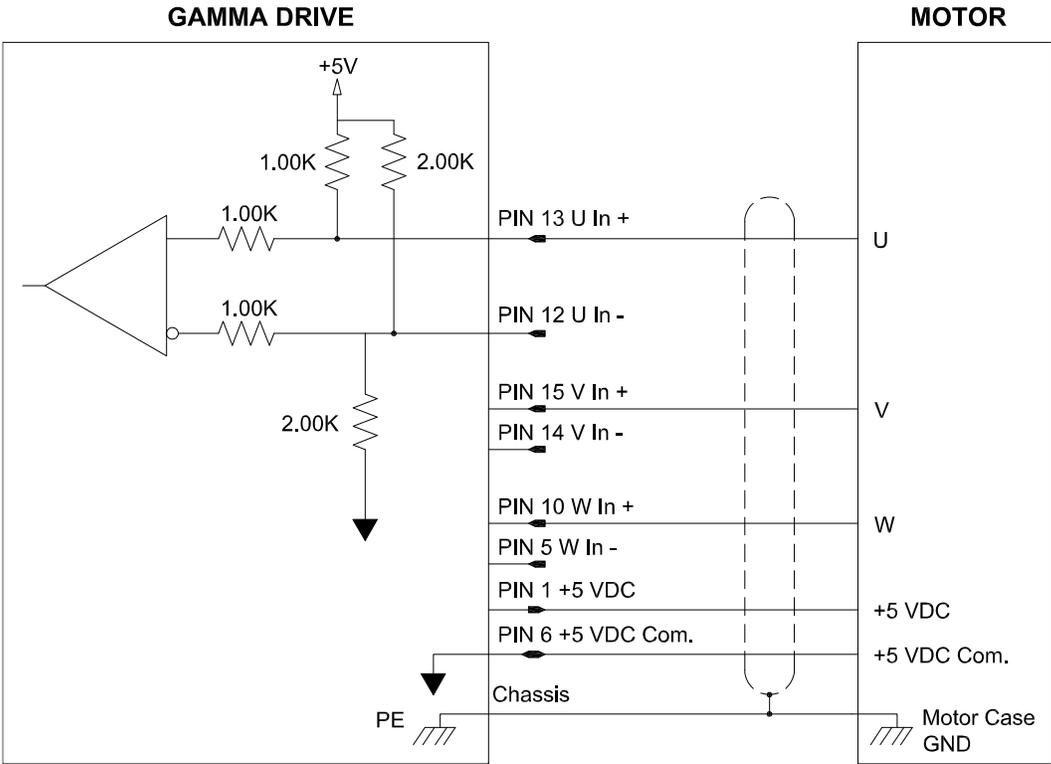


Figure 3-24 Digital Hall Circuit (Single Ended)

3.4.1 Tachometer

Table 3-25 – Tachometer Sensor Specs

Input Voltage	Max Voltage	+/- 30 V *
Cut off Frequency	5 KHz	

* Other voltages available on order

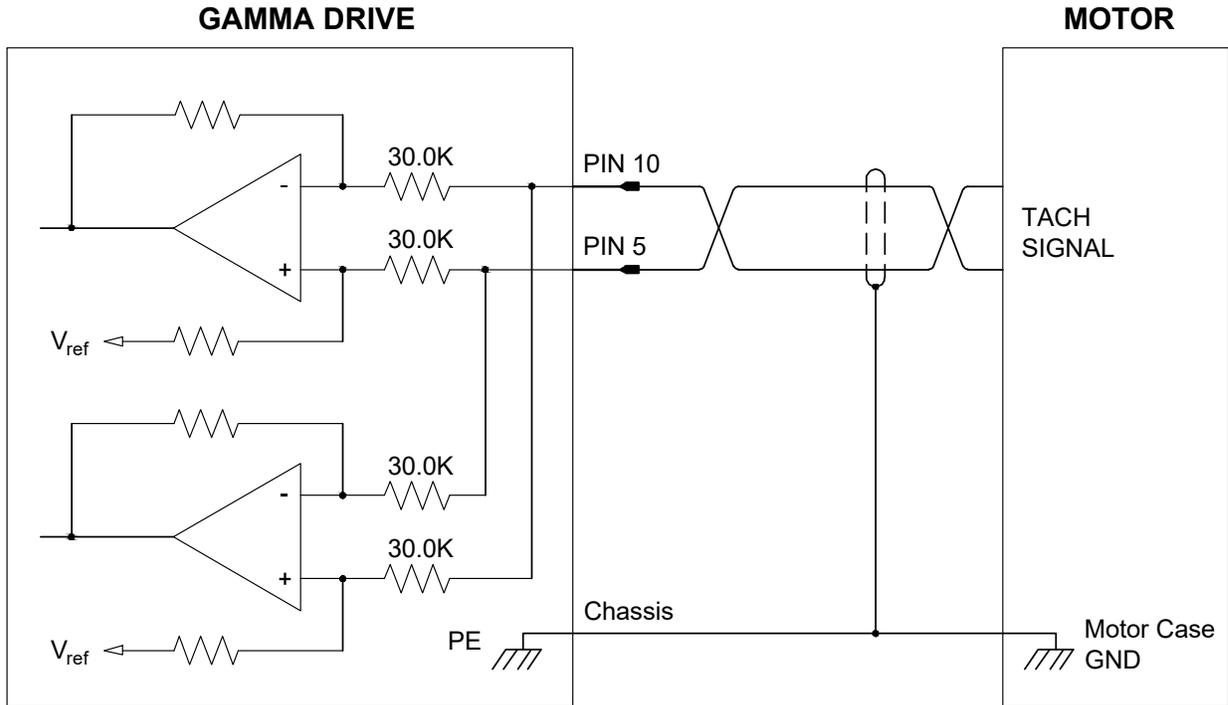


Figure 3-25 Tachometer Circuit

3.4.2 Resolver

Table 3-26 – Motor Feedback Designations: Resolver

Pin #	Pin Name	Pin Function
1	Reserved	Reserved
2	Sin -	Sine Signal Input -
3	Cos -	Cosine Signal Input -
4	Exc_Out -	Resolver Reference Output -
5	Reserved	Reserved
6	Common Digital	Common (Digital)
7	Sin +	Sine Signal Input +
8	Cos +	Cosine Signal Input +
9	Exc_Out +	Resolver Reference Output +
10	Reserved	Reserved
11	Motor Temp	Motor Temperature Sensor Input
12	Reserved	Reserved
13	Reserved	Reserved
14	Reserved	Reserved
15	Reserved	Reserved

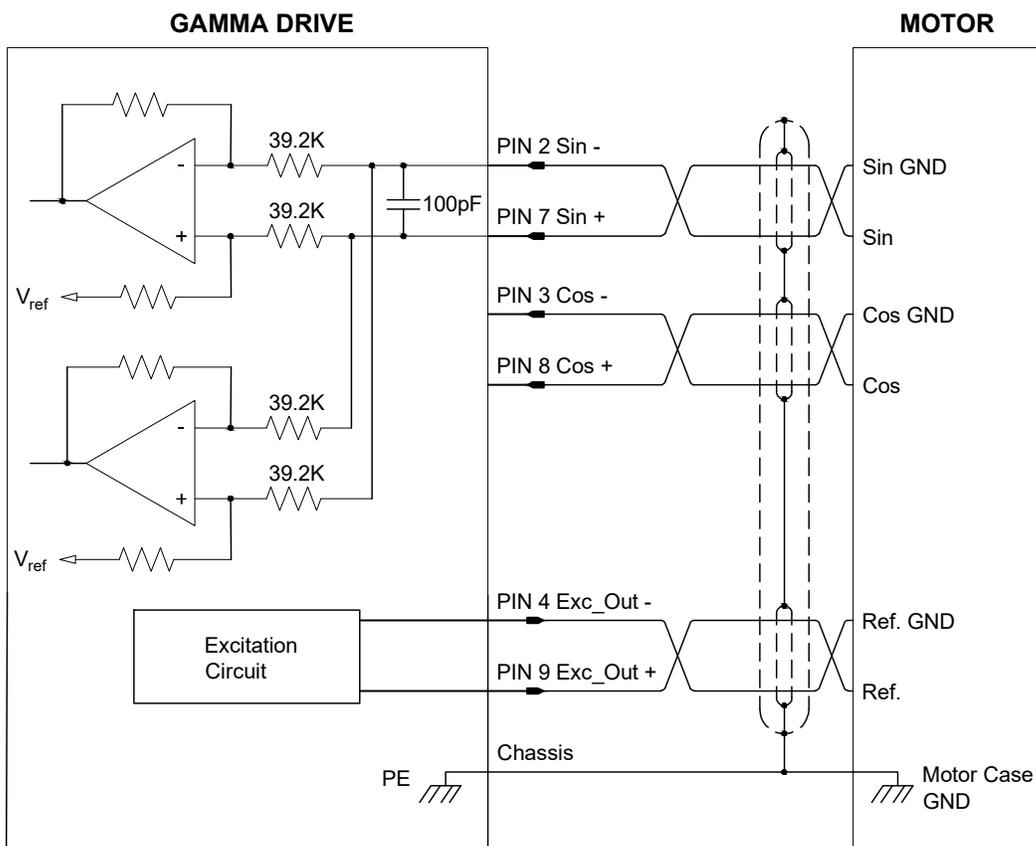


Figure 3-26 Resolver Circuit

3.4.3 Sin/Cos Encoder

**Table 3-27 – Motor Feedback Designations:
Sin/Cos & Absolute Encoder**

Pin #	Pin Name	Pin Function
1	+5 VDC	Encoder +5 VDC Power Out
2	Sin -	Sine Signal Input -
3	Cos -	Cosine Signal Input -
4	Enc Z In -	Encoder Z Input -
5	Reserved	Reserved
6	+5 VDC Com	Common (Digital)
7	Sin +	Sine Signal Input +
8	Cos +	Cosine Signal Input +
9	Enc Z In +	Encoder Z Input +
10	Reserved	Reserved
11	Motor Temp	Motor Temperature Sensor Input
12	Abs SL -	Encoder Data -
13	Abs SL +	Encoder Data +
14	Abs MA -	Clock Signal -
15	Abs MA +	Clock Signal +

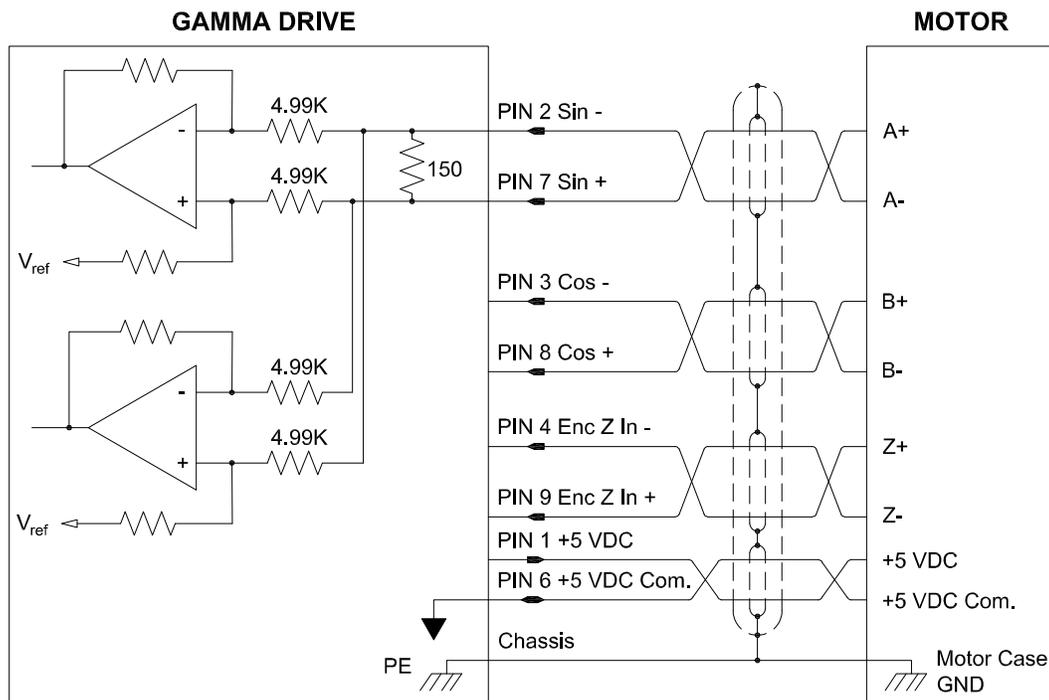


Figure 3-27 Sin/Cos Encoder Circuit

3.5 Servo Drive Motor and Power Connectors

The servo drive motor and power connectors are suitable for field wiring of 24 AWG to 10 AWG solid/stranded wire. Select wire gauge based on continuous current requirement.

Table 3-28 – UL and Non-UL Stand Alone Motor Output Designations – 3 Pin

Pin #	Pin Type	Pin Name	Pin Function
1	Output	T	Motor Phase T / Brush Output B
2	Output	S	Motor Phase S
3	Output	R	Motor Phase R / Brush Output A

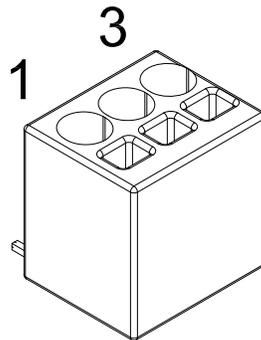


Figure 3-28 UL Stand Alone Motor Output Connector

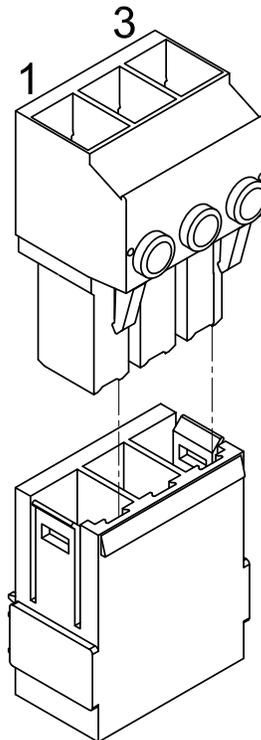


Figure 3-29 Non-UL Stand Alone Motor Output Connector

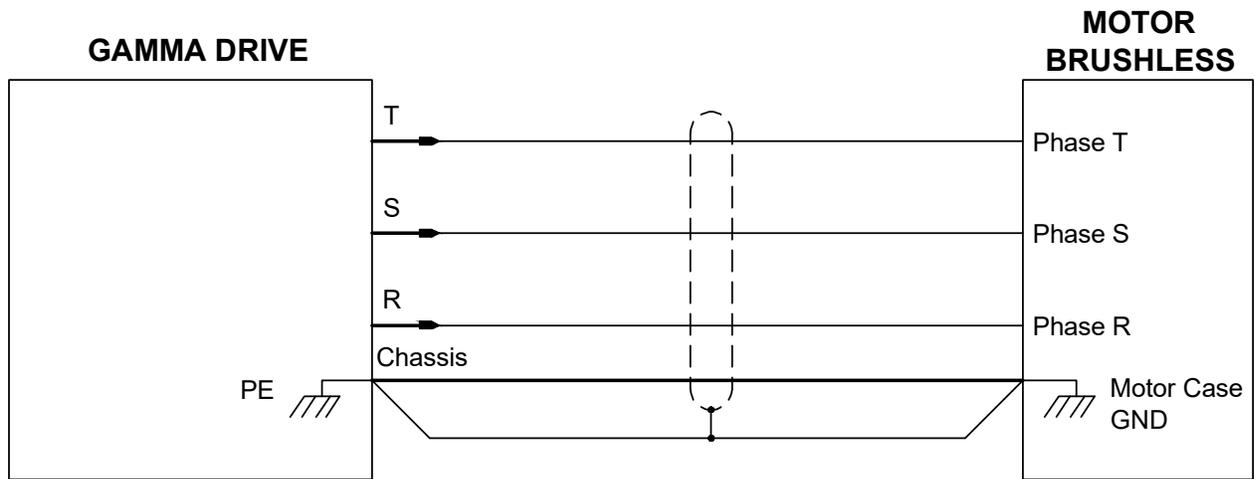


Figure 3-30 UL and Non-UL Stand Alone Motor Output Brushless

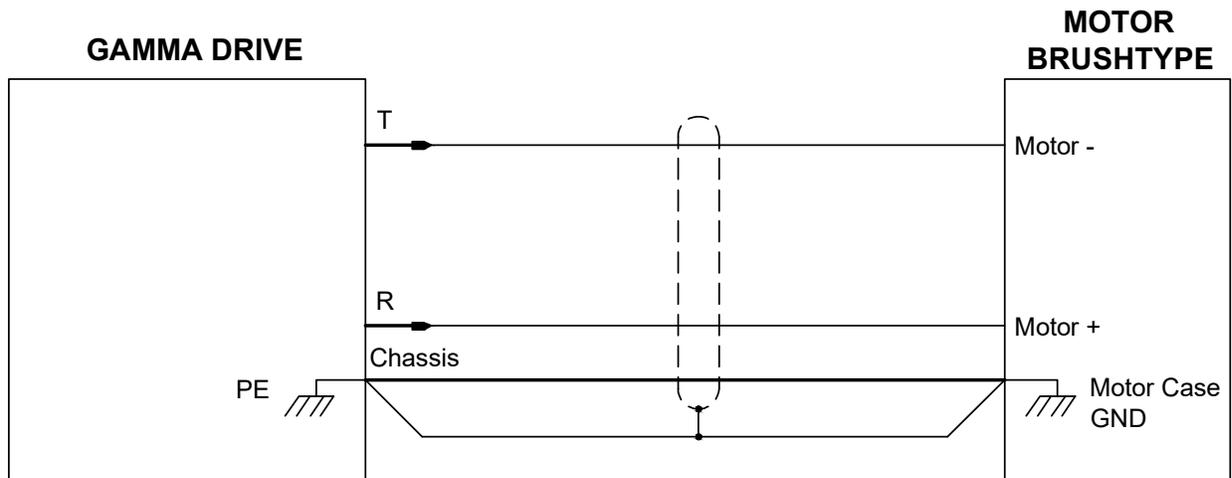


Figure 3-31 UL and Non-UL Stand Alone Motor Output Brush Type

Table 3-29 – UL and Non-UL Stand Alone AC Power Input Designation – 4 Pin

Pin #	Pin Type	Pin Name	Pin Function
1	Input	L1	Phase 1 Input
2	Input	L2	Phase 2 Input
3	Input	L3	Phase 3 Input
4	Input	PE	Ground

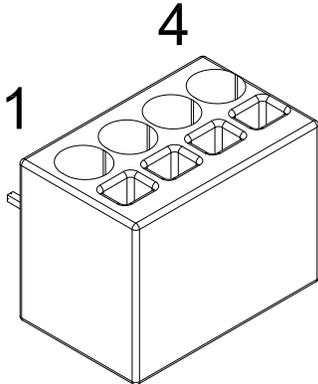


Figure 3-32 UL Stand Alone AC Power Input Connector

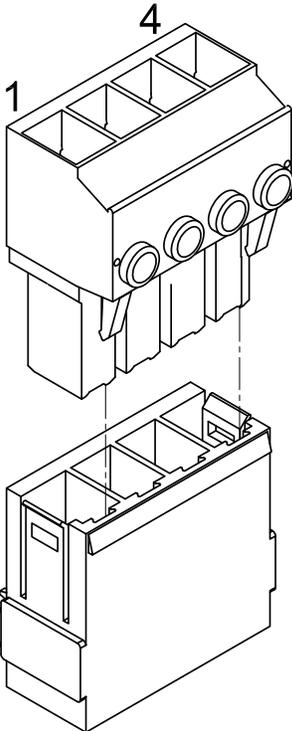


Figure 3-33 Non-UL Stand Alone AC Power Input Connector

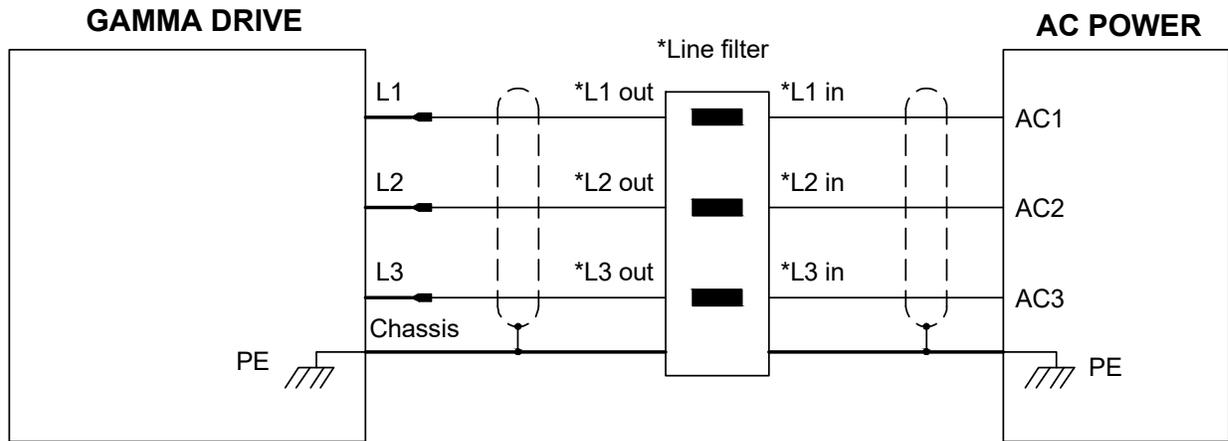


Figure 3-34 UL and Non-UL Stand Alone AC Power Input

Table 3-30 – UL and Non-UL Module DC Power Input and Motor Output Designation – 5 Pin

Pin #	Pin Type	Pin Name	Pin Function
1	Input	B-	DC Bus Return
2	Input	B+	DC Bus+
3	Output	T	Motor Phase T / Brush Output B
4	Output	S	Motor Phase S
5	Output	R	Motor Phase R / Brush Output A

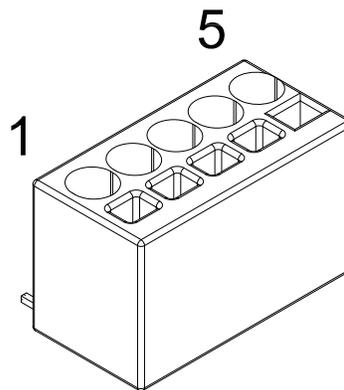


Figure 3-35 UL Module DC Power Input and Motor Output Connector

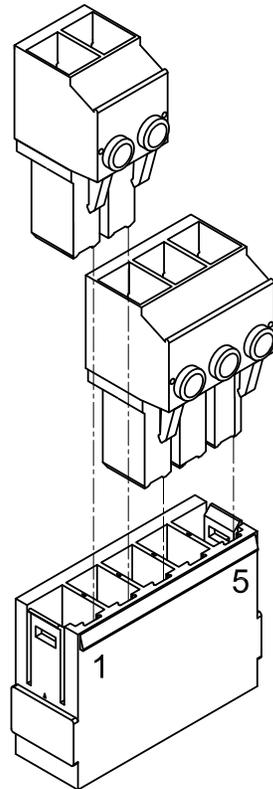


Figure 3-36 Non-UL Module DC Power Input and Motor Output Connector

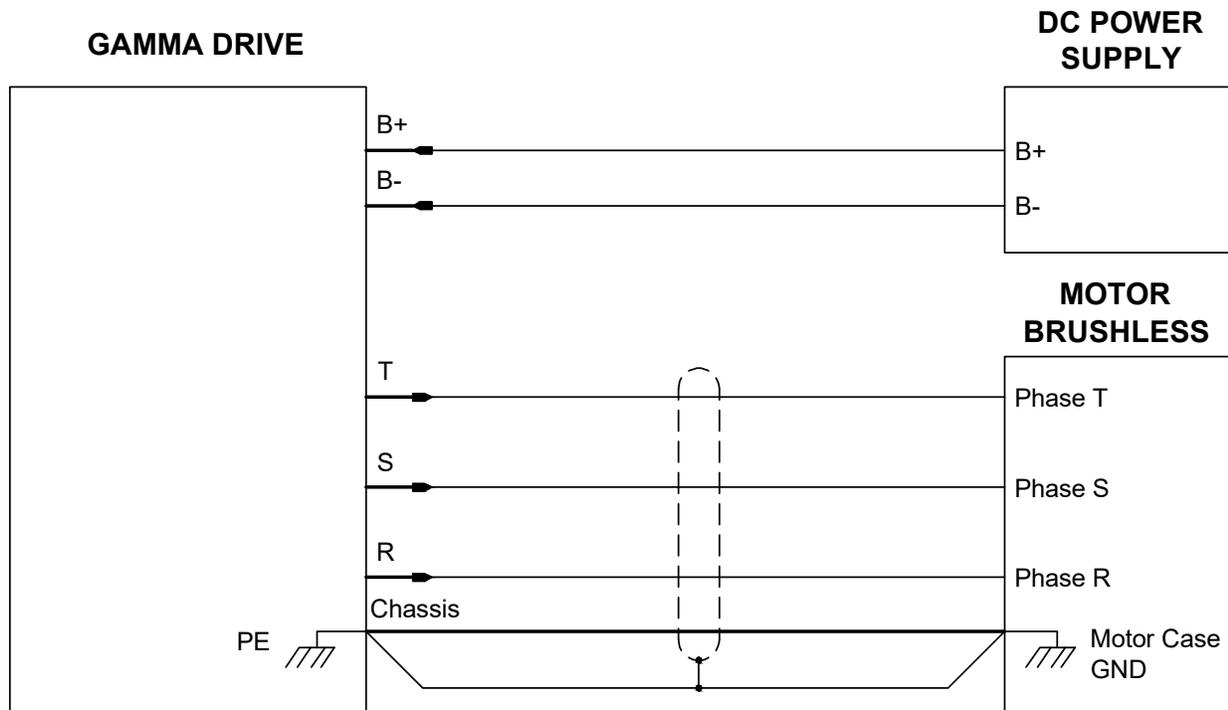


Figure 3-37 UL and Non-UL Module DC Power Input and Motor Output

4. Drive Setup

Glentek's Gamma Series Digital PWM Servo Drives are tuned utilizing Glentek's proprietary motion control software, MotionMaestro. Tuning is a process where coefficients of the drive's internal equations are optimized to match the motor and the inertial load of the system it is driving. It is important to achieve a high gain, high bandwidth, and critically damped velocity loop. This will result in optimum position loop performance. Pressing F1 on any window will open an additional window with more information. When any parameters are changed, it is necessary to send these changes to the drive. To do this, the drive must first be disabled, and then the values can be sent temporarily to the drive. To permanently save these changes, you must save to non-volatile memory after the values are sent to the drive (go to **Setup -> Save to NVM**).

4.1 Using MotionMaestro to Setup a Brushless Motor

This guide is intended for users who are looking to quickly setup their Gamma Series Drive for use with a rotary brushless motor that uses a quadrature (TTL) encoder with Hall sensors or commutation tracks. Other types of motors or feedback devices will follow a similar path, but will be slightly different. For more detailed information about the various MotionMaestro parameters and windows, please refer to appropriate sections of this manual.

1. Open Communications
 - a. Connect the drive to the PC via serial cable and connect the motor feedback cable to the drive.
 - b. Do **not** connect the motor power cable at this time, and make sure that the controller port has no input.
 - c. Turn on power to the drive.
 - d. Select **Communications -> Open**, select your drive, then press **OK**.
2. Motor Parameters
 - a. Select **Setup -> Motor Parameters**.
 - b. Make sure that the drive is disabled.
 - c. Enter values for *Motor Resistance*, *Motor Inductance*, and *Nominal DC Bus* according to the motor.
 - d. Enter 2000 for *Current Loop Bandwidth*.
 - e. Click **Send Values to Drive** then close the window.
3. Motor Safety (Typical Method)
 - a. Select **Setup -> Motor Safety**.
 - b. Compare the rated peak current of the motor and the rated peak current of the drive. Enter the lesser for *Current Limit*.
 - c. Compare the maximum rpm of the motor and the maximum desired rpm of your system. Enter the lesser for *Overspeed Threshold*.
 - d. If you will be operating in position mode, check the box next to *Position Following Error Limit* and enter a value for *Position Following Error Limit*.
 - e. By default, the box next to *Low Speed Electronic Circuit Breaker* will be checked. Compare the continuous current ratings of the motor and the drive. Enter the lesser for *Trip Current (amps)*, and enter a time of 2-4 seconds for *Trip Time (sec)*.
 - f. *Current Fold Back* and *I2T Protection Prediction* are optional motor safety methods.
 - g. Click **Send Values to Drive**, then close the window.
4. Commutation
 - a. Commutation is highly dependent on the feedback devices mounted to the motor. The following procedure is for a quadrature (TTL) encoder with Hall sensors or commutation tracks and Glentek Standard Alignment. Refer to the *Commutation* section of this manual for more information (p. [94](#)).
 - b. Select **Setup -> Commutation**.

- c. Select *Brushless* and *Rotary* for *Motor Type and Configuration*. Then check the boxes for *Quadrature (TTL)* and *Hall* under *Feedback Type Selection*.
 - d. On the *Commutation Config* tab, select *Hall* for *Initialization Type*. Enter the *Number of Poles* for the motor (for more information on this, see p. [132](#)). Enter 0 for *Angle Offset* and 0 for *Phase Lead*. Select *Hall Edge* under *Correction Method*, and enter 0 for *Hall Signal Offset (deg)* and 0 for *Index Offset*.
 - e. On the *Feedback Config* tab, enter the *Lines per Revolution* for the encoder and determine if your setup requires *Encoder Reverse* (Refer to *Encoder Reverse* p. [131](#)).
 - f. Click *Send Settings To Drive*, then close the window.
5. Drive Mode
 - a. Select *Setup -> Drive Mode*.
 - b. On the *Current* tab, ensure that *Enable* is checked, and *Two Phase Current Mode* is not. Ensure that *Enable* is not checked on the *Velocity* tab and the *Position* tab.
 - c. Enter the *Signal Gain* for your system under *Analog Input Setup*. To determine the maximum *Signal Gain*, divide your board's full-scale current (*I full scale A* under *Tools -> Model Info*) by 10.
 - d. Save to Non-Volatile Memory, *Setup -> Save to NVM*, then close the window.
 6. Connecting Power to the Motor
 - a. Select *Communications -> Close*, then turn off all power to the drive and wait approximately 30 seconds.
 - b. Ensure that there is no load on the motor. Connect the motor power leads and to the servo drive and the ground wire to a grounding point. Then turn on the logic power. Then turn on the motor power.
 - c. Open communications with your drive.
 - d. Ensure that the servo drive has no faults via *Status -> Drive Status*, then close the window.
 7. Current Mode Tuning
 - a. Verify that a positive current results in a positive velocity:
 - i. Select *Tools -> Control Panel*.
 - ii. Press *Options* and enter a value of 0.1 for *Current Step*. Press *OK*. Press *Enable Drive*. Increment the current by pressing the \gg button until the motor starts to spin. Both *Current (Amps)* and *Actual Velocity (RPM)* should be positive. If not check *Tach. Reverse*. Press *Stop*.
 - b. Determine the *Signal Offset*:
 - i. Open the *Control Signals* window, *Status -> Control Loop Signals*, and check the *Commanded* and *Measured Current* boxes. Open the *Drive Mode* window, *Setup -> Drive Mode*.
 - ii. Enter a 0 amp command for *Current (Amps)* on the *Control Panel* window. Verify that the *Commanded* and *Measured* values match (within a margin of error that suits your application). If they do not match, adjust the *Signal Offset* under *Analog Input Setup* in the *Drive Mode* window by the difference of the commanded and measured values.
 - c. Disable the drive and *Save to NVM*.

At this point your drive is ready to operate in current mode. Continue if you are using velocity or position mode.

8. Velocity Mode Tuning
 - a. Select *Setup -> Drive Mode*.
 - b. Select the *Velocity* tab, check *Enable*, then select from *Analog Input*, *50% PWM*, and *100% PWM*, depending on your system.
 - c. Select *Setup -> Servo Tuning*.
 - d. Set *the Loop Gain* to 10, then enable the drive. If it starts to run away, disable the drive and double check the previous steps. Otherwise, increase the *Loop Gain* to 100.

- e. Enter values for *Velocity Loop* gains. A starting point for general use would be 8 for *Compensation (Master Gain)*, 200 for *Integral*, 32767 for *Proportional*, 0 for *Derivative*, and 32767 for *Tach*.
- f. Click Setup Tuning Params and enter 0 for *Base Velocity*, 20% of the rated motor speed (RPM) for *Target Velocity*, 1 for *Step Duration*, and 1 for *Inter-Step Dwell*. Then, select *Bidirectional* and select *Continuous*. Press OK.
- g. Press Display Oscilloscope, press Start (Continuous), then adjust the gains until you see a satisfactory response. (See Section [4.3](#) for more detailed tuning instructions)
- h. Disable the drive and Save to NVM.

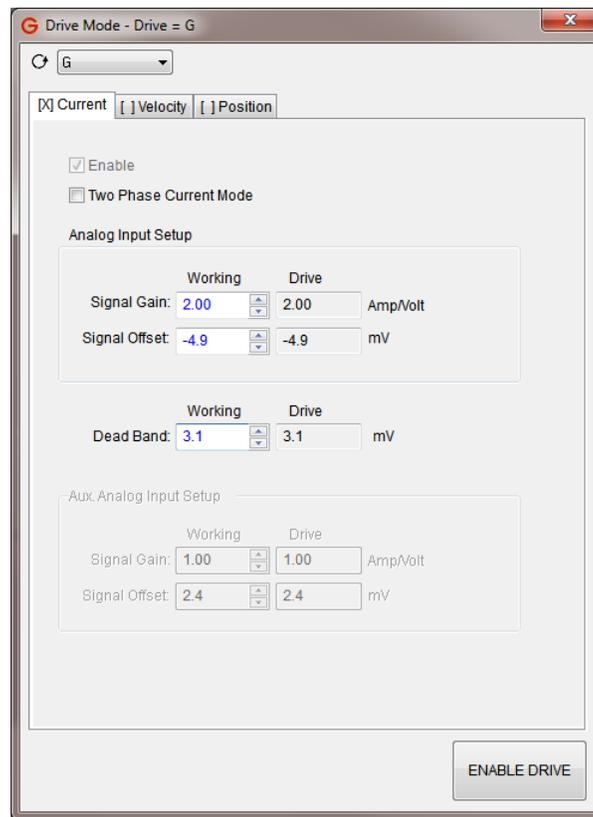
At this point your drive is ready to operate in velocity mode. Continue if you are using position mode.

9. Position Mode Tuning

- a. Select Setup -> Drive Mode.
- b. Select the *Position* tab, check *Enable*, then select *Digital Only* or *Pulse Follower*, depending on your system.
- c. Select Tools -> Control Panel, then click Set Zero Pos.
- d. Select Setup -> Servo Tuning.
- e. Enter values for *Position Loop* gains. A starting point for general use would be 64 for *Proportional Gain*, 0 for *Integral Gain*, and 0 for *Derivative Gain*.
- f. Click Setup Tuning Params and enter 0 for *Base Position*, the encoder line count for *Target Position*, 1 for *Step Duration*, 1 for *Inter-Step Dwell*, select *Bidirectional*, and select *Continuous*. Press OK.
- g. Press Display Oscilloscope, press Start (Continuous), then adjust the gains until you see a satisfactory response. (See Section [4.4](#) for more detailed tuning instructions)
- h. Disable drive and Save to NVM.

Your system may require additional setup beyond the scope of this guide. You can use MotionMaestro to setup Analog outputs, Digital I/O, filters, and more. If you need those features, please read the appropriate sections.

4.2 Current (Torque) Mode



If you wish to run your drive in current (torque) mode, complete the following steps.

Select Setup -> Drive Mode and click the tab for *Current*. Ensure that the drive is disabled.

Ensure that *Enable* is checked but *Two Phase Current Mode* is not.

Also ensure that there is no X in between the brackets next to the *Velocity* tab and the *Position* tab. If there is, click the appropriate tab and uncheck the *Enable* box.

4.2.1 Signal Gain

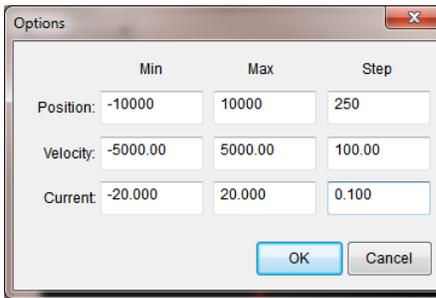
In current (torque) mode, the drive receives a +/- 10 VDC analog input signal from the control. The drive takes this signal and multiplies it by the *Signal Gain* parameter to determine the amount of current to output to the motor. Enter the *Signal Gain* for your system under *Analog Input Setup*. To determine the maximum *Signal Gain*, divide your board's full-scale current (*I full scale A* under Tools -> Model Info) by 10 VDC.

4.2.2 Tach. Reverse

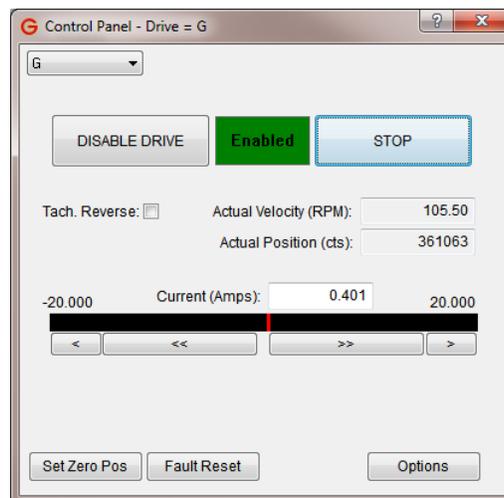
The *Tach. Reverse* option is used to ensure that a positive current command results in a positive velocity.

Open the *Control Panel* window by selecting Tools -> Control Panel. The control panel will be used to issue a current command to the drive and to view the velocity of the motor.

Click the Options button to view and edit the command limits and step increments. For most motors, a value of 0.1 for *Current Step* will be sufficient. Verify that the *Current Min* and *Current Max* values span a large enough range to see movement in your motor. Click OK.



Type 0 into the *Current (Amps)* field and press enter to ensure that the motor will not move when enabled. Enable the drive, then press the \geq button to positively increment the current command. Press the button until you see the motor move. Both the *Current (Amps)* and *Actual Velocity (RPM)* values should be positive. If the *Actual Velocity (RPM)* is negative, check the *Tach. Reverse* box.

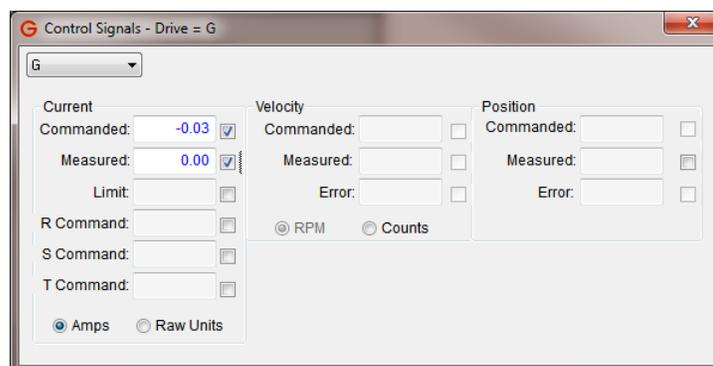


When complete, click Stop and Disable Drive. Save to NVM.

4.2.3 Signal Offset

When setting up your drive and motor, it is possible that there is a slight bias, positive or negative, in the analog input command signal. The *Signal Offset* parameter counteracts that bias.

To determine the *Signal Offset*, Open the *Control Signals* window, Status -> Control Loop Signals, and check the *Commanded* and *Measured* boxes in the *Current* section. Open the *Control Panel* window, Setup -> Control Panel, as well.



Enter a 0 amp command for *Current (Amps)* on the *Control Panel* window and enable your drive. Verify that the *Commanded* and *Measured* values match (within a margin of error that suits your application). If they do not match, adjust the *Signal Offset* under *Analog Input Setup* in the *Drive Mode* window by the difference of the *Commanded* and *Measured Current* values divided by the *Signal Gain*.

It is also possible to determine the amount of *Signal Offset* by clicking the up and down arrows to the right of *Signal Offset* in the *Drive Mode* window while viewing the *Commanded* and *Measured Currents*. Adjust the *Signal Offset* until the *Commanded* and *Measured Currents* match.

When complete, click Stop and Disable Drive. Save to NVM.

4.2.4 Dead Band

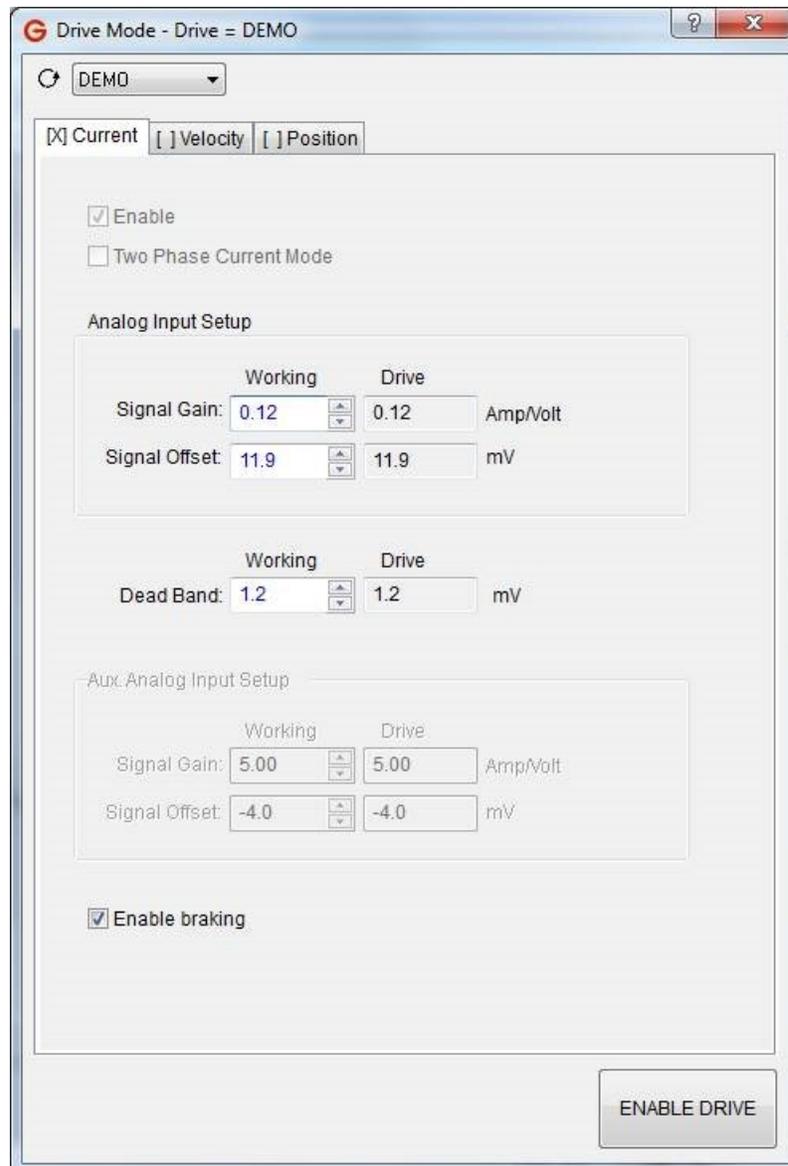
Analog input commands will often contain some degree of noise. Therefore, an analog input command of 0 VDC will not be exactly 0 VDC. The drive will read any discrepancy and output a current to the drive. The *Dead Band* parameter (in the *Current* tab of the *Drive Mode* window) is used to prevent that. The drive will treat any input command less than the *Dead Band* voltage as a 0 VDC command.

E.g. Set the *Dead Band* to 10 mV, and any input that is between -10 mVDC and +10 mVDC will be treated as 0 VDC.

4.2.5 Current Mode Brake Operation

One option for a control system is to use a brake to hold an axis while the drive is disabled. Pin 2 on the Logic Power/Brake/STO connector is used for brake output. By including the brake output on the Logic Power connector instead of the Controller I/O connector, wiring is simplified when the brake wires are in the motor power cable. Refer to Section [3.2](#) for connector details.

Select **Setup -> Drive Mode**, go to the *Current* tab and check the *Enable braking* option. In current mode, when the drive receives a disable command, the drive is disabled and the brake is activated immediately and simultaneously. Refer to Section [4.3.3](#) for information about the velocity mode brake operation.

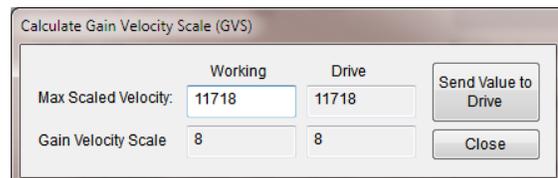
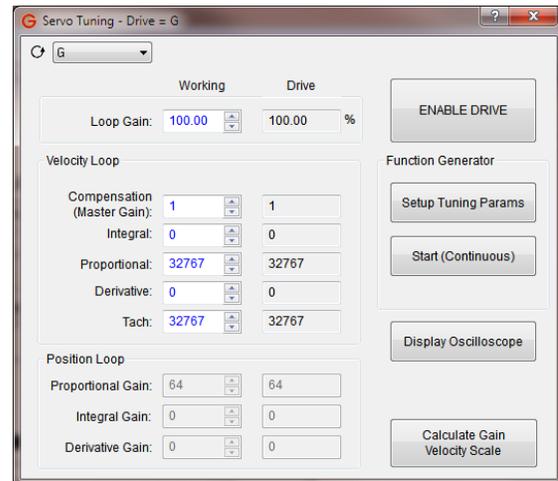


4.3 Velocity (RPM) Mode Tuning

For this section, refer to the *Velocity Control Loop Diagram* (p. 141). Before starting this section, be sure you have completed the current mode tuning for the drive as described in the previous section.

4.3.1 GVS (Gain Velocity Scale) Setting

1. Ensure that the drive is disabled. Click on **Setup -> Drive Mode**. Verify that only the current mode is active (the velocity and position modes are not enabled).
2. Click on **Tools -> Control Panel**. Click on **Enable drive** and enter a small positive current value (enough to rotate the motor) in the *Current (Amps)* field. Verify that the *Actual Velocity (RPM)* field displays positive velocity value. If the *Actual Velocity (RPM)* reading is negative for positive current command or vice versa, check or uncheck the *Tach. Reverse* selection box so that the sign of *Current (Amps)* and *Actual Velocity (RPM)* readings match.
3. Click on **Setup -> Save to NVM**. Click on **Yes** to save.
4. Click on **Setup -> Drive Mode**. Enable the velocity mode.
5. Click on **Setup -> Servo Tuning**, to open the *Servo Tuning* window.
6. Click on **Calculate Gain Velocity Scale** to open the *Calculate GVS* window. Enter the motor maximum velocity in the *Max Scaled Velocity* field.
7. Note: MotionMaestro will adjust the *Max Scaled Velocity* value to the exact velocity associated to the calculated GVS value. If the adjusted value is less than the required system operating speed, re-enter a larger *Max Scaled Velocity* value.
8. Click on **Send Values to Drive** to update the drive values, and then click on **Close** to close the window.

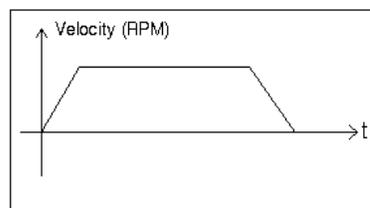
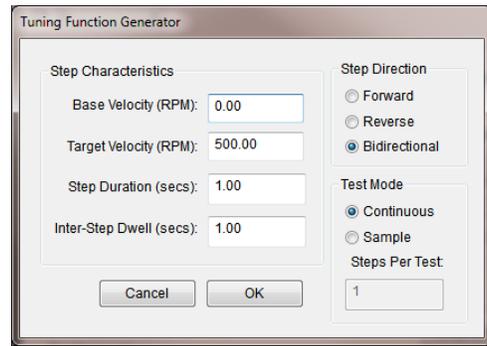


4.3.2 Velocity Loop PID Setting

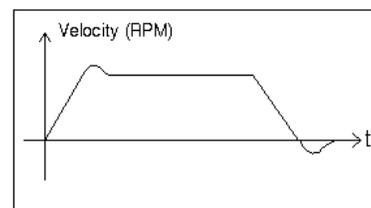
1. At the *Servo Tuning* window, set the *Loop Gain* field value to 100%.
2. Use the following velocity loop coefficient values for initial tuning:
 - Compensation (Master Gain): 1
 - Integral: 0

- Proportional: 32767
 - Derivative: 0
 - Tach: 32767
3. Click on Setup Tuning Params, to open the *Tuning Function Generator* window to setup an excitation signal needed during velocity tuning:
 - Enter 0 RPM for *Base Velocity (RPM)*.
 - Enter 500 (keep it to about 20% of motor rated) for *Target Velocity (RPM)*.
 - Enter 1 sec for *Step Duration (secs)*.
 - Enter 1 sec for *Inter-Step Dwell (secs)*.
 - In *Step Direction* section, select *Bidirectional*.
 - In *Test Mode* section, select *Continuous*.
 - Click OK to close the window.
 4. Click on Tools -> Oscilloscope to open the oscilloscope to display the system velocity response. Select the *Velocity Measured* trace to be displayed.

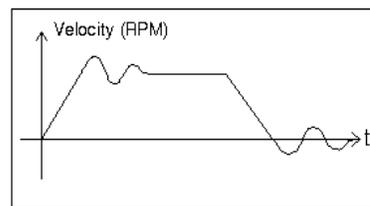
Note: The Time range (horizontal axis) and Y-range (vertical axis) may need to be adjusted to properly display the *Velocity Measured* waveform (refer to Section 5.16 for more information about MotionMaestro's oscilloscope).
 5. Go back to the *Servo Tuning* window, and enable the drive.
 6. Arrange the *Oscilloscope* window and the *Servo Tuning* window so that both can be seen side by side. Click on Start (Continuous) in the *Function Generator* section. Click Yes to start the step response.
 7. Slowly increase the *Compensation (Master Gain)* field value until the oscilloscope waveform shows a critically damped response. This should be achieved without the system becoming unstable. The compensation can be increased or decreased by the up and down arrow keys on the keyboard when the cursor is in the *Compensation* edit box.
 8. The following illustrations provide a reference for the waveforms on the oscilloscope. Note that a critically damped waveform is an ideal response for most applications.



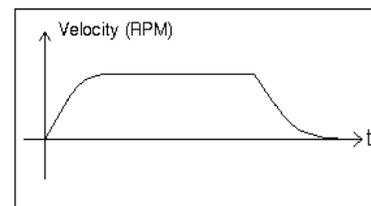
A.) Critically Damped Signal



B.) 1 Hook Overshoot Signal



C.) Under Damped Signal



D.) Over Damped Signal

Figure 4-1 Oscilloscope Waveforms

9. Tuning suggestions:
 - In most cases, increasing the compensation value should tune the drive to the application. Try to achieve a compensation value of six or better for high gain loop.

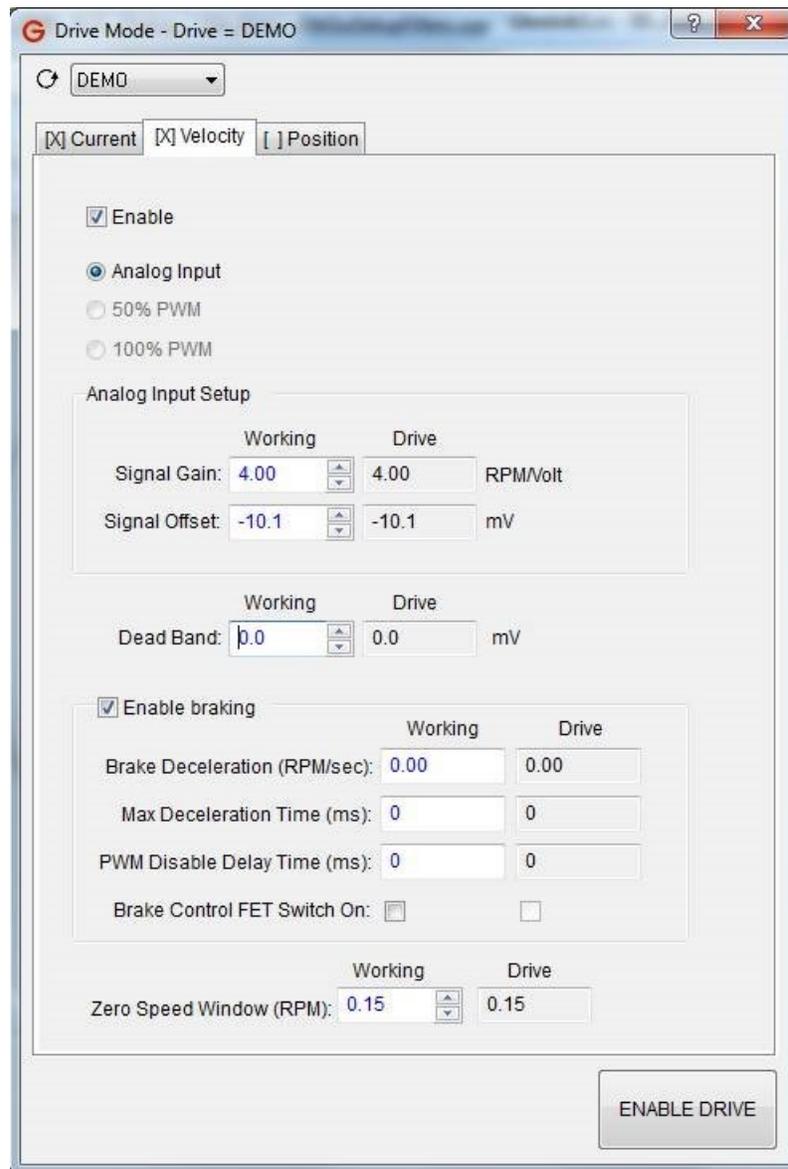
- Integral gain may be increased to achieve stiffness at zero speed. However, do not add too much, as the system may become unstable. Try to keep the maximum integral gain to less than 1000.
 - In most cases, derivative gain is not needed. However, in systems with high inertia, you may want to increase derivative gain toward 2,000, and in systems with low inertia, you may want to decrease derivative gain toward 1,000 to achieve a critically damped response.
10. When the response is achieved, click on Stop in *Function Generator* section to stop the motor. Click on **Setup -> Save to NVM**. Click on Yes to save.

The drive is now optimally tuned to run in Velocity Mode.

4.3.3 Velocity Mode Brake Operation

One option for a control system is to use a brake to hold an axis while the drive is disabled. Pin 2 on the Logic Power/Brake/STO connector is used for brake output. By including the brake output on the Logic Power connector, instead of the Controller I/O connector, wiring is simplified when the brake wires are in the motor power cable. Refer to Section [3.2](#) for connector details.

Select **Setup -> Drive Mode -> Velocity** and check the *Enable braking* option. In velocity mode as compared to current mode there are additional parameters that need to be specified. These parameters define the Brake/Stop sequence (see the next page for details).



Brake/Stop Sequence

The following sequence starts when the drive receives a disable command and *Enable braking* is checked.

The motor starts to decelerate at the rate specified by *Brake Deceleration*. At the same time, a counter for *Max Deceleration Time* starts. A nonzero *Max Deceleration Time* allows the drive to slow the motor before activating the brake.

If either the motor velocity reaches the *Zero Speed Window* (Figure 4-2) OR the *Max Deceleration Time* is reached (Figure 4-3), the brake is activated and the *PWM Disable Delay Time* counter starts.

Once the *PWM Disable Delay Time* is reached, the drive is disabled. This delay ensures that the brake has time to engage before disabling the drive.

The *Brake Control FET Switch On* box determines the type of signal sent to the brake when it is activated. The majority of brakes will activate if no power is being supplied. If that is how your brake works, leave the *Brake Control FET Switch On* box unchecked. If the brake requires power to activate, check the box.

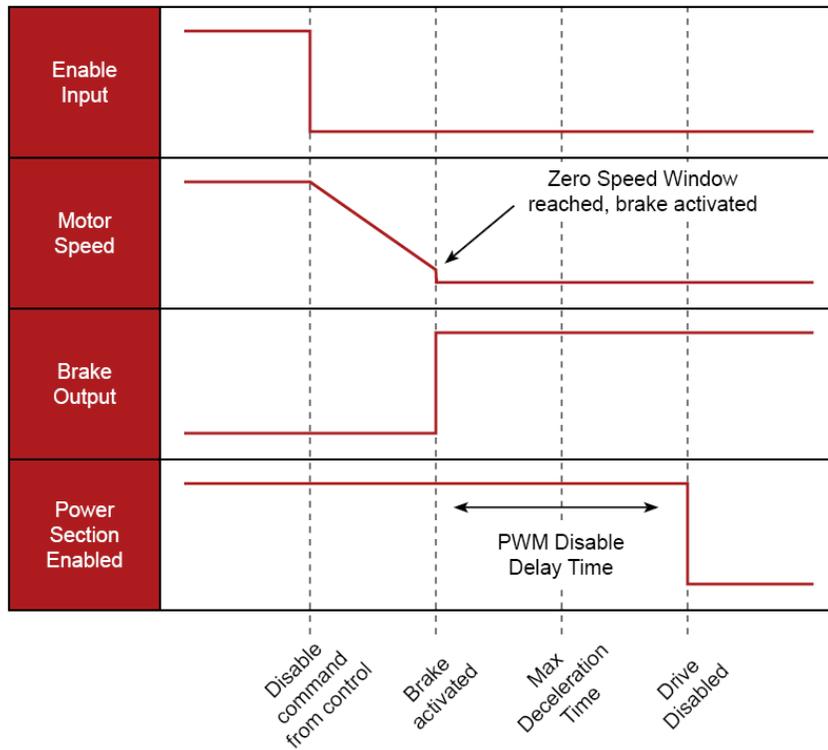


Figure 4-2 Brake/Stop Sequence If Zero Speed Window is Reached

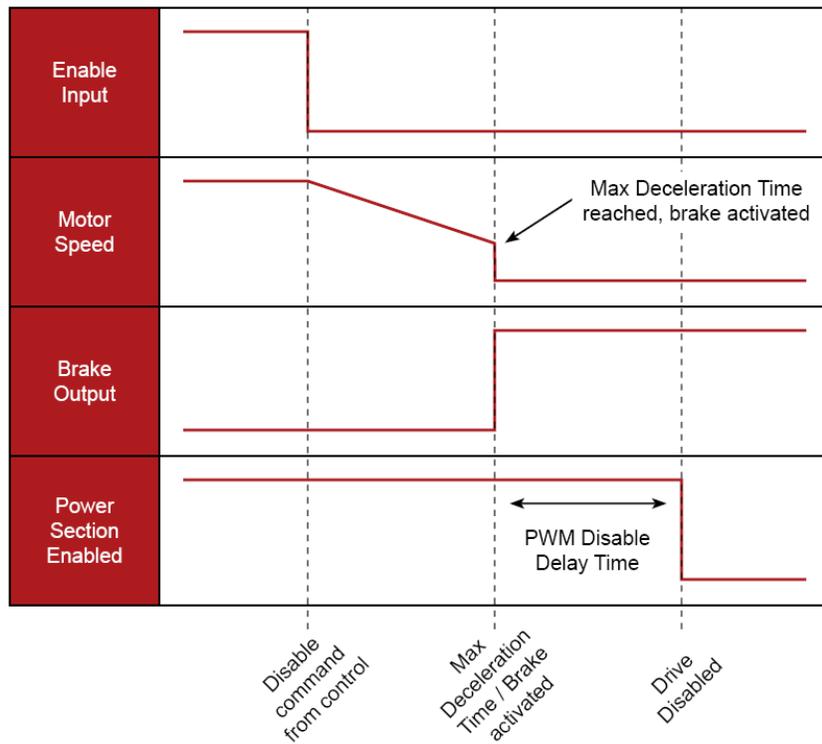


Figure 4-3 Brake/Stop Sequence If Maximum Deceleration Time is Reached

4.4 Position Mode

4.4.1 Pulse Follower Position Mode Tuning

The user must first tune the velocity loop before tuning the position loop. See *Velocity Tuning* (p. 68). Be sure to save velocity loop coefficients to NVM.

The position loop must be tuned for the drive and motor before they can be used optimally, regardless of whether the command signal inputs are Pulse and Direction, CW and CCW Pulse, or Encoder Quadrature A/B types.

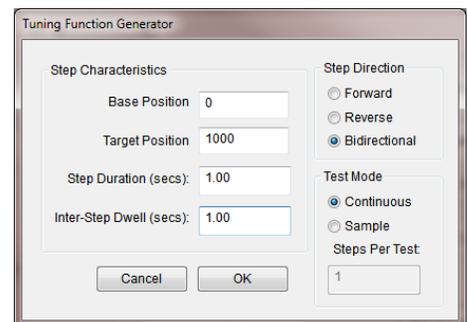
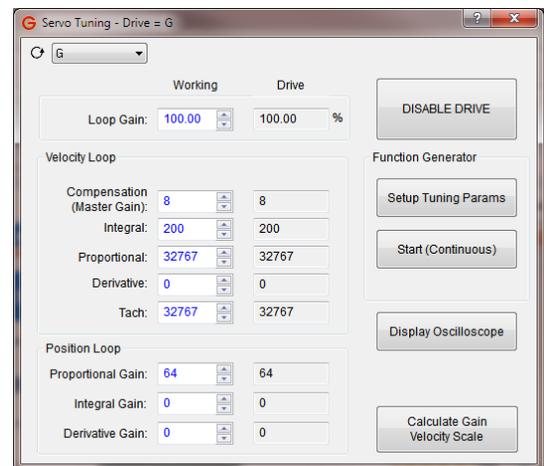
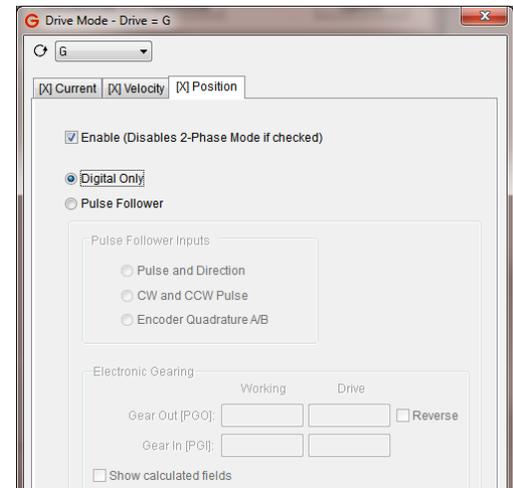
When tuning, the step function can come from external command signals (through the Controller I/O connector), or MotionMaestro generated step function signal. Use an external position command if possible to tune the position loop and skip steps 5 and 6 below because the built-in *Function Generator* feature in current version of MotionMaestro does not have position trajectory generator. Refer to *Configure Pulse and Direction Follower Mode* (p. 75) for setting up the command signal inputs. The following procedure use MotionMaestro step function.

1. Click on **Setup -> Trajectory Generator**. Disable the acceleration and deceleration limits by checking the *Acceleration Disabled* and *Deceleration Disabled* selection boxes. Enter the maximum speed of the motor in the *Velocity Limit* field.
2. Click on **Setup -> Drive Mode**, then the *Position* tab, enable *Pulse Follower* mode, and select *Pulse and Direction* inputs option.
3. Click on **Tools -> Control Panel**. Initialize the position counter to zero by clicking on *Set Zero Pos* before attempting to tune the drive in position mode.

Note: Failure to clear the counter may result in the motor running away when first pulsing the motor.

4. Click on **Setup -> Servo Tuning**, to open the tuning window where different gain values of the *Position Loop* section can be changed. Start by setting *Proportional Gain* to 64, *Integral Gain* and *Derivative Gain* to 0 in the *Position Loop* section.
5. Next, setup an excitation signal needed for position mode tuning. Click on **Setup Tuning Params**, to set the following):
 - Enter 0 for *Base Position*.
 - Enter a value of encoder edge counts (after quadrature, this should result in a < 45° move) for *Target Position*.
 - Enter 1 for *Step Duration* and for *Inter-Step Dwell*.
 - Select *Bidirectional* in the *Step Direction* section.
 - Select *Continuous* in the *Test Mode* section.
 - Click **OK** to close the *Tuning Function Generator* window.

6. In the *Servo Tuning* window, click on **Display Oscilloscope** to open the oscilloscope to display the system position response. Select the *Position Measured* trace to be displayed.



Note: The Time range (horizontal axis) and Y-range (vertical axis) may need to be adjusted to properly display the *Position Measured* waveform.

7. Arrange the *Oscilloscope* window and the *Servo Tuning* window so that both can be seen side by side. Enable the drive and click on Start (Continuous) in the *Function Generator* section. Click OK to start the step response.
8. While the motor pulses back and forth, increase the *Proportional Gain* to as high a value as possible without causing any oscillation. Next, slowly increase *Integral Gain* as much as possible to achieve a quick response. Normally there is no need to add any *Derivative Gain* to the system. However, if the system must have some derivative gains, slowly increase the value in the *Derivative Gain* field to help calm down the oscillation. Observe the response through the oscilloscope. The feedback encoder quadrature edges are counted into a 32-bit position feedback counter and this counter is compared with a scaled input command 32-bit counter. The position difference is then amplified by a proportional gain and used as an error velocity command. This command is used as an input to the velocity loop; see *Command Input Control Diagram* on p. [140](#).
9. When the response is achieved, click on Stop in *Function Generator* section to stop the motor. Click on **Setup -> Save to NVM**. Click on Yes to save.

The drive is now optimally tuned to run in Pulse Follower Position Mode.

4.4.2 Configure Pulse and Direction Follower Mode

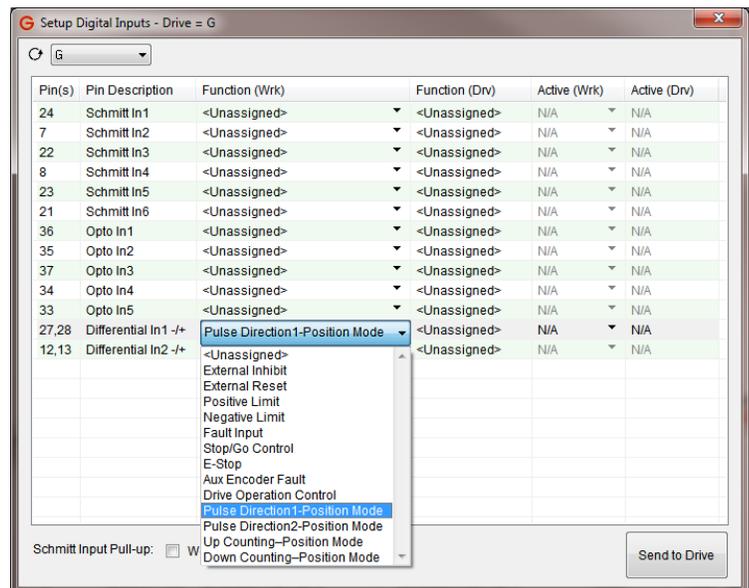
The velocity and position mode tuning procedures must be completed prior to the implementation of this section.

When operating in Pulse (Step) and Direction Follower Mode, the first input is a pulse train that establishes the distance and velocity of the motor and the second input is a direction signal (Hi/LO) that establishes the direction of the motor.

Gamma Series Drives can accept pulse and direction inputs through three types of inputs, single ended Schmitt trigger inputs, opto-isolated inputs, or differential digital inputs. It is highly recommended that the user select and use differential digital inputs because they have good immunity to common mode noise. If single ended 24 V signal is provided, use Schmitt trigger inputs as Pulse and Direction Follower command inputs. Opto-isolated inputs are not recommended for high-speed applications due to their slow response rate. Refer to *Programmable Digital Inputs* on p. 26 for more detail.

A) Setup Programmable Digital Inputs.

1. Click on **Setup -> Digital Inputs**. In the *Function* column, click the down arrow that corresponds to pins 27, 28 and select **Pulse Direction 1 – Position Mode**. Pins 27 and 28 are the pulse inputs.
2. In the *Function* column, click the down arrow that corresponds to pins 12, 13 and select **Pulse Direction 2 – Position Mode**. Pins 12 and 13 are the direction inputs.
3. Click on **Send To Drive**, to update the the drive values.
4. Click on **Setup -> Send to NVM**. Click on **Yes** to save.



Note: Refer to Control I/O Interface for wiring diagram.

One of the applications for Pulse and Direction Follower Mode is in replacing an existing stepper motor system. Many stepper motor controllers provide this pulse type and allow upgrading a stepper motor system to a servo motor system without the need to change controllers.

It is important to note that to scale an encoder feedback to the typical stepper scale of 1 pulse = 1.8° of rotation, the encoder count must be evenly divisible by 200.

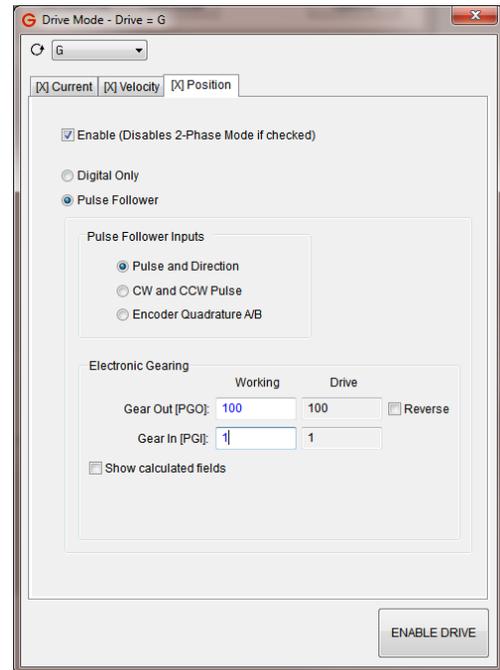
An example of pulse system scaling is described as follows:

- a. Feedback Encoder = 5,000 lines per revolution
 - b. Desired motor rotation per input pulse = 1.8°
- 1 rev (360°) of feedback encoder = 5,000 * 4 = 20,000 counts
 $1.8^\circ / 360^\circ * 20,000 = 100$ counts

Therefore, each input pulse to the drive must increment the motor encoder by 100 quadrature counts. To achieve this, in the *Drive Mode* window *Position* tab, set *Gear In [PGI]* to 1 and *Gear Out [PGO]* to 100 such that 1 pulse in = 100 pulses out.

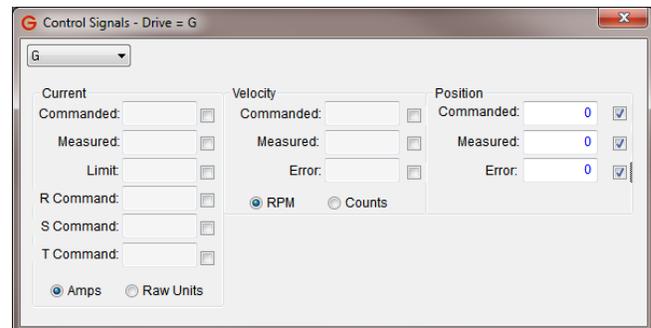
B) Setup Position Mode.

1. Click on **Setup -> Drive Mode**. Disable the drive.
2. In the *Position* tab click *Pulse Follower* and *Pulse and Direction*.
3. Note: Ensure that the drive is disabled before proceeding to the next step and changing the PGI and PGO values or clicking on the *Reverse* check box as it may cause undesired motor behaviors.
4. Enter a value for *Gear In [PGI]*, and a value for *Gear Out [PGO]*, depending on your system. The parameters are updated on the fly. That is, any changes will take effect immediately after a value is entered.
5. Check or uncheck the *Reverse* box to reverse the motor direction.
6. Click on **Setup -> Save to NVM**. Click on Yes to save.



C) Setup Control Signals.

1. Click on **Setup -> Control Signal**. In the *Position* section check the *Commanded*, *Measured*, and *Error* boxes. The following error can also be monitored using the MotionMaestro *Oscilloscope* window. If the error is less than 100 counts the motor will Always follow within 1.8° . For more info, refer to the MotionMaestro guide at "www.glentek.com".



The drive is now set up to accept pulse and direction follower command inputs.

4.4.3 Configure Encoder Quadrature A/B (Encoder Follower) Mode

When operating in Encoder Follower Mode, the outputs of an incremental encoder or an encoder pot determine distance and direction. This is useful for slaving one motor to another by connecting the master motor's encoder output to the slave motor's drive.

An additional example of encoder follower scaling is described as follows:

1. Input command encoder (master) = 2,000 lines per revolution
2. Feedback following encoder (slave) = 5,000 lines per revolution
3. Desired following ratio = 1 revolution to 1 revolution

Set PGI = 2 and PGO = 5

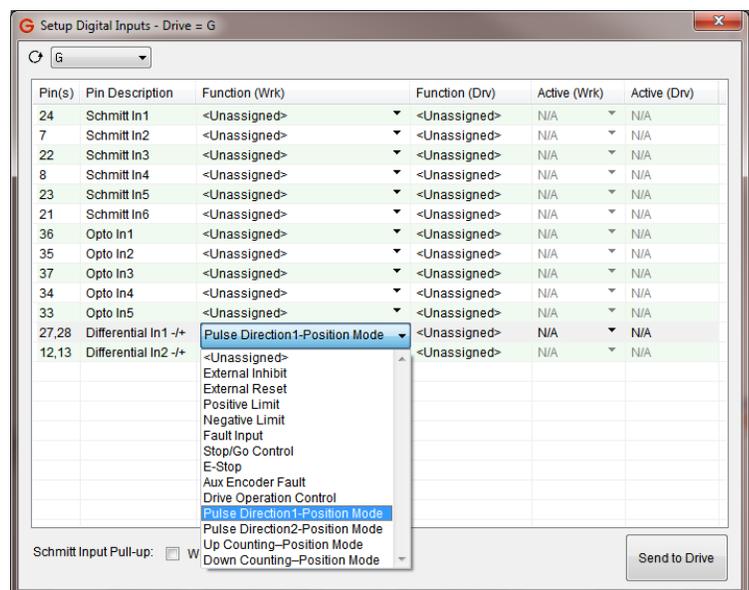
For every 2 pulses of the input command encoder (master), the input command position counter will be incremented by 5 counts.

To further explain the above scaling example, an additional description is provided as follows:

Let us pick the example where we have a shaft somewhere in a system that has a 2000 line encoder mounted to it and we want to remotely slave another shaft to this encoder. On this remote shaft, we mount a servo motor with a 5000 line encoder. Then, we connect the 2000 line encoder to the inputs of the remote servo drive in the pulse follower mode and set PGI = 2 and PGO = 5. This sets up the ratio for every two counts of the 2000 line encoder the 32-bit input command position counter (see *Position Mode Control Diagram* on p. 139) is incremented by 5 counts. Now the remote servo will follow on a 1 to 1 ratio. That is, the remote motor with 5000 line encoder will rotate one revolution when the 2000 line encoder motor rotates one revolution. When used as an encoder follower, the count (lines) per revolution of the encoder is preferred to have either both binary or both decimal.

A) Programmable Digital Inputs.

1. In this mode of operation (Encoder Follower), the drive can only accept command signals through the differential inputs.
2. Click on **Setup -> Digital Inputs**. In the Function column, click the down arrow that corresponds to pins 27, 28 and select Pulse Direction 1 – Position Mode. Pins 27 and 28 are the pulse inputs.
3. In the Function column, click the down arrow that corresponds to pins 12, 13 and select Pulse Direction 2 – Position Mode. Pins 12 and 13 are the direction inputs.
4. Click on **Send To Drive**, to update the the drive values.
5. Click on **Setup -> Save to NVM**. Click on **Yes** to save.
6. **Note:** Refer to Control I/O Interface for wiring diagram.

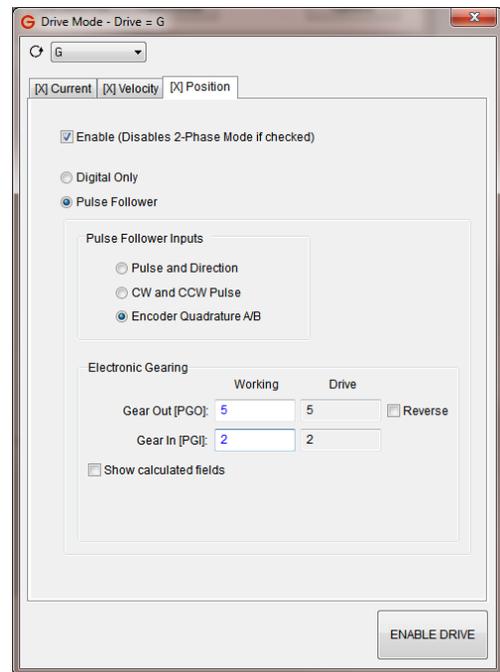


B) Setup Position Mode.

1. Click on **Setup -> Drive Mode.**
2. In the *Position* tab, select *Pulse Follower* and *Encoder Quadrature A/B*.

Note: Ensure that the drive is disabled before changing any PGI and PGO values, or click on the *Reverse* check box as it may cause undesired motor behaviors.

3. Enter a value for *Gear In [PGI]*, and a value for *Gear Out [PGO Out]*, depending on your system. The parameters are updated on the fly. That is, any changes will take effect immediately after a value is entered.
4. Check or uncheck the *Reverse* box to reverse the motor direction.
5. Click on **Setup -> Send to NVM.** Click on yes to save.



The drive is now set up to accept encoder quadrature A/B command inputs.

4.4.4 Configure CW and CCW Pulse Follower Mode

When operating in CW (clockwise) and CCW (counter-clockwise) Mode, two input pulse trains are sent to the drive, one for CW rotation and one for CCW rotation.

The *Electronic Gearing* box is used to set the ratio between pulses into the drive (PGI) from the controller and the pulses into the drive from the encoder (PGO) (quadrature count).

If PGI = 1 and PGO = 1, one input pulse = one encoder pulse.

If PGI = 1 and PGO = 2, one input pulse = two encoder pulses.

If PGI = 2 and PGO = 1, two input pulses = one encoder pulse.

A) Programmable Digital Inputs.

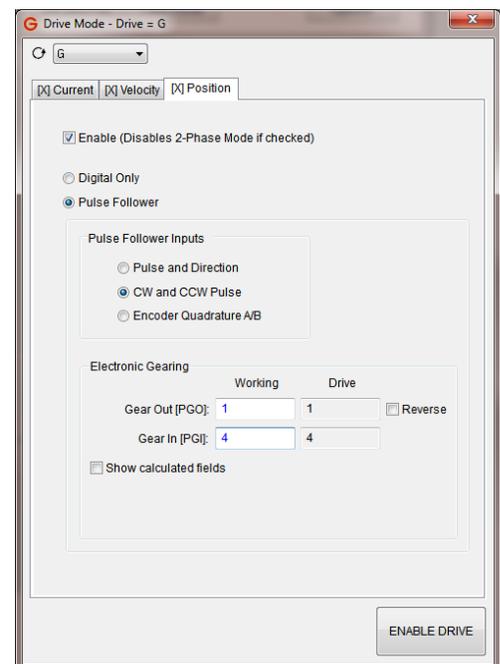
1. Click on **Setup -> Digital Inputs**. Assign *Pulse Direction 1* and *Pulse Direction 2* to the desired input pins. Any of the three digital input types may be used (Schmitt, opto, or differential).

B) Setup Drive Mode.

1. Click on **Setup -> Drive Mode**.
2. In the *Position* tab, select *Pulse Follower*, and *CW and CCW Pulse*.

Note: Ensure that the drive is disabled before changing the PGI and PGO values, or clicking on the *Reverse* check box as it may cause undesired motor behaviors.

3. Enter a value for *Gear In [PGI]* and a value for *Gear Out [PGO Out]*, depending on your system. The parameters are updated on the fly. That is, any changes will take effect immediately after a value is entered.
4. Check or uncheck the *Reverse* box to reverse the motor direction.
5. Click on **Setup -> Save to NVM**. Click on Yes to save.



The drive is now set up to accept CW and CCW pulse follower command inputs.

4.5 Two Phase Current Mode Tuning

The following procedure details the steps that allow the user to configure the drive to operate in two phase current mode with the most optimized settings. After each step, send the values to the drive and click on **Setup -> Save to NVM** to save the values to NVM.

4.5.1 Preliminary Setup

1. With the drive's power off, connect the command signal inputs (Signal 1 +/-, Signal 2 +/-) and the logic common from the controller to the drive. Leave the motor power leads disconnected from the drive.
2. Set the system controller command signals to 0 V (at the controller) for both the Signal 1 (Phase R) and the Signal 2 (Phase S) inputs to the drive.
3. Apply power to the drive and open communications to the drive with MotionMaestro.
4. Click on **Setup -> Setup Digital Inputs** and **Setup -> Setup Digital Outputs** to configure the digital I/O's as required by the system.

4.5.2 Setup Motor

1. Click on **Setup -> Motor Parameters**, to enter the *Motor Resistance* and *Motor Inductance* values of the motor, and the bus voltage for the system. For the *Current Loop Bandwidth (Hz)*, use a value of 2500 as a starting point (values can range up to 4000 maximum). If the *Motor Inductance* is less than 1 mH, check the *Fine Tuning* check box to expand the setup options. Refer to the *Fine Tuning* section for further details (p. 83).
2. Click on **Setup -> Motor Safety**, to set the *Current Limit (amps)*, *LSECB Trip Current (amps)*, *LSECB Trip Time (sec)*, *Foldback Trip Current (amps)*, and *Foldback Rate (amps/sec)* to the desired operational settings.

	Working	Drive
Motor Resistance (ohms):	0.40	0.40
Motor Inductance (mh):	3.50	3.50
Nominal DC Bus (volts):	325	325
Current Loop Bandwidth (Hz):	2500	2500
Proportional Current Gain (%):	94.450	94.450
Integral Current Gain (%):	5.94	5.94
Master Gain (GIM):	8	8

Fine Tuning

ENABLE DRIVE Send Values to Drive

4.5.3 Configure Command Signal Inputs

1. Click on **Tools -> Oscilloscope**. Click on *Settings* and select *Primary Command* and *Auxiliary Command* traces to be displayed. Adjust the vertical scale so that the offsets can be observed clearly on the screen.
2. Click on **Setup -> Drive Mode**. Select *Two Phase Current Mode*.
3. Set *Signal Gain* values for *Analog Input Setup* (Signal 1 command) and *Aux. Analog Input Setup* (Signal 2 command) to the desired Amp/Volt parameters based on the system requirement. Set the *Dead Band* value to 0 (this can be set to desired values after command signal input offsets are balanced).
4. Verify that the *Primary Command* and *Auxiliary Command* traces are sweeping across the oscilloscope about the 0 value on the vertical axis. Adjust the *Signal Offset* values until the observed offset is zero for both signals.



4.5.4 Drive Running

1. Remove the drive's power. Connect the motor phase R, S, and T leads to the drive's R, S, and T terminals respectively.
2. Power on the drive. Check, then clear all faults by referring to the *Drive Status* window.
3. From the system controller, enable the drive, and command a small signal to the inputs of the drive. Use the MotionMaestro Oscilloscope to verify that the commanded input is as expected. Ensure not to command signals that cause greater current than the motor can handle.
4. Set the controller command signals to 0 V.

The drive is now optimally tuned to run in Two Phase Current Mode.

4.6 Tachometer Feedback Dedicated Drive

This section is only for users who have purchased a dedicated drive to run a brushed motor with an analog DC tachometer. Remember to save all changes (**Setup -> Save to NVM**). This section assumes you are already familiar with sending values to the drive and opening communications.

1. The drive is preconfigured at the factory for a brushed motor.
2. In the **Setup** dropdown configure the *Motor Parameters* and the *Motor Safety* sections based on the motor data sheet for your motor.
3. Continue to **Setup -> Commutation** and select the *Feedback Config.* tab. The *Tachometer Data* box should be preconfigured for a 7 V/kRPM tachometer. This is a very common tachometer. Change this setting if you are using a tachometer with a different voltage constant. See the *Tachometer Data* section of this manual for more information on the tachometer data setup (p. [102](#)).
4. Turn off the power to the drive and disconnect the motor from the load for a safe start up. Connect the motor wires, tachometer wires, and signal input wires. Turn on the power to the drive. Go to the **Tools -> Control Panel** and push the **Enable/Disable Drive** button to enable the drive. The drive is configured from the factory in current (torque) mode. Before changing to velocity mode give a small *positive* current command in the *Control Panel* command bar and observe the velocity polarity. If the velocity polarity is negative, check the *Tach. Reverse* box. Repeat the positive current command and confirm that the velocity is now positive.
5. In **Setup -> Drive Mode** select the *Velocity* tab, check the *Enable* box and enter a signal gain value in the *Signal Gain* box that scales your analog input signal to your desired velocity (volts of tachometer feedback). Enable the drive and observe the motor shaft, which will most likely be rotating slowly. Use the *Signal Offset* to balance the signal and stop any rotation of the motor shaft.
6. Apply an input signal and observe the motor as it responds by accelerating to the commanded speed.
7. Go to the *Fine Tuning* section (p. [83](#)) of this manual to tune the velocity loop for the desired velocity loop response (damped response).

4.7 Fine Tuning (Manual Tuning)

Current loop bandwidth values can be set manually if the user prefers. This is recommended if the motor inductance is less than 1 mH or more than 20 mH. Running Bode plots to optimize the response is recommended. Alternatively, you can apply a step command and observe the response on the MotionMaestro oscilloscope for a critically damped response (see [Figure 4-1](#)).

In **Setup -> Filters** select the *Filter One* tab, select *NONE* in the drop down box, push the **Generate Working Conditions** button, then push the **Send to Drive** button. Repeat for the *Filter Two* tab and the *Filter Three* tab, setting both to *NONE*.

In **Setup -> Motor Parameters** check the *Fine Tuning* box and the *Manual Tuning* box. Set the *Proportional Gain (GIP)* to a small value (32,767 is the maximum) and increase the value until the motor makes an audible sound. Reduce the *GIP* value to 80% of that value, or further if the audible sound persists.

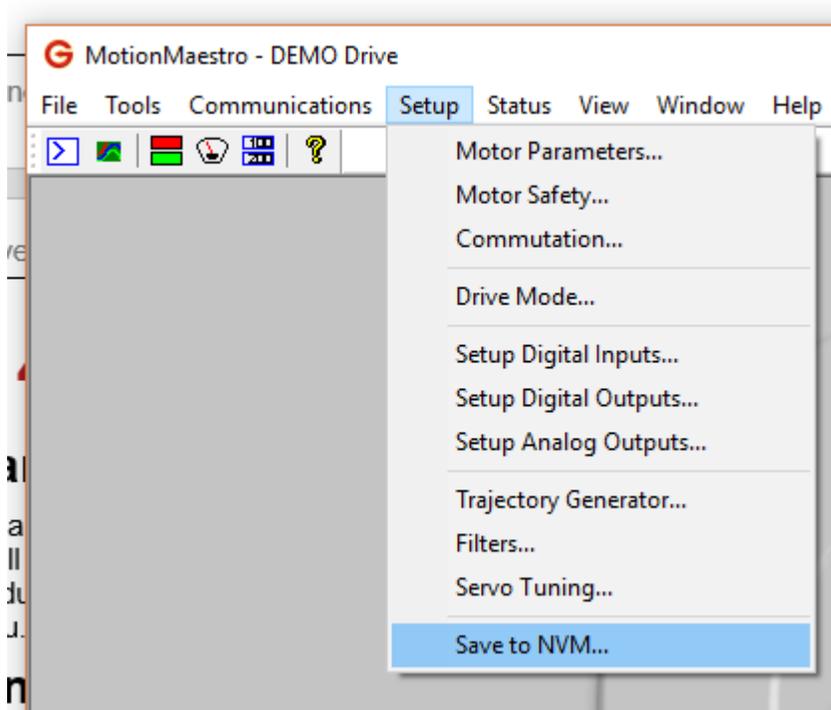
Adjust the *Master Gain (GIM)* (32,767 is the maximum) and observe results. The Overall Gain = $GIP/32767 * GIM$. Keep the *GIP* as high as possible, observe your results (Bode plot or oscilloscope), and maximize the overall gain.

Integral Gain (GII) is typically 10% or less of the *GIP* value. More than 10% usually causes motor instability.

5. MotionMaestro©

5.1 Important Information Before Starting

When using MotionMaestro, the changes you make are only made to the current memory of the drive. If power is lost or the drive is reset, all settings will revert to the stored memory. To make the changes permanent and load during the next power cycle, you must use the **Setup -> Save to NVM** command. This will save your changes into the permanent non-volatile memory (NVM) storage of the drive.



5.2 Installing MotionMaestro

MotionMaestro requires Windows XP, Windows Vista, or Windows 7/8/10 operating system running on a PC with at least one serial port. It is suggested that you have no less than 30 megabytes of application program disk space remaining on the hard drive prior to installation. The MotionMaestro install USB Stick is setup to utilize Install Shield to simplify installation. When installation is complete, you will find a MotionMaestro shortcut on the Windows Start\Programs menu and on the desktop.

The MotionMaestro installation program is named *Setup.exe*. It is found in the MotionMaestro directory of the distribution USB Memory Stick. The installation will create a Glentek folder in the Program Files folder. A MotionMaestro X.X folder is created where X.X matches the version number. You can have multiple versions of MotionMaestro installed if you wish. Each will be placed into its own directory.

Start the *Setup.exe* and follow the prompts accepting the defaults unless you have otherwise received instructions.

5.3 Conventions used in this manual

The following conventions will be used in this section to describe commands, mouse movements, and program menus:

Main Application Window:

This is the main window or view of the application. It contains the menus and the main toolbar. MotionMaestro's functions depend on this window being open. If this window is closed, the application will close and will need to be opened again to function. The application window can be closed either with the *File* menu or by clicking the X in the top right corner of the window.

Application Sub-Windows:

Specific sets of functionalities are presented to the user in windows. A window displays like the main application window, but can be moved around to the user's desired layout and workflow. A window can be closed by clicking on the little boxed X in the upper right corner of the window. This will close only the individual window instead of the main application window.

Notifications:

Notifications are how MotionMaestro directly interacts with the user. This is where questions or statuses are specifically shown and require interaction from the user prior to allowing the user to continue. Notifications are often referred to as blocking because they prevent further actions by the user until the notifications are either closed or resolved. A notification will either require a choice between two or more options or it will simply request confirmation.

Menu Selections:

This manual describes choices made through the menu system contained in the top bar of the application window. These will be highlighted by a bold font which has been underlined and italicized. It will begin with the top-level menu, followed by a dash and greater than sign (->), followed by the menu selection. If additional selections are needed, they will follow the same menu selection model with a dash and greater than sign (->).

Example: ***File -> Exit***

Buttons:

Buttons are the method through which a user directs MotionMaestro to do something. When a button is clicked, MotionMaestro will perform the action which is on the button label. In this manual, references to buttons will be italicized and underlines.

Example: ***Send Values to Drive***

Parameters

Parameters are fields where the user can enter values. Parameters are represented in italics.

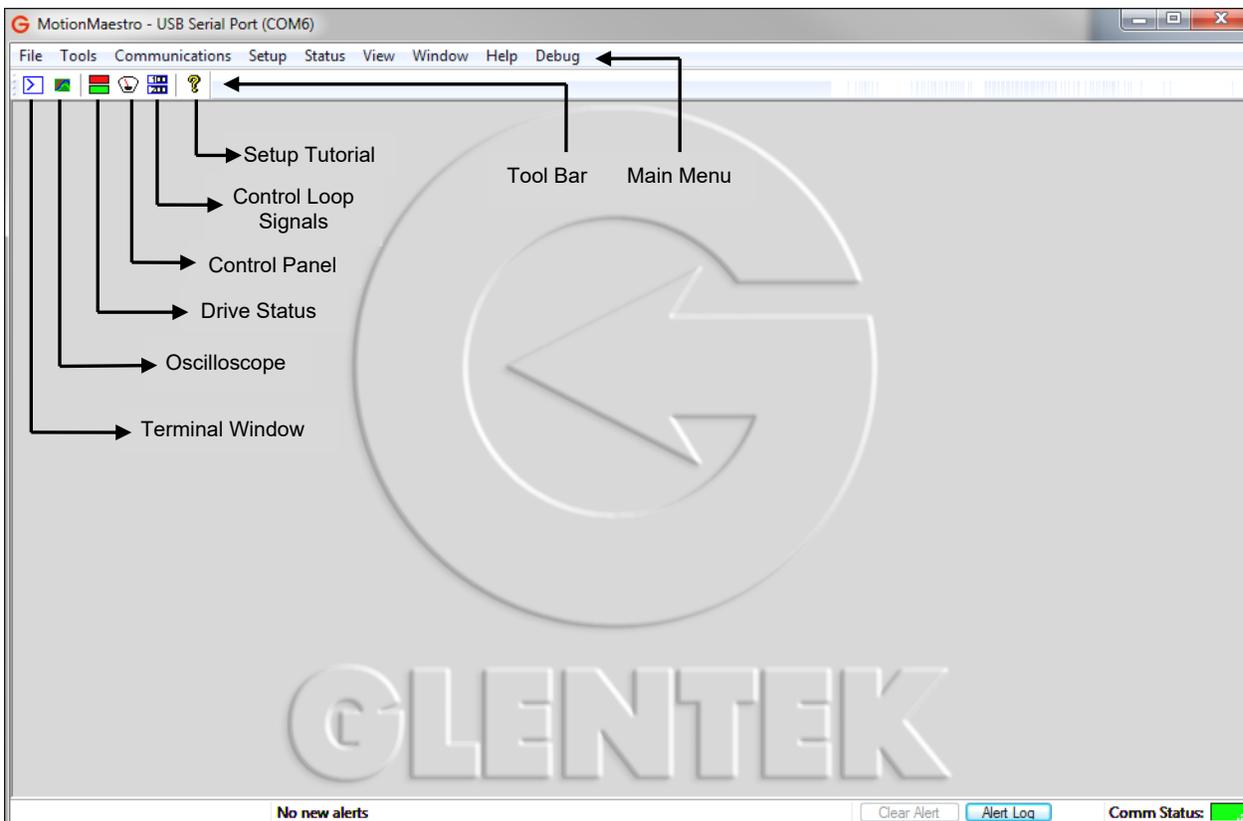
Example: *Motor Resistance*

5.4 MotionMaestro Overview

When any parameters are changed, the drive must be disabled before sending these changes to the drive. Then, saving to NVM is a crucial step after values are sent to the drive to ensure the drive has the new parameters.

5.4.1 Main Menu and Toolbar

The main search bar give you access to all the menus. The toolbar displays icons that can be used for quick access.



↑ Alert Log
↑ Communication Status

Table 5-1 – MotionMaestro Menu Options

Main Menu	Selection	Description
File	Editor	Create new files or manage files.
	Exit	Close MotionMaestro.
Tools	Setup Wizard	View a tutorial on how to connect and operate the drive.
	Model Info	View the drive parameters (Intended for in-house only).
	Terminal Window	Directly communicate with a drive.
	Oscilloscope	Plot and record data in real time.
	Control Panel	Command current, velocity, or position to a drive.
	Backup Drive	Save original file.
	Reports	Create a text file that contains the settings and parameters used to configure a drive.
	Alert Log	View all reported alerts.
	Watch Registers	Watch Registers allows you to monitor the value any terminal command response
	Profile Generator	This feature allows you to create a drive command step list which may be executed independently by a start pin
	Drive Assignments	Multi-Drive capabilities setup and name assignment
	Communications	Open
Close		Disconnect the drive from the PC.
Demo		Allow MotionMaestro to act like a drive is connected to the PC.
Setup	Motor Parameters	View and change the current motor parameters.
	Motor Safety	View and change of the parameters that define a motor's safety characteristics.
	Commutation	View and change the parameters that define a motor's commutation characteristics.
	Drive Mode	Choose the mode of operation for the drive.
	Setup Digital Inputs	Configure the functions for the drive's digital inputs
	Setup Digital Outputs	Configure the functions for the drive's digital outputs
	Setup Analog Outputs	Configure the functions for the drive's analog outputs
	Trajectory Generator	Limit the change of velocity or current command.
	Filters	Use filters to help reduce the noise of the motor.
	Servo Tuning	Use tools and features to tune the motor.
	Save to NVM	Save the settings to non-volatile memory.
Status	Control Loop Signals	View certain commanded and measured quantities.
	Drive Status	View the drive's status and faults.
	Last Drive Fault Status	View the last fault the drive encountered.
	Motor and Other Status	
	Digital Inputs Status	

Main Menu	Selection	Description
View	Toolbar	Choose to display the toolbar or remove the toolbar from the main window.
	Status Bar	Choose to display the status bar (alert log) or remove the status bar from the main window.
Window	Layout	Save or restore the window layout to a file.
	Close All Setup Windows	Close all setup windows.
	Close All Editor Windows	Close all editor windows.
	Windows	View which windows are currently open.
Help	MotionMaestro Help	Open MotionMaestro Help.
	Search	Search the MotionMaestro help menus using a keyword or phrase.
	Contents	View the table of contents for MotionMaestro.
	Index	View an alphabetical list of MotionMaestro's help pages.
	About MotionMaestro	View the software version of MotionMaestro.

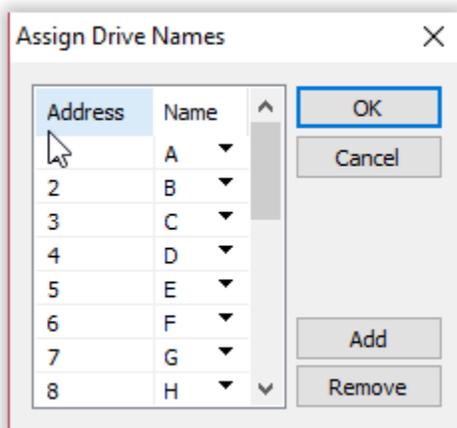
5.5 Communications

Before you can make changes to or view the configuration of your Gamma Series Drive, communications must first be established between MotionMaestro and the drive. This is done through a serial (RS-232/RS-485) connection. The following steps describe how to establish these communications once the drive is connected to the computer and the drive is powered on.

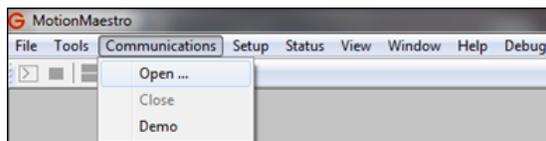
1. Open MotionMaestro by clicking on its shortcut icon.



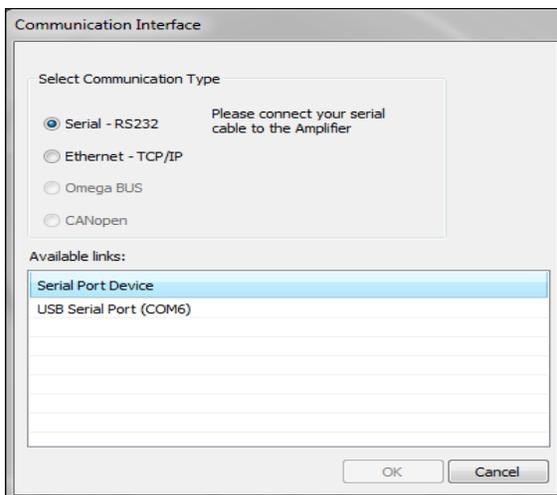
2. If using RS-485, you must tell MotionMaestro the addresses of any additional drives and name each drive using the Tools -> Drive Assignments dialog.



3. Click on **Communications** -> **Open** to open the *Communication Interface* window.



4. Select the communication type that is being used. Select the appropriate port device, based on how the servo drive is connected to the PC. Click **OK** to proceed.



5. A notification will let the user know which type of drive is connected. After verifying the correct drive(s) is/are shown click OK.



6. If the drive is properly connected, the *Comm Status* bar at the bottom right of MotionMaestro's main window will turn green.



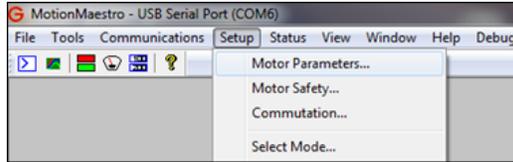
7. In the top left-hand corner of every drive window, there is a Reload icon  and a dropdown

displaying the currently selected drive.  You can choose to select a different drive from the dropdown or open an additional window for a different drive. You can have as many open windows and you have drives connected.

5.6 Motor Parameters

Every motor configuration can be different. Therefore, the values entered into the *Working* column must match the motor parameters.

- A. Click on **Setup -> Motor Parameters** to open the *Setup Motor Parameters* window.



- B. The *Motor Parameters* window appears as shown. To update the parameters, the drive must be disabled. Enter values for the individual parameters into the unshaded boxes of the *Working* column. Parameter descriptions are found below in the table below. Note that a good starting point for the *Current Loop Bandwidth* is 1500Hz.
- C. Click on **Send Values to Drive** to send the values in the *Working* column to the drive (and thus appear in the Drive column).
- D. Finally, Save to NVM. This ensures changes are saved. Click on **Setup -> Save to NVM**. Click on Yes to save.

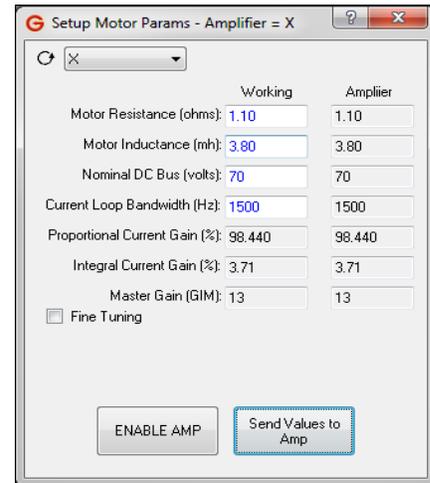


Table 5-2 – Motor Parameter Field Information

Parameter	Description
Motor Resistance	Phase-to-phase resistance of the motor is typically the resistance on the manufacturer's motor plate.
Motor Inductance	Phase-to-phase inductance of the motor is typically the inductance on the manufacturer's motor plate.
Nominal DC Bus	The bus voltage supplied to the drive at B+. For AC rectified line voltage, the following applies. 120 VAC = 160 VDC 230 VAC = 325 VDC
Current Loop Bandwidth	Enter the desired bandwidth (1500 Hz is a suggested starting value). Range: 1-4000 Hz.
Proportional Current Gain	The current loop proportional gain (calculated gain is expressed as a percentage) is from 0 to 100 percent.
Integral Current Gain	The current loop integral gain (calculated gain is expressed as a percentage) is from 0 to 100 percent.
Master Gain	This allows for the adjustment of the servo loop response and accuracy. The master gain applies to both proportional and integral gain.
Fine Tuning	This allows the user to adjust the proportional, integral, and master gains (see <i>Fine Tuning</i> , on p. 83).
Enable/Disable Drive	Enables or disables the drive.
Send Values to Drive	Press this button to send the working parameters to the drive. The motor must be disabled before this can be performed.

5.7 Motor Safety

Found at [Setup -> Motor Safety](#)

The *Motor Safety* window gives you access to parameters that set safety limits. These limits will protect the motor and drive from conditions when the current remains at an extreme amount for an excessive period. The table on the next page lists the parameters and information you should enter into the fields.

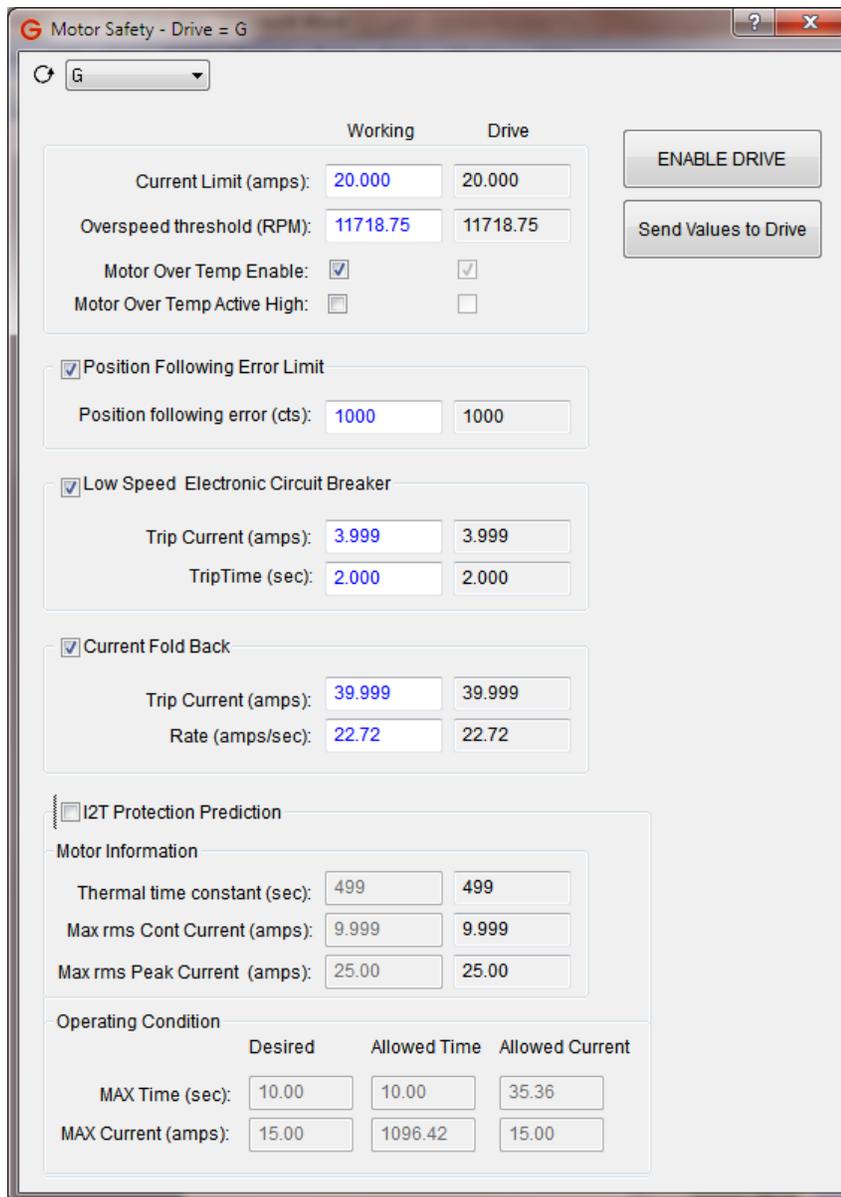


Table 5-3 – Motor Safety

Parameter	Description	
Current Limit	Maximum peak current that the drive can output. Range: 0 to <i>I Max</i> (in Amps) see the <i>Model Info</i> window.	
Position Following Error Limit	Maximum number of encoder line count errors allowed before the drive faults (Only available in position mode).	
Low Speed Electronic Circuit Breaker	Protects the motor and drive when the current remains at a limit for an excessive period (Fault latches).	
	Trip Current	When the current is above this level the low speed filter timer advances. When the current is below this level the filter timer is reduced at twice the rate that it had advanced.
	Trip Time	If the low speed filter timer exceeds this value, a low speed fault occurs. The drive must be reset.
Current Fold Back	Protects the motor and drive when the current remains at a limit for an excessive period of time (Fault does not latch).	
	Trip Current	The current fold back threshold. Typically set below the continuous current rating of the drive. To disable, set at or above the current limit, or uncheck the <i>Current Fold Back</i> box.
	Rate	Rate at which current is reduced to below threshold when current is determined to be above the threshold.
I2T Protection Prediction	Prevents the drive and motor from overheating.	
	Motor Information	The fields are <i>Thermal time constant</i> (in seconds), <i>Max rms Cont Current</i> (Amps in RMS) and <i>Max rms Peak Current</i> (Amps in RMS). All this data should be obtainable from the motor datasheet.
	Operating Condition	Input the maximum desired time (in <i>MAX Time</i>), calculating the <i>Allowed Current</i> . Or input the desired operating peak current (in <i>MAX Current</i>), calculating the time allowed at the <i>Allowed Current</i> .
	Prediction Condition	Assume motor and drive starting from 0 initial current (or at 25° C temperature). Compute both the motor and drive maximum allowed current and maximum allowed time. Whichever is smaller will be the actual allowed value.

5.8 Commutation

The commutation window allows you to configure feedback devices and how the drive commutates the motor. To open this window use **Setup -> Commutation**. These two pieces of information are related because drive commutation is handled differently based on the feedback types available to your system.

The screenshot shows the 'Commutation Settings' window for a 'DEMO' drive. The window title is 'Commutation Settings - Drive = DEMO'. At the top left, there is a refresh icon and a dropdown menu set to 'DEMO'. The main content is organized into several sections:

- Motor Type and Configuration:** Features three radio buttons: 'Brushless' (selected), 'Brush', and 'Induction'. Below these are two columns for 'Working' and 'Drive' settings. Under 'Working', 'Linear' is unselected and 'Rotary' is selected. Under 'Drive', 'Linear' is unselected and 'Rotary' is unselected. A 'Position' field contains the value '16944'.
- Feedback Type Selection:** A section titled 'Select feedback types you wish to enable and use:' containing checkboxes for 'Quadrature (TTL)', 'SIN/COS Encoder', 'Resolver', 'Absolute Encoder', 'Hall' (checked), and 'Tachometer'.
- Commutation Config / Feedback Config:** Two tabs are visible. The 'Commutation Config' section includes:
 - Initialization Method:** 'Select Method:' dropdown set to 'Hall', with 'Hall' selected for both 'Working' and 'Drive'.
 - Brushless Configuration:** 'Number of Poles' field set to '8' for both 'Working' and 'Drive'.
 - Phase Lead:** 'Angle Offset (deg):' and 'Phase Lead (deg/kRPM)' fields both set to '0.000' for both 'Working' and 'Drive'.
 - Correction Method:** Radio buttons for 'None', 'Hall Edge' (selected), 'Index-Auto', and 'Index-Manual'. 'Hall Signal Offset (deg):' and 'Index Offset (deg):' fields are both set to '0.000' for both 'Working' and 'Drive'.

At the bottom right of the window are two buttons: 'ENABLE DRIVE' and 'Send Settings To Drive'.

This window is designed to only display relevant information based on the motor type and feedback. As you make changes to the *Motor Type* and *Feedback Type Selection*, the bottom section of the window with the tabbed interface will change and adapt to the selections. This way, options which cannot be used are not shown.

The top left corner of the window displays different motor types. The three most common motor types are *Brushless*, *Brush*, and *Induction*. Two-Phase motors are treated within the drive as *Brushless* motors with two-phase commutation and require additional circuitry inside the drive. Other motor types can be setup, but they should be discussed with your Glentek representative first.

The motor type will most often be selected for you at the factory. If you received a drive which was not preconfigured for you, it will likely show up configured as a brushless motor. You can change the *Motor Type*, if needed, by clicking the appropriate radio button.

Once the *Motor Type* is selected, you should then identify whether the drive is rotary or linear. The *Position* display represents the position information from the drive based on the feedback sensors and other internal calculations. If this is the first time you are setting up the drive, the *Position* information may be inaccurate.

The top right section of the window displays different motor feedback types. A common factory configuration is to have only the *Hall* box checked. Checking or unchecking additional boxes will change the options available in both the *Commutation Config* tab and the *Feedback Config* tab.

The only *Commutation Config* section available for motor types other than Brushless is the *Initialization Method* section, which will automatically default to the correct commutation method for those motor types (i.e. *Brush* for brushed motors).

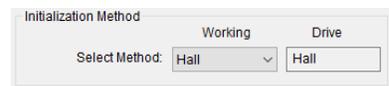
The setup of the *Commutation* window continues in the next sections with a description of the *Commutation Config* tab ([5.9](#)) and a description of the *Feedback Config* tab ([5.11](#)).

5.9 Commutation Config Tab

There are seven groups to configure within the *Commutation Config* tab. Not all seven are visible at once, only those which pertain to your current settings for *Motor Type* and *Feedback Type Selection*. These groups are *Initialization Method*, *Brushless Configuration*, *Phase Lead*, *Correction Method*, *Smart Commutation*, *Simulated Hall*, and *Auto-Phase*. These sections are outlined below along with the conditions which will enable them.

5.9.1 Initialization Method (Visible for all motor and feedback types)

To properly commute a brushless motor, the servo drive must know the absolute position of the rotor with respect to the motor windings in the stator. Since incremental shaft encoders only supply “relative” rotor position, the servo drive must perform a power-on, phase-finding scheme to determine the absolute position of the shaft. This is known as commutation initialization. Once the absolute position is determined, the position from the encoder can be used to maintain the absolute position. The SMx9G16 drives have three power-on commutation initialization methods available for finding the absolute position of the rotor. The *Smart-Comm* method requires the rotor to move; *Hall* commutation does not require motion; and *Resolver* also does not require motion. The *Hall* method does require the addition of Hall sensors or commutation tracks on the motor. Commutation tracks are simulated Hall sensors built into the shaft encoder. The *Initialization Method* section contains a dropdown for choosing the commutation initialization method appropriate for your configuration. The current method the drive is using will be pre-populated here in the dropdown along with a *Drive* field next to it representing the value currently set in the drive’s memory. You should not need to change this field unless your configuration is different than what was provided by the factory.



Currently available methods:

Table 5-4 – Commutation Initialization Methods

Motor Type	Initialization Methods
Brushless motor with true Hall sensors or encoder with commutation tracks	Hall
Brushless motor with a resolver	Resolver
Brushless motor with a <i>TTL</i> or <i>Sin/Cos</i> encoder only	Smart-Comm
Brushless motor with an absolute encoder	Absolute Encoder
Two-phase drive	Two-Phase
Brush motor	Brush*
Induction motor	Induction*

*Note: The brush and induction motor types do not require commutation but are included as part of the *Initialization Methods* configuration on the drive to specify these motor types.

5.9.2 Selection of a Commutation Initialization Method

Glentek recommends using either *Hall* or *Resolver* motor commutation. If you have specific needs which preclude the use of these initialization methods, contacting your Glentek representative is a great option to discuss additional methods.

Selecting a commutation initialization method starts by determining whether motion can be tolerated upon power up of the motor. If motion is not acceptable, then the motor must be equipped with Hall/Resolver sensors or commutation tracks, so Hall/Resolver initialization can be used. Additionally, if a large external torque exists which will either resist rotor motion (such as a brake or excessive friction), or cause the rotor to rotate (such as gravity), then Hall/Resolver initialization should be used.

If your requirements are such that *Hall* or *Resolver* modes are not available, you may be able to use *Smart-Comm*. This mode is based upon finding equilibrium between the applied motor current and the rotor position. External torque will alter this equilibrium position. However, if a large enough current is applied during initialization, it is possible this external torque can be overcome and an acceptable commutation angle can be achieved.

If *Smart-Comm* is selected, the amount of current to the motor during initialization must be set. Note that both the *Initial Current* and *Final Current* values need to be set for commutation initialization to occur. The default values can be used as a starting point.

Hall initialization is available when the *Hall* feedback type is checked. With this method, you should also configure the *Number of Poles* and the *Phase Lead* and *Correction Method*.

The *Resolver* method may require different firmware loaded onto your drive. Specific details for configuring for a resolver are found in the *Resolver* section below.

5.9.3 Brushless Configuration

This section allows you to select the number of poles for your motor or what the *Pole Pitch* is for a linear motor. You get this information from the manufacturer's specification for the motor. What you enter here is used in various calculations including calculations for the *Hall* feedback type. For more information see p. [132](#).

Brushless Configuration		
	Working	Drive
Number of Poles	8	8

5.9.4 Phase Lead

The *Phase Lead* section settings are used to help reduce undesirable frequency response in the drive system. Glentek's advanced algorithms provide automatic phase lead calculation and eliminate the need to manually specify the phase lead. These advanced algorithms ensure that the system is operating at the highest possible speed with maximum efficiency.

Phase Lead		
	Working	Drive
Angle Offset (deg):	0.000	0.000
Phase Lead (deg/kRPM)	0.000	0.000

5.9.5 Correction Method

The options contained in this section vary based on the feedback types you have selected. Here are the available options: *None*, *Hall Edge*, *Index-Auto*, and *Index-Manual*. There are two fields which need to be entered based on your selected option: *Hall Signal Offset* (in degrees) and *Index Offset* (in degrees). The parameter related to your selected correction needs to be filled out to apply.

Correction Method		Working	Drive
None:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hall Edge:	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hall Signal Offset (deg):	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>
Index-Auto:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Index-Manual:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Index Offset (deg):	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>	<input type="text" value="0.000"/>

5.9.6 Smart Commutation

Smart-Comm commutation is a method that does not rely on encoder commutation tracks or hall sensors for motor commutation. It is important to note that the Smart-Comm algorithm always returns the motor shaft to its initial starting position after moving the motor shaft a few encoder counts to determine the correct commutation angle. The following gain variables listed below can be used to additionally tune the algorithm if it is desired.

Note: For the Smart-Comm commutation method, the commutation tracks are not needed (only an incremental encoder is needed) as shown in the *Current Loop Control Diagram Gamma Series* on p. [142](#).

If you are planning to use Smart-Comm, be sure to contact your Glentek representative first, and he/she can have the following variables preset at the factory before shipment. However, the default value in the drive will work for most cases.

Proportional Gain: This value should initially be set to a low value. The default value is 1024 and this should be a low enough value to start off with in most situations. Depending on the shaft size or the inertia of the motor, the beginning *Proportional Gain* may need to be set lower than the default value. The higher the *Proportional Gain* value, the less movement the shaft will have during commutation initialization. The max value for this value is 32767.

Integral Gain: This value can be initially set to 0. If a high *Proportional Gain* can be achieved, there will be very little movement during commutation initialization, and *Integral Gain* may not be necessary. However, any value of *Integral Gain* will pull the motor back to its original position. The higher the *Integral Gain* the faster this will happen. This value should be relatively low and the max value should be no more than 100.

Derivative Gain: This value can initially be zero, but after the *Proportional Gain* is set, then the *Derivative Gain* can be set as high as possible, typically 1/2 of *Proportional Gain*.

Initial Current: This value can always be 0. The only reason to use the *Initial Current* would be to reduce the total initialization time by giving the current a head start. This is especially true if the *Final Current* is a large number.

Final Current: This value must be greater than the *Initial Current*. The *Final Current* should be enough to make the motor shaft move, or enough to make the load move. Typically, the *Final Current* is set at the motor's rated stall current.

Ramping Time: This value is the amount of time that it will take to change the *Initial Current* to the *Final Current*. This value is in seconds.

Timer Ticks: This value is the amount of time that the commutation initialization will take. This value must be greater than the *Ramping Time*. This value is in seconds.

Smart Commutation		
	Working	Drive
Proportional Gain:	1024	1024
Integral Gain:	0	0
Derivative Gain:	256	256
Initial Current (amps):	0.000	0.000
Final Current (amps):	5.333	5.333
Ramping Time (sec):	3.919	3.919
Timer Ticks (sec):	3.99	3.99

5.9.7 Simulated Hall

Drives create simulated Hall signals from feedback devices. These signals can be connected to digital output pins on the I/O, and used to manually align resolvers and encoders to the motor BEMF.

Before using the simulated Hall signals for manual alignment, be sure to uncheck the *Simulated Hall* checkbox. This ensures no offset angles in the commutation setup area of MotionMaestro are incorporated into the simulated Hall signals. For more information on feedback device alignment see the appendix on that subject.

Simulated Hall		
	Working	Drive
Simulated Hall with Correction Offset:	<input type="checkbox"/>	<input type="checkbox"/>

5.9.8 Auto-Phase

The procedure for using Auto-Phase is in the Appendix.

Auto-Phase		
<input type="checkbox"/> Auto Phasing	Alignment Offset (degs):	0.0
	Phase Sequence Reverse:	<input type="checkbox"/>

5.10 Drive Mode

(Found at [Setup -> Drive Mode](#))

The drive can be set to operate in current (2-phase), velocity, or position mode. Current mode is always enabled. If the drive is selected to operate in 2-phase mode, it can only operate in this setting. You'll notice when you first bring this up on a new drive it will have the current mode automatically selected. It cannot be deselected. In addition, the *Current* tab header label has an *[X]* next to it to show that the current mode is enabled. You can also see the velocity and position modes are not enabled since they do not have an X in the brackets next to their tab labels.

Drive Mode - Drive = G

Refresh G

[X] Current [X] Velocity [] Position

Enable (Disables 2-Phase Mode if checked)

Analog Input

50% PWM

100% PWM

Analog Input Setup

	Working	Drive	
Signal Gain:	199.99	199.99	RPM/Volt
Signal Offset:	-3.4	-3.4	mV

	Working	Drive	
Dead Band:	0.0	0.0	mV

Enable braking

	Working	Drive
Brake Deceleration (RPM/sec):	6985.13	6985.13
Max Deceleration Time (ms):	500	500
PWM Disable Delay Time (ms):	100	100

Brake Control FET Switch On:

ENABLE DRIVE

5.11 Feedback Config Tab

This tab is used to configure the specific items related to the feedback type(s) you selected. Some feedback types, like *Hall*, do not require any additional configuration. The sections visible in this window will only be the ones necessary for you to configure. Unnecessary sections will be hidden from view.

5.11.1 Encoder Data

This group is shown for the *Quadrature* and *Sin/Cos* encoder types. The *Lines per Revolution* is found on the datasheet for your encoder. The *Encoder Output Divider* (optional) and *EZ Out* features are only enabled if you have this specific option on your drive. If you need to enable *Encoder Fault* or *Encoder Reverse*, the checkboxes for these options are found here. The *Additional Calculations* button opens another window which contains information needed by Glentek customer support to help diagnose problems.

	Working	Drive
Lines per Revolution	5000	5000
Encoder Divisor	1	1
EZ Out (Working):	Straight Pass Through	
(Drive):		Straight Pass Through
Encoder Fault:	Enable Wkg <input type="checkbox"/> Drv <input type="checkbox"/>	Encoder Reverse <input type="checkbox"/>
		Additional Calculations

5.11.2 Sin/Cos Interpolation

Resolver or *Sin/Cos* encoder feedback may be interpolated. The maximum interpolation is 12 bits. If no interpolation is desired, set the value to 1 bit.

	Working	Drive
Interpolation Coefficient:	0	0

5.11.3 Analog Motor Feedback Calibration

This box is factory set when the drive is preconfigured for a *Resolver* or *Sin/Cos* encoder. If it is necessary to set this in the field, consult a Glentek application engineer.

Analog Motor Feedback Calibration			
		Offset	Scale
Calibration	Sine:	0	0
	Cosine	0	0

5.11.4 Tachometer Data

The *Tach Scale (Volts/kRPM)* should be set to match the value of the tachometer on your motor (7V/kRPM is a very typical value). The *Tach Gain* is typically set to 100% but may be reduced if desired. A zero value will disconnect the tachometer feedback. The *Tach Offset (mV)* is preset at the factory for drive internal analog offsets on the tachometer input but may be adjusted to balance very low motor speeds at zero commanded velocity.

Tachometer Data		
	Working	Drive
Tach Scale (Volt/kRPM):	7.00	7.00
Tach Gain:	100.00	100.00
Tach Offset (mV):	3778.8	3778.8

5.12 Setup Digital Inputs

(Found at [Setup -> Setup Digital Inputs](#))

This window allows you to specify the functions associated with the programmable digital inputs. As shown below, the drive is equipped with six Schmitt inputs, five optical inputs and two differential inputs. The 44-pin connector pin number is shown for each input, and the related settings for each of the inputs is also shown. The current working (*Wrk*) values and the current drive (*Drv*) values are shown as separate columns. Working columns are where you can make changes to the values and the drive columns show what is currently saved into the drive memory.

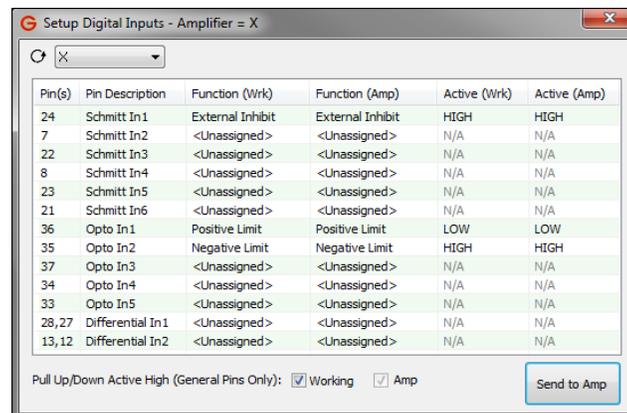
The *Function (Wrk)* dropdown shows a list of functions available for assignment to the associated drive pin. These functions are described in [Table 3-11](#). Input functions fall into three primary groups: functions which can be assigned to one or more input pins, functions which can only be assigned to one pin at a time, and functions which can only be assigned to specific input pins. Depending on the row you are on, the dropdown list will change based on what is currently available for that pin.

The *Active* column represents the input value of the pin to satisfy the conditions of the function. For example, if you want the Gamma drive to perform the *External Reset* function when pin number 24 (*Schmitt In1*) goes high, you would set the *Active (Wrk)* column dropdown to *High*.

The window will also notify you of default settings by changing the color of the value to yellow. For example, you can pick *External Inhibit* for *Schmitt In2* and move to the next line without changing the active dropdown. The *Active (Wrk)* column for *Schmitt In2* will then turn yellow to remind you that you have not yet selected a setting for *Active*. The highlight is cleared when you open the dropdown and select an option. The *Schmidt Input Pull-up* checkbox changes all Schmitt inputs to use an internal pull-up resistor to make the normal input value *High*. You can then change the value by pulling down the input to ground.

Like most settings in MotionMaestro, the drive does not change until you click the [Send to Drive](#) button. You can have setting which are shown in yellow and still [Send to Drive](#). After you have tested your settings and are ready to make the changes permanent, use the [Setup -> Save to NVRam](#) menu option to save the settings to permanent memory on the drive.

Each digital input shows its pin location. These inputs can be assigned to different functions. In the *Function (Wrk)* column, select a function and assign it to an input. Select *Unassigned*, followed by the function you want. In the *Active (Wrk)* column, select *High* or *Low* (this represents the state of the pin when the function is active). Once all *Function* and *Active* columns are assigned, select [Send to Drive](#) and then [Setup -> Save to NVRam](#).



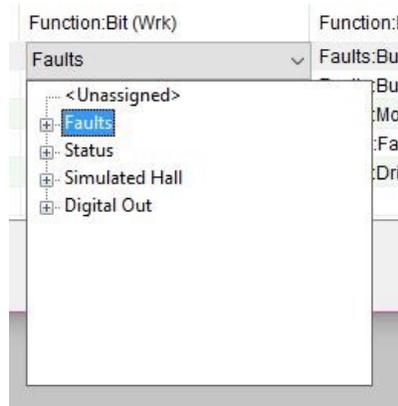
5.13 Setup Digital Outputs

(Found at [Setup -> Setup Digital Outputs](#))

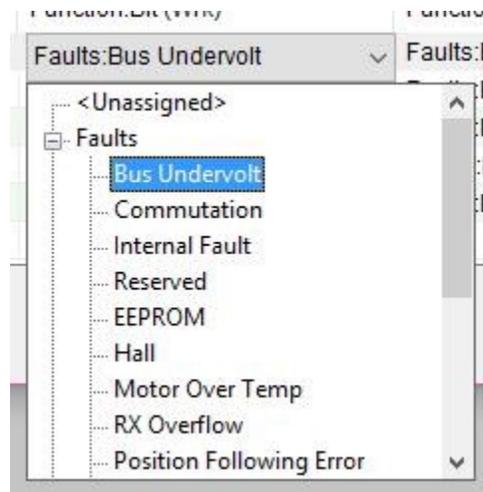
This window allows you to specify the functions associated with the programmable digital outputs. For the Gamma Series Drives, you may have different output options on your drive, but shown here are two optical outputs, two MOSFET outputs, and a relay output. The din connector pin numbers for each output, and the related settings for each of the outputs are also shown. The current working (*Wrk*) values and the current drive (*Drv*) values are also shown. Working columns are where you make changes to the values and the drive columns show what is currently saved into the drive memory.

Pin(s)	Pin Description	Function:Bit (Wrk)	Function:Bit (Drv)	Active (Wrk)	Active (Drv)
39,40	Opto Out1 C/E	Faults:Bus Undervolt	Faults:Bus Undervolt	ON	ON
41,42	Opto Out2 C/E	Faults:Bus Overvolt	Faults:Bus Overvolt	ON	ON
9	MOSFET Out1	Faults:Motor Over Temp	Faults:Motor Over Temp	HIGH	HIGH
31,32	Relay Out 1&2	Status:Fault	Status:Fault	ON	ON
6	MOSFET Out2	Faults:Drive Over Temp	Faults:Drive Over Temp	HIGH	HIGH

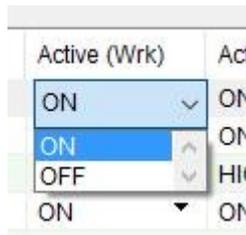
This dropdown tree shows four categories of functions which can be assigned to the drive pins. These functions are described in Table 3-12. Within MotionMaestro, the functions are found on the *Drive Status* window ([Status -> Drive Status](#)) and a few additional places. The functions are broken down into categories represented in the tree with a + next to the category name.



Each category can be expanded by clicking the + sign. In the *Faults* category, the faults you see are a list of the faults that relate to the *Drive Status* window (**Status -> Drive Status...**) and in Table 5-3.



The *Active* column represents the output value of the function when the conditions are met. For example, if a *Bus Overvolt Fault* occurs, the pin would be set to the value listed in the *Active* dropdown. If I wanted an output pin to be turned ON, then I would select *High* or *ON*.



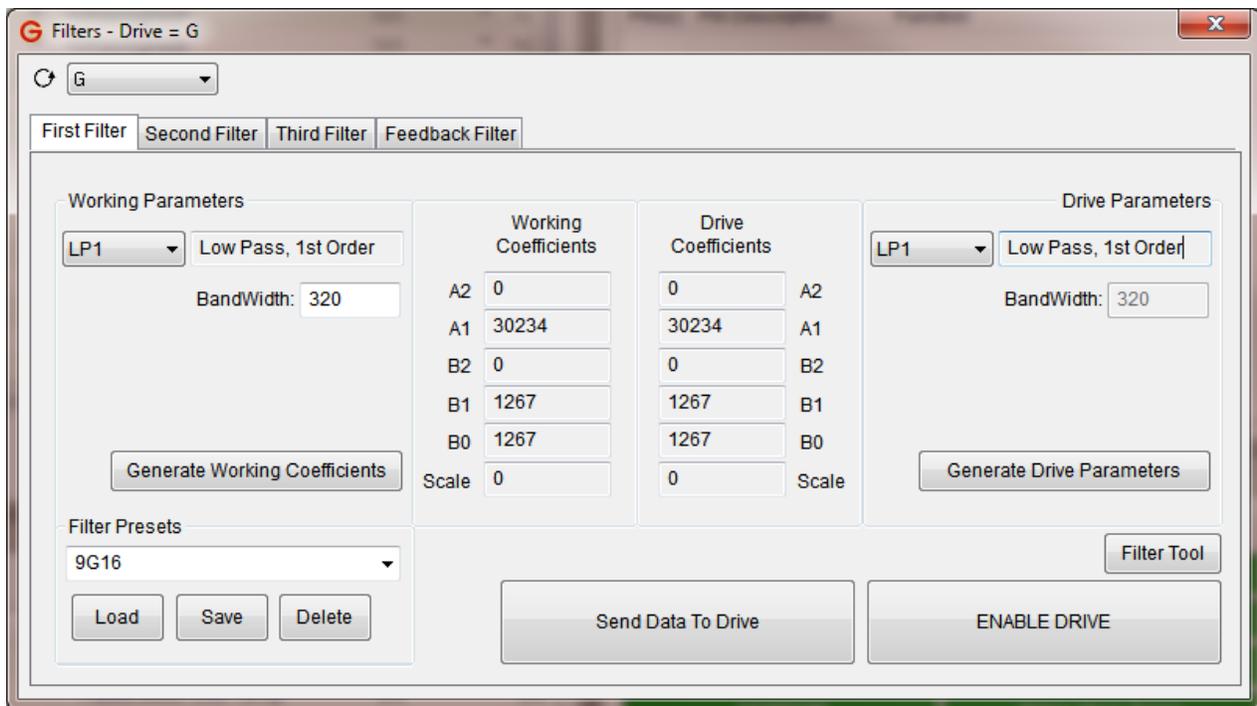
The window will also notify you of default settings by changing the color of the value to yellow. For example, you can pick *Fault: Bus Under Voltage* for *Optical Out1* and move to the next line without changing the active dropdown. The *Active* column for *Optical Out1* turns yellow to highlight you haven't selected a setting for *Active*. *Active* does not highlight if you select a setting from the dropdown prior to changing the line.

	Active (Wrk)	Active (Drv)
Undervolt	ON	ON
Overvolt	ON	ON
Over Temp	HIGH	HIGH

Like most settings in MotionMaestro: The drive does not change until you click the **Send to Drive** button. After you have tested your settings and are ready to make the changes permanent use the **Setup -> Save to NVM** menu option to save the settings to permanent memory on the drive.

5.14 Filters

Different filters can be chosen to fit any application. They can be edited and displayed at the same time, but they need to be opened one at a time. Filters are not always needed, but they help reduce noise caused by the motor.



1. Open the Filter window by clicking **Setup -> Filters**.
2. Go to the *First Filter* tab and select the desired filter type (i.e. *HP1*, *LP1*, etc.) from the drop down menu in the *Working Parameters* section. Note that a short description of the filter type will appear to the right of the drop down menu and various field(s) will appear in this section.
3. Enter the appropriate parameters into the fields in the *Working Parameters* section.
4. Click **Generate Working Coefficients** and MotionMaestro will automatically generate appropriate coefficients in the *Working Coefficients* section.
5. Click **Send Data to Drive** to implement any changes in the drive.
6. Select **Setup -> Save to NVM** to save any changes.
7. Repeat the above steps with the *Second Filter* and the *Third Filter* if you need more filters. Note that a filter can be disabled if the *None* filter type is selected (and **Send Data to Drive** is clicked).

Note: The right section contains *Drive Coefficients* and *Drive Parameters*. This section is used if the type or parameters of the drive are not known. Step 8 elaborates on this process.

Click **Generate Drive Parameters**. The parameters being used and the estimated filter type of the drive are retrieved. Click **Setup -> Save to NVM**.

Table 5-5 – Filter Parameters

Parameter	Description
Working Parameters	Allows the filter type to be selected.
Working Coefficients	Displays the filter coefficients that are currently being worked on.
Drive Coefficients	Displays the filter coefficients that are currently stored in the drive.
Drive Parameters	Upon clicking <i>Generate Drive Parameters</i> , estimates of the filter type and parameters of the drive will be done by MotionMaestro.
Filter Presets	Allows filters to be saved as a set.

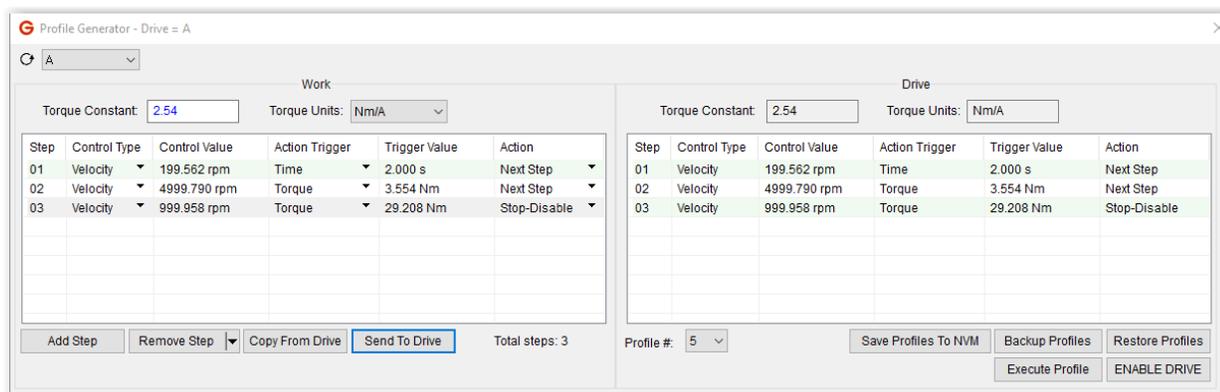
5.15 Profile Generator

The Profile Generator features allow you to create up to sixteen sequences of 16 steps which are saved to the non-volatile memory (NVM) of the drive. Profiles can be selected by using physical selector pins and an execution pin to start a profile, removing the need for a separate controller in many instances. These sequences are called motion control profiles.

Refer to [3.1.6 Programmable Digital Input Functions](#) for the pinout when using the profile generator.

Each step within a profile is a single command to the drive to do something. It consists of a control, a trigger and an action. The control is the command to the drive to do something, the trigger is the value the drive is watching before advancing to the next action, and the action may be to continue to the next step or stop.

The Profile Generator setup is found under **Tools -> Profile Generator**. This screen is used to setup and test the profile generator function included in the Glentek drive. This functionality allows you to set up to 16 steps to be executed in order. Each step consists of a control type and control value, an action trigger and what to do next action. Each drive can hold sixteen different profiles which can be selected using four pins on the I/O connector. This section will describe how this functionality is intended to be used.



When you first bring up this screen it will give you a single step on the left. As long as the drive is not currently executing a profile, the currently active profile for the drive on the right. If your drive is currently executing a profile, you will be prompted to disable the drive so the profile can be loaded. Your drive may be preloaded with profiles set by the factory based on your use case.

The left-hand side of this screen represents your work area where you make changes, set values, and configure actions. Here you can add steps, remove individually selected steps, remove all steps, copy a profile from the drive, or load your working profile to the current drive profile.

The right-hand side of the screen represents the profile you have selected on the drive with a dropdown showing the other fifteen profile numbers. Buttons allow you to save the profile you changed to NVM, backup all your profiles to your PC, and restore a backup from your PC. There are also buttons to test the profile and enable/disable the drive.

There are four Control Types or Modes: *Current*, *Torque*, *Velocity*, and *Position*. Each of these types has a different unit for the value. The *Velocity* and *Position* mode will use the *Acceleration* and *Deceleration* (in the **Setup -> Trajectory Generator** screen) as part of the ramp to RPM.

Table 5-6 Control Type/Mode

Current	In current mode, the drive outputs the current specified in the control value field.
Torque	Torque is measured in either in Lb-in or Nm, depending on the Torque units specified. In torque mode, the drive will work to maintain this amount of torque until the trigger value is met. The Torque Constant is a given value based on the motor specifications and any additional gearing or optimizations in-line.
Velocity	Velocity is in RPM or mm/s, the drive will work to maintain this velocity until the trigger value is met.
Position	In Position mode, set the desired position as the trigger value. The action trigger can be set to either absolute or incremental position values. When the step is executed, the motor will accelerate and decelerate at the rates set by the Trajectory Generator (<u>Setup -> Trajectory Generator</u>). The control value is the maximum velocity allowed for the step. In position mode, only the Position (Absolute and Incremental) action types are available.

We will be setting up an example to demonstrate the Profile Generator. This example will get you started in your understanding of how it works and how the different options correlate. You should adjust any values shown here to your specific drive, motor type, in-line gearing etc. It is assumed your drive and motor are configured, tuned, properly limited and working properly prior to beginning this process.

The first step determines the initial state of your motor once the *Profile Start Trigger* (See [3.1.6 Programmable Digital Input Functions](#) for pin information) is pulsed. We are going to use the *Torque* option for our example step 01. The drop down at the top for *Torque Units* determines whether 0.5 is Lb-in or Nm. We will use Nm as our type. Select the *Torque* option from the dropdown in the *Control Type* column. You can then enter a value into the *Control Value* column to set the amount of torque to be applied by the motor. Our initial value will be “0.5”. The *Control Value* should display something close to 0.5 Nm. MotionMaestro automatically calculates the closest approximation for your drive configuration.

Setting a *Control Type* of Torque and a *Control Value* of 0.5 Nm means that the drive will attempt to turn the motor at a constant torque of 0.5 Nm when you start this profile. If you were to select *Velocity* or *Position* the drive will start to move the motor at the *Control Value* considering the complete drive setup, including acceleration and deceleration values.

The *Action Trigger* defines the type of trigger which should take place prior to the action being executed. First, we will talk about the actions before we talk about the triggers. There are four possible actions:

Table 5-7 – Actions

Stop-Disable	This disables the drive. Executing a new profile will reenable the drive prior to executing the profile
Stop-0 Current	This sends a current command of zero to the motor.
Stop-0 Vel (Velocity)	This sets the Velocity of the motor to zero.
Stop-Hold Pos	This holds the motor at the current position count.
Next Step	Begin the next step of the profile.

You will always be using the Next Step Action for every step in your profile except the last step. The stop action should match the type of stop you want to achieve with your design.

IMPORTANT: TO CHANGE THE PROFILE TO A NEW PROFILE ON THE DRIVE, YOU MUST WAIT FOR THE CURRENT PROFILE TO FINISH EXECUTING, OR ABORT THE PROFILE TO LOAD THE PROFILE SELECTED EITHER IN MOTIONMAESTRO OR THE ONE SELECTED BY THE FOUR PROFILE ADDRESS SELECTOR PINS.

Possible Action Triggers and their Values are described in the table below:

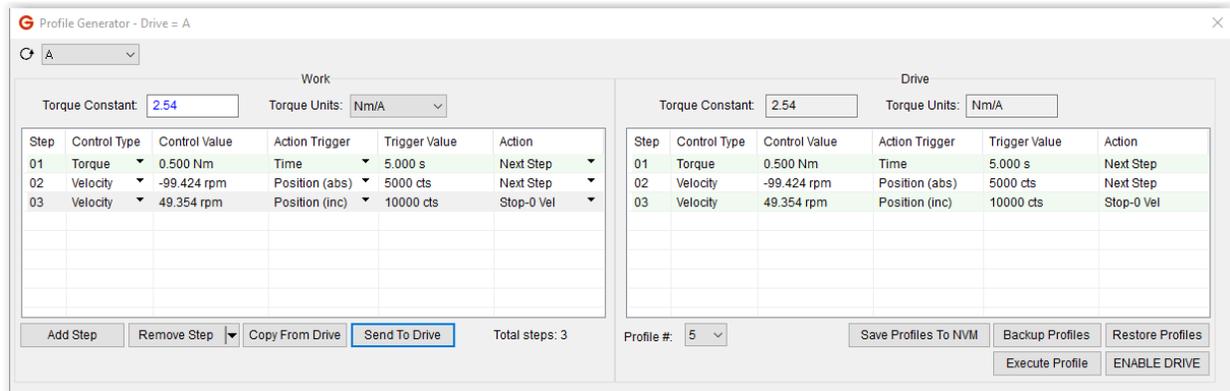
Table 5-8 – Action Triggers

Time	The step control type will be enabled to run for a specific amount of time in seconds before moving to the next step or stopping if this is the last step.
Torque	Torque uses torque sensing based on the current/motor information. The Torque Constant field in the header of the screen.
Analog Input (ex. Torque Sense V)	Analog Input – This trigger uses the signal passed through the analog +/- pins (See 3.1.3 Analog Inputs) to determine when the trigger matches the trigger value. An example would be using a torque sensor. The voltage scale is set for you by the factory and is application specific. This option is special order.
Position (abs)	Absolute Position is the exact encoder count needed to match the Trigger Value.
Position (inc)	Incremental Position is how many encoder counts are needed from the current position to trigger the next action.
Digital Input	This monitors a designated pin on the controller connector. Active on this pin evaluates to True (i.e. Trigger). To use this function, configure the pin to use the <i>Profile Step Stop</i> function. An example would be to use a limit switch as a trigger.

For our example's first step we will choose *Time*, set the *Trigger Value* to 5 seconds, and choose *Next Step* for the Action. This will cause the motor to spin at the specific torque level for five seconds and then continue to step 02. When you select *Next Step* as the action, step number 02 is automatically created on the next line.

WARNING - KEEP IN MIND YOUR SPECIFIC APPLICATION AND THE SETUP OF YOUR MOTOR, IF YOUR MOTOR IS CONNECTED TO AN AXIS AND YOU RUN THIS PROFILE AS SUGGESTED HERE IT MAY CAUSE A CRASH AND DAMAGE EQUIPMENT AND POSSIBLY THE MOTOR.

For our next step we are going to do a *Velocity* of -100 RPM for the control type and *Position (abs)* of 5000 for the control value with the Action as *Next Step*. For our third step we are going to do a *Velocity* of 50 RPM and a *Position (inc)* of 10,000. With the Action of *Stop-0 Vel(ocity)*. You should have a screen which looks very close to this screenshot:



The second and third step will turn the motor until the encoder moves through 5000 counts (from the current encoder count) in the negative direction at -100 RPM and then move in the positive direction through 10,000 encoder counts at 50 RPM.

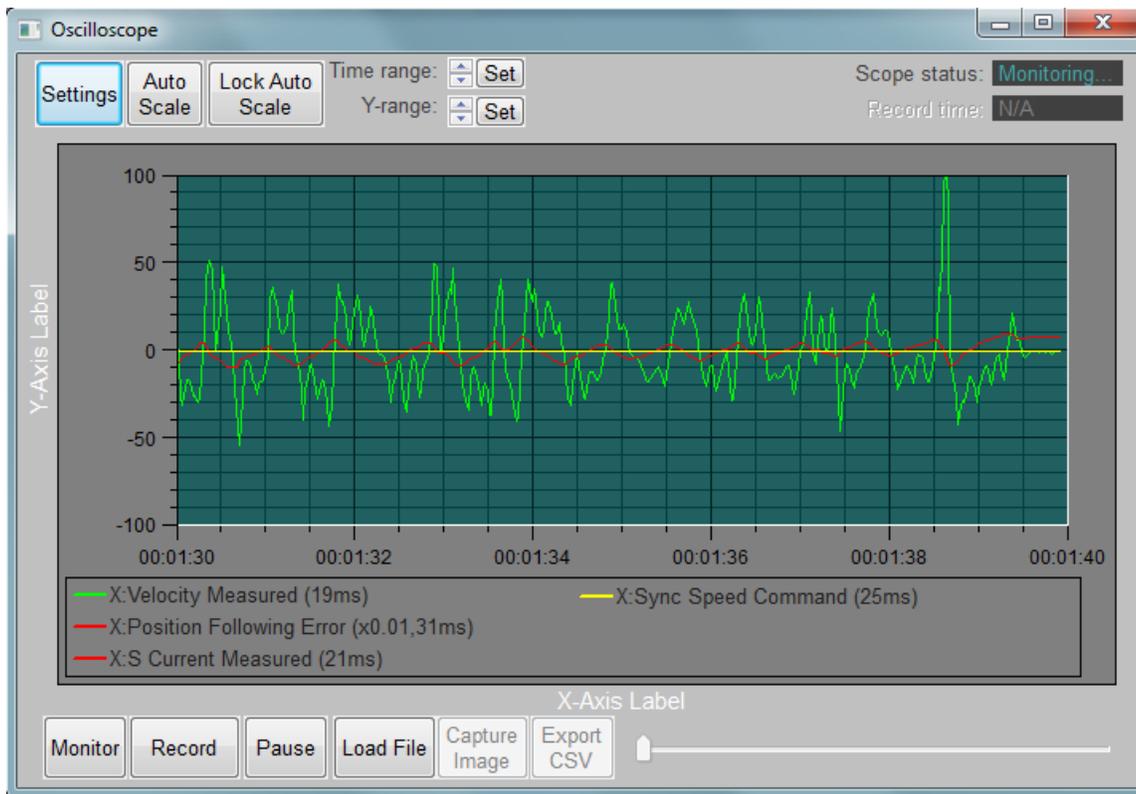
To test our profile, make sure the drive is not currently executing a profile by looking at the Execute Profile/Abort Profile button. The button should state Execute Profile. If it appears as Abort Profile, click that button to abort. We can then click the Send to Drive button to copy our work to the drive RAM. If we were now to click the Execute Profile button and the answer Yes our drive would perform the steps we have specified. If our drive performs the steps as desired, we should then click the Save Profiles To NVM button to save the current settings to permanent storage on the drive. If save to NVM is not pressed the values will be lost if the drive is reset or power is removed.

Table 5-9 – Truth Table for Profile Address Selector (PAS) Pins

Profile #	Profile Address Selector Pins			
	PAS3	PAS2	PAS1	PAS0
0	0	0	0	0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

Up to 16 different profiles can be saved to the NVM of your drive. When the drive is not connected to MotionMaestro, the profile that will be executed will be determined by the state of the profile selector pins and the table above. 0 = Non-active. 1 = Active. The actual logic level will be determined by how the pin is configured (active high or active low). See [3.1.6 Programmable Digital Input Functions](#) for pin information.

5.16 Oscilloscope



The MotionMaestro Oscilloscope window is a full-featured, real-time data plotter and recorder that provides the following capabilities:

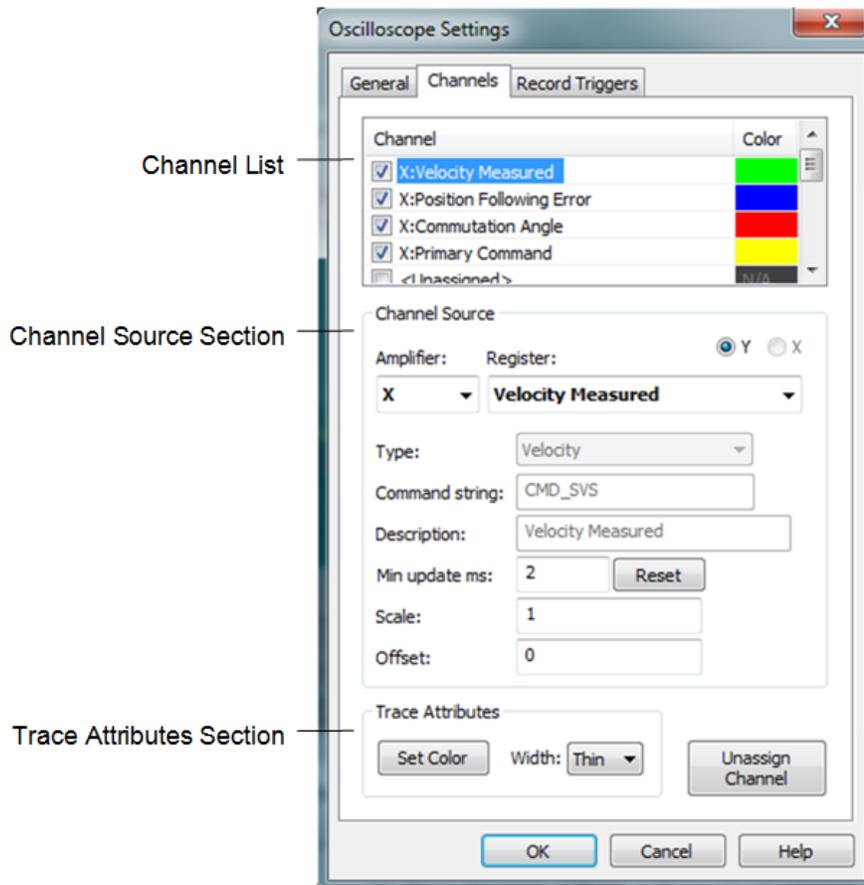
- Real-time data plotting
- Real-time data recording
- Non-linear playback control during recording
- Pre-record function, which saves up to 5 seconds of data prior to start of recording.
- Playback of previously recorded data.
- Capture plot image to file or clipboard
- Auto scaling and manual scaling of plot window.
- Real-time auto-scaling
- Export recorded data to CSV
- Programmable record start/stop triggers.
- Scaling and offset plotted data.
- Plot up to 12 data sources
- Select preset data sources or create customized one
- Select from sweep or XY plotting mode
- Customizable plot appearance, including:
 - Time/X & Y axis labels
 - Plot area grid
 - Optional plot key
 - Trace and plot background color
 - Time format

5.16.1 Adding Scope Channels

Scope channels are setup in the *Channels* tab of the oscilloscope *Settings* window using the following procedure:

1. Select the desired channel entry in the *Channel* list.
2. In the *Channel Source* section, select a drive from the *Drive* list. This will automatically populate the fields in the rest of the *Channel Source* section in update the selected *Channel List* item. By default, the *Custom* register is selected.
3. If you wish to setup a custom channel, select a *Type* and then fill in the *Command String* and *Description* fields for the desired channel. You may also select from one of the pre-defined registers available to the currently selected drive.
4. Fill in the *Min update ms*, *Scale*, and *Offset* fields as desired. Then choose a trace color and width.
5. Repeat steps 1-4 until all desire channels are added (maximum of 12 are available).

5.16.2 Oscilloscope Channels Settings



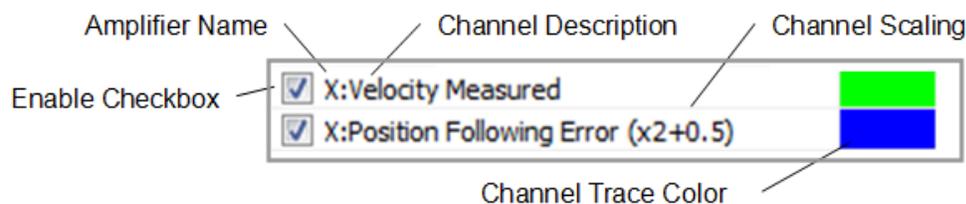
This window sets up the channels that are to be displayed in the oscilloscope plot area and optionally recorded.

5.16.3 Channel List

Channel	Color
<input checked="" type="checkbox"/> X:Velocity Measured	
<input checked="" type="checkbox"/> X:Position Following Error	
<input checked="" type="checkbox"/> X:Commutation Angle	
<input checked="" type="checkbox"/> X:Primary Command	
<input type="checkbox"/> <Unassigned>	N/A

The *Channel* list shows the current channels that have been setup for display in the scope plot area. There are 12 channels available to be setup, each taking a row in the list.

Each row in the list has the following components:



- Enable Checkbox** Check this box to display this channel for data collection and scope display. If unchecked, this channel will not appear in the *Show Traces* list.
- Drive Name** The name of the drive associated with the channel.
- Channel Description** The description of the channel. Taken from the *Description* field in the *Channel Source* section for the channel.
- Channel Trace Color** Shows the color used for the trace for this channel when displayed in the scope's plot area. A trace color is automatically assigned when a channel is first created, but can be changed by clicking on the [Set Color](#) button in the *Trace Attributes* section.

Unassigned Channels

All 12 channels are displayed in the list whether assigned or not. If a channel is not assigned, the row reads "<Unassigned>". A currently assigned channel can be unassigned by clicking on the [Unassign Channel](#) button at the bottom right sided of the window

<input type="checkbox"/> <Unassigned>	N/A	(Sweep Mode)
<input type="checkbox"/> <Unassigned> / <Unassigned>	N/A	(X-Y Plot Mode)

5.16.4 Channel Source Section

This section displays the settings for the currently selected channel, allowing the user to make changes.

- Select Axis** Select the axis for which the *Channel Source* fields refer. In *Sweep* mode (see *Oscilloscope Settings General*) only the *Y* option is available.
- Drive** Select the drive associated with this command from a list of currently connected drives. Drives in the list are grayed-out and non-selectable when 4 channels are using that drive (4 is the maximum number of scope traces permitted for a single drive).
- Register** Select from a list of registers available to the currently selected drive. Registers already used in channels definitions for the selected drive are grayed-out and non-selectable.
- Type** Specifies the type of data in the selected source and essentially translates into how the data is scaled after collected.
- Each register has a pre-assigned type that cannot be changed, so this setting is normally grayed-out and non-settable, unless the *Custom* register is selected in the *Register* setting.

6. Reference Information

6.1 On Board Status Display

The onboard Status Display is an eight segment LED display. The following table describes the meaning of each code.

Table 6-1 – Status Display Codes

Display	Fault Description
	EEPROM Fault
⊖	External Reset
⊔	Bus Overvoltage
⌈	Clamp
⌈.	STO Active
E	Encoder Fault
F	Foldback
H	Heatsink Overtemp
h	Motor Overtemp
L	LS/ESB
0	Normal Operation
S	HS/ECB
U	Under Voltage
∩	Position Follow Error
-	Hall Fault
≡	Commutation Fault
A	Over Speed
⊖.	Processor in Reset
Single Outer Segment	Drive Enabled, Hall

6.2 Matching Brushless Motor Phase Leads to Motor Feedback

For your brushless motor to run properly with your drive, the motor BEMF waveforms must be properly aligned with the Hall or commutation track signals. The proper alignment is shown in the figure below, as measured when rotating the motor shaft clockwise when viewing the face of the motor.

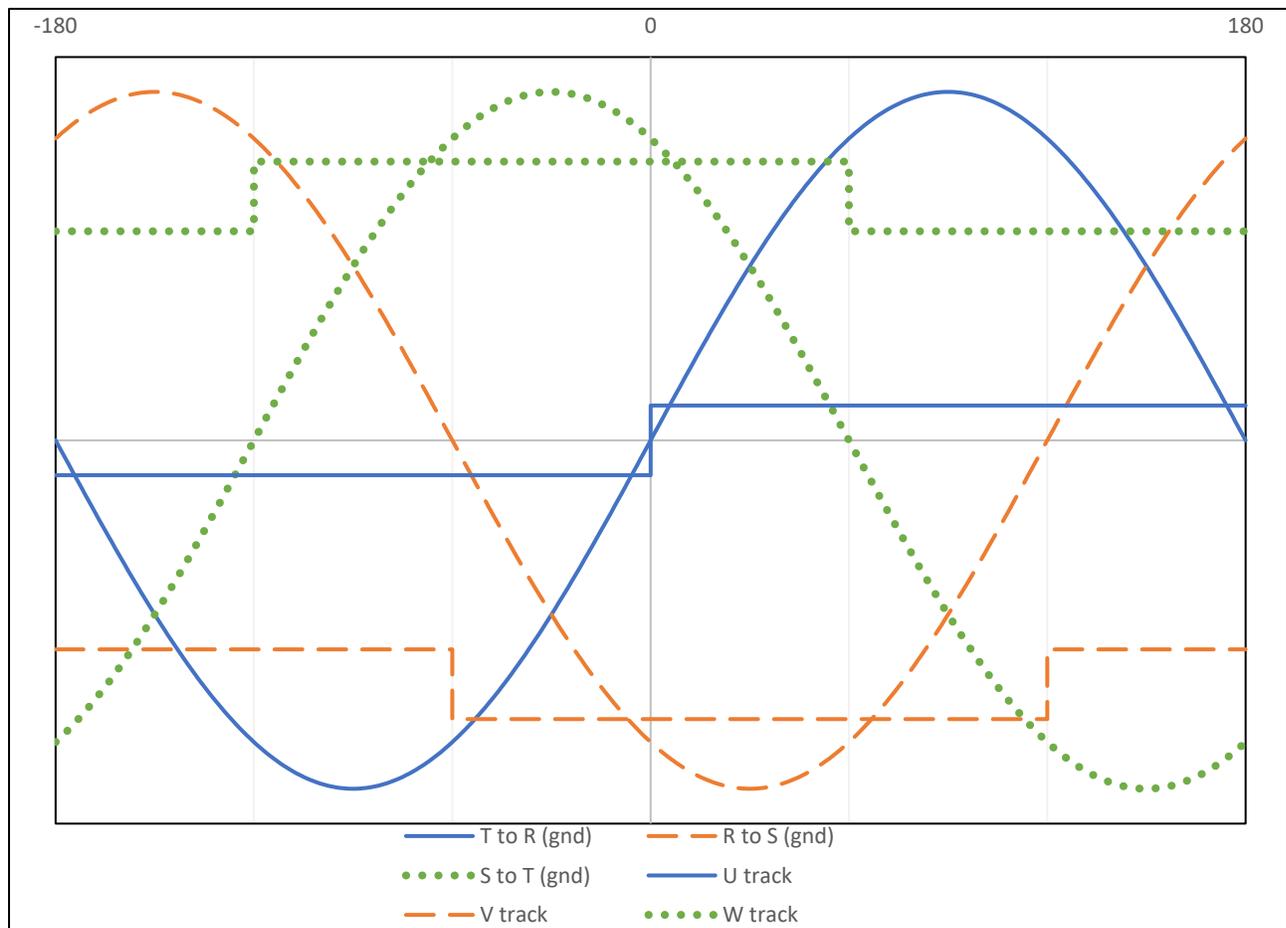


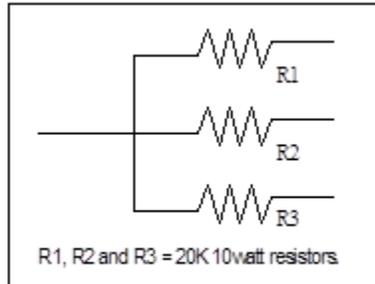
Figure 6-1 Commutation Track Signals and Phase-to-Phase BEMF

If you are using a standard wound Glentek motor, alignment is performed at the factory. GMB and GMBF series motors use a *Hall Signal Offset* of 0 degrees. GMBM series motors use a *Hall Signal Offset* of -30 degrees.

If you are using a third-party motor, verify motor phasing and alignment before use.

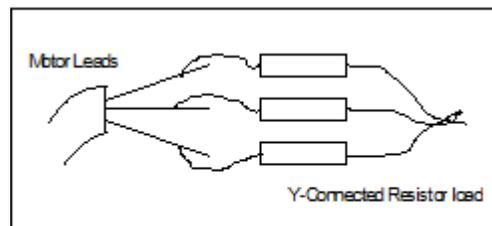
6.2.1 Verify Motor Phasing and Alignment

- The following equipment is required to verify motor phasing and alignment:
 - A 2 channel oscilloscope (four channel is best).
 - A 3-phase Y-connected resistive load as illustrated below.



Specification for resistive load

- A computer with MotionMaestro installed.
 - An RS232 cable.
- Disconnect any power to the drive, then connect the drive to the computer via the RS232 cable. Connect the motor feedback cable to the drive. **Leave the motor power leads disconnected from the drive.**
 - Connect the 3-phase Y-connected resistor load to the motor power leads. **Do not connect the resistor leads to the drive.**



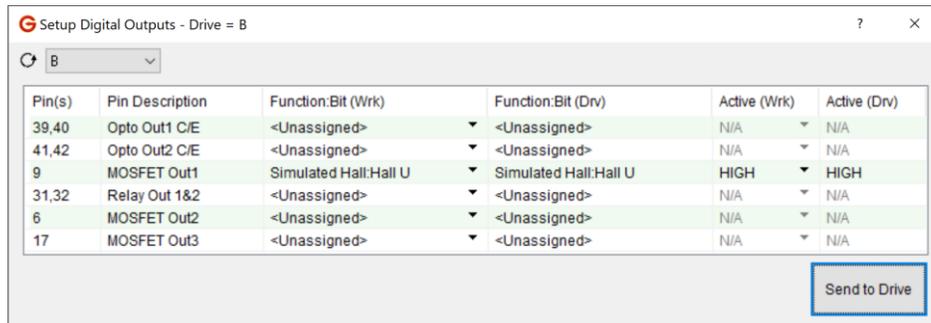
3-phase Y-connected resistor load

- Connect the oscilloscope's channel 1 scope probe to pin 9, and channel 1 scope common to pin 11 (Common) of the drive's controller I/O connector. Set the channel 1 vertical scale to around **2 V per division**.
- Connect the channel 2 scope probe to the phase T motor lead. Connect the channel 2 scope common to the phase R motor lead. Set the channel 2 vertical scale to around **2 V per division**. Set the horizontal scale to around **100 ms per division**. Scaling may need to be changed in order to best see the waveform.
- Power on the drive and open MotionMaestro. Click on **Communications -> Open**, to establish communications with the drive.

7. Select **Setup -> Commutation**.

- Select the appropriate *Motor Type and Configuration* and *Feedback Type*.
- On the *Commutation Config* tab, under *Initialization Method*, select *Hall*. Enter the *Number of Poles* for your motor (not pole pairs). Set all values under *Phase Lead* to 0. For *Correction Method*, select none. Check the box for *Simulated Hall with Correction Offset*.
- For *Hall Signal Offset*, set the value to 0 if the Hall signals are aligned with the phase-to-phase BEMF waveform. If they are aligned to the phase-to-neutral BEMF waveform, the value will either be -30 or +30. The value has to be determined experimentally. If you are using a resolver or absolute encoder for feedback, use the manufacturer supplied value.
- If you are using an encoder, on the *Feedback Config* tab, enter the value for *Lines per Revolution*.
- Click *Send Settings to Drive* and **Setup -> Save to NVM**.

8. Select **Setup -> Setup Digital Outputs**. Assign the function of pin 9 (MOSFET Out1) to *Simulated Hall: Hall U* and *Active High*. Click *Send to Drive*.



9. Rotate the motor by hand in the clockwise direction when viewing the motor face, and verify the trace on channel 1 (Hall U signal) follows a rectangular wave pattern. Verify that the trace on channel 2 (T to R BEMF signal) is aligned with the trace from channel 1 (Hall U signal) according to Figure 6-1. The Hall signal's transitions should align with the phase-to-phase BEMF zero crossings.
10. Repeat step 8, but change the function of pin 9 to *Hall V*. Move the channel 2 scope probe to the phase R motor lead and move the channel 2 scope common to the phase S motor lead. Verify that the signals are aligned, as done in step 9.
11. Repeat step 8, but change the function of pin 9 to *Hall W*. Move the channel 2 scope probe to the phase S motor lead and move the channel 2 scope common to the phase T motor lead. Verify that the signals are aligned, as done in step 9.

If all of the Hall signals are aligned with the appropriate phase-to-phase BEMF waveform, the motor is properly commutated and phased. If they are not aligned, proceed to the next step.

6.2.2 Adjusting Alignment

If the motor BEMF waveforms and the Hall or commutation track signals are not aligned as in Figure D-1, there are two possible scenarios.

1. If the motor BEMF waveforms and the Hall or commutation tracks signal's zero crossings do not coincide then the Hall or commutation track signals require mechanical alignment or a digital offset. This is due to the feedback device being installed out of alignment with the phases of the motor.
2. If the zero crossings do coincide, but the phases do not match Figure 6-1 (e.g. T-R (gnd) should cross zero at the same time as the U track), then the motor phases need to be determined experimentally. For this situation, proceed to section 6.3.3 Manual Phasing Procedure. This is due to mislabeling of the motor leads, or if the motor lead phasing is unknown.

Adjusting the alignment can be performed two different ways, mechanically or digitally. Mechanical adjustment is the preferred method, because it allows the same backup file to be used across identical systems. However, it requires access to the motor and to the Hall sensors or encoder on the motor. If this is not possible, an offset can be added digitally with MotionMaestro.

For complete instructions about aligning the feedback device with the motor BEMF waveforms, please contact Glentek. In brief, the procedure is as follows.

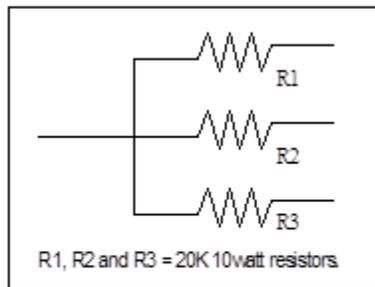
1. Remove the rear end cap of the motor.
2. Connect a Y-connected resistive load to the motor leads.
3. Connect oscilloscope probes to the motor leads and to the Hall or commutation track signals as in the previous section
4. Spin the motor by hand and adjust the Hall sensors or encoder until the oscilloscope signals match Figure 6-1.

Digital alignment is accomplished with MotionMaestro. Use the same oscilloscope setup as in section 6.2.1 and perform steps 1-7. However, for *Hall Signal Offset*, enter a value based on the signals from the oscilloscope. Estimate a value for the offset based on the distance between zero crossings of the motor BEMF waveform and the Hall or commutation tracks signals. Click [Send Settings to Drive](#). Spin the motor by hand and evaluate the new signals. If the signals are still not aligned, repeat this process until the zero crossings match.

6.2.3 Manual Phasing Procedure

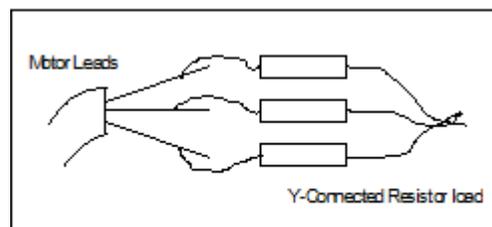
If you have already attempted to verify the motor phasing according to section 6.3.1, you may proceed to step 9. The setup described in steps 1-8 are identical.

- The following equipment is required to determine the phases of a brushless motor:
 - A 2 channel oscilloscope (four channel is best).
 - A 3-phase Y-connected resistive load as illustrated below.



Specification for resistive load

- A computer with MotionMaestro installed.
 - An RS232 cable.
- Disconnect any power to the drive, then connect the drive to the computer via the RS232 cable. Connect the motor feedback cable to the drive. **Leave the motor power leads disconnected from the drive.**
 - Connect the 3-phase Y-connected resistor load to the motor power leads. **Do not connect the resistor leads to the drive.**



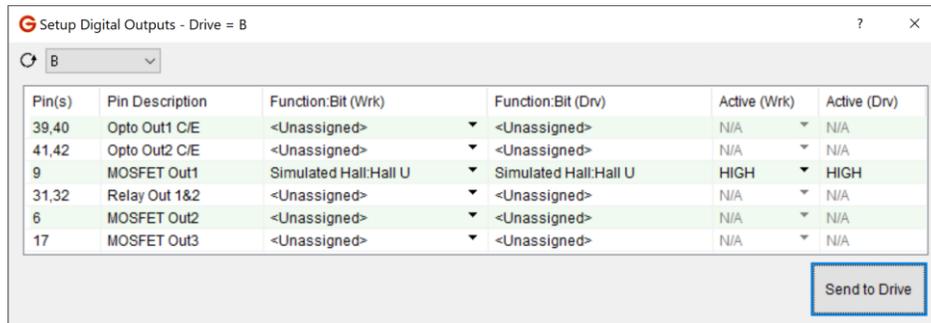
3-phase Y-connected resistor load

- Connect the oscilloscope's channel 1 scope probe to pin 9, and channel 1 scope common to pin 11 (Common) of the drive's controller I/O connector. Set the channel 1 vertical scale to around **2 V per division**.
- Connect the channel 2 scope probe to the phase T motor lead. Connect the channel 2 scope common to the phase R motor lead. Set the channel 2 vertical scale to around **2 V per division**. Set the horizontal scale to around **100 ms per division**. Scaling may need to be changed in order to best see the waveform.
- Power on the drive and open MotionMaestro. Click on **Communications -> Open**, to establish communications with the drive.

7. Select **Setup -> Commutation**.

- Select the appropriate *Motor Type and Configuration* and *Feedback Type*.
- On the *Commutation Config* tab, under *Initialization Method*, select *Hall*. Enter the *Number of Poles* for your motor (not pole pairs). Set all values under *Phase Lead* to 0. For *Correction Method*, select none. Check the box for *Simulated Hall with Correction Offset*.
- For *Hall Signal Offset*, set the value to 0 if the Hall signals are aligned with the phase-to-phase BEMF waveform. If they are aligned to the phase-to-neutral BEMF waveform, the value will either be -30 or +30. The value has to be determined experimentally. If you are using a resolver or absolute encoder for feedback, use the manufacturer supplied value.
- If you are using an encoder, on the *Feedback Config* tab, enter the value for *Lines per Revolution*.
- Click *Send Settings to Drive* and **Setup -> Save to NVM**.

8. Select **Setup -> Setup Digital Outputs**. Assign the function of pin 9 (MOSFET Out1) to *Simulated Hall: Hall U* and *Active High*. Click *Send to Drive*.



9. Find the phases T and R motor leads.

Rotate the motor by hand and verify the trace on channel 1 (Hall U signal) follows a rectangular wave pattern. Move the channel 2 scope probe and scope common to any two of the motor three leads to determine which BEMF waveform is in phase with the Hall U signal. Once the matching waveforms are determined, label the motor lead with the scope probe attached as Phase T, and the motor lead with scope common attached as Phase R.

This method of matching motor leads to the drive requires that the motor's Hall sensors transitions are aligned with the motor phase to phase BEMF zero crossings. If the Hall sensors are aligned with the motor's phase to neutral BEMF, then the commutation offset angle must be set to +30 or -30 degrees (you have to try both) before comparing the simulated Hall signal to the BEMF waveforms. If the motor does not have Hall sensors feedback (such as when using absolute encoder, or resolver), the drive is able to generate simulated Hall signals derived from absolute encoder or resolver feedback information.

If no combination of any of the motor phase leads are aligned with the Hall U signal (such as when using absolute encoder or resolver that has arbitrary offset angle), trial-and-error values have to be entered for the *Hall Signal Offset* in the Correction Method section of the Commutation Settings dialog until a matching between the Hall U signal with respect to phases T and R motor leads BEMF is found.

Once the phase T and R motor leads are determined, the remaining motor lead is phase S motor lead. All the motor phase leads are identified at this point, however, it is recommended to double check all the motor phase leads alignment with other Hall signals as well for complete assurance as in steps 7 (Find the phases R and S motor leads) and 8 (Find the phases S and T motor leads). Verify that the three phase R, S, and T motor leads result in waveforms that are in phase with the corresponding Simulated Hall signals on the drive when rotating the motor in the same direction for all three cases.

10. Repeat step 8, but change the function of pin 9 to *Hall V*. Move the channel 2 scope probe to the phase R motor lead and move the channel 2 scope common to the phase S motor lead. Verify that the signals are aligned, as done in step 9.
11. Repeat step 8, but change the function of pin 9 to *Hall W*. Move the channel 2 scope probe to the phase S motor lead and move the channel 2 scope common to the phase T motor lead. Verify that the signals are aligned, as done in step 9.
12. Once, the motor phase leads are identified, it will be necessary to run the motor. Begin by resetting any current limits, foldback thresholds to the desired operational settings. Reset the Control Panel options to appropriately safe values. Set the Analog Input Signal Gain back to the desired operational value. Click on **Setup -> Send to NVM**. Click on yes to save.

13. Remove the drive's power. Remove the scope probes. Remove the 3-phase Y-connected resistor load from the motor power leads. Connect the motor phase R, S, and T leads to the drive's R, S, and T terminals respectively.
14. Power on the drive. Check then clear all faults by referring to the Drive Status dialog.
15. Click on **Setup -> Drive Mode**, and ensure the only mode enabled is *Current*. If *Velocity*, or *Position* are enabled, disable them. Enable the drive. From the Control Panel dialog, issue a *Current (amps)* command of *0.5 to 2 amps*, or enough so the motor begins to rotate. If the motor runs and the shaft rotates, skip the next step. If the motor shaft locks upon applying current, click on **STOP**, to stop commanding current to the motor and proceed to the next step.
16. Click to apply a check mark (remove if checked previously) to the *Encoder Reverse* box in Feedback Config tab of Commutation Settings dialog. Click on **Send Settings to Drive**, to update the drive values. Click on **Setup -> Send to NVM**. Click on yes to save. Repeat step 15.
17. While the motor is rotating, verify that the polarity of the velocity in the *Actual Velocity (RPM)* matches the polarity of the commanded current in the *Current (Amps)*. If NOT, mark (or unmarked if were marked previously) the *Tach Reverse* checkbox on the Control Panel and verify that the polarity now matches. Command the opposite polarity current to the motor, *-5 to -2.0 amps* and verify that the motor reverses direction and runs at approximately the same speed. The signs of the current command and actual velocity should still match.
18. Verify that for the same magnitude current command in both directions, the *Actual Velocity* readings in both directions are very close to each other.
19. Click on **STOP**, to stop commanding current to the motor. Click on **Setup -> Send to NVM**. Click on yes to save.

The motor should now be properly commutated and phased.

6.2.4 Auto Phasing Procedure

This procedure should only be used at the initial startup of a system. Once completed, the settings can be saved as a backup, and these settings can then be restored in future systems. Future systems must be identical and wired exactly the same.

1. Power on the drive. Click on **Setup -> Drive Mode**, to set the drive in *Current* mode only (the *Velocity* and *Position* modes are not enabled).
2. Click on **Setup -> Commutation**. Select the appropriate motor type, the feedback type, and enter the correct information in Commutation Config and Feedback Config tabs (namely the Number of Poles and Lines per Revolution).

Commutation Settings - Drive = B

Motor Type and Configuration

Working Drive

Brushless
 Brush
 Induction

Linear: Working Drive
 Rotary: Working Drive
 Position:

Feedback Type Selection

Select feedback types you wish to enable and use:

Quadrature (TTL) Absolute Encoder
 SIN/COS Encoder Hall
 Resolver Tachometer

Commutation Config Feedback Config

Initialization Method

Working Drive

Select Method:

Brushless Configuration

Working Drive

Number of Poles:

Phase Lead

Working Drive

Angle Offset (deg):
 Phase Lead (deg/krpm):

Correction Method

Working Drive

None: Working Drive
 Hall Edge: Working Drive
 Hall Signal Offset (deg):
 Index-Auto: Working Drive
 Index-Manual: Working Drive
 Index Offset (deg):

Shaft Rotation Direction

Working Drive

Reverse Shaft Rotation: Working Drive

Simulated Hall

Working Drive

Simulated Hall with Correction Offset: Working Drive

Auto-Phase

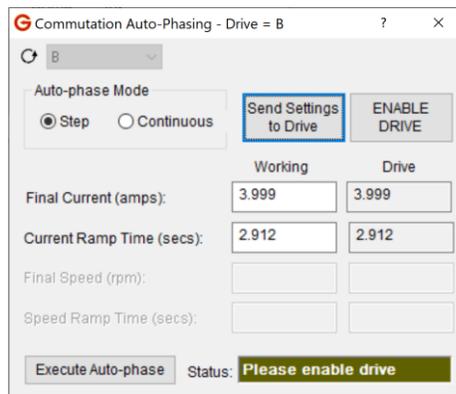
Auto Phasing Alignment Offset (degs):
 Phase Sequence Reverse:

ENABLE DRIVE Send Settings To Drive

3. Turn off power to the drive. Connect the motor power and feedback cables to the drive.

Note: Ensure that motor shaft is free to spin, and is not tied to any mechanical linkage.

4. Power on the drive. Clear all faults, and enable the drive. From the Commutation Settings dialog, click on **Auto Phasing**, to bring up the Commutation Auto-Phasing dialog.



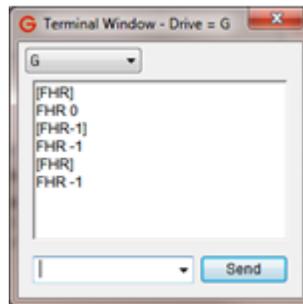
5. In the Auto-phase Mode section, select *Step* if the motor is linear or rotary type (with limited range of motion or travel distance). Alternately, if the motor has unlimited range of motion (during auto-phasing process), it is recommended to select *Continuous* auto-phase mode because it helps null out any uneven inertial load on the motor shaft and produce a higher accuracy phase alignment.
6. Set *Final Current* field to approximately to one third (1/3) of the motor's rated current. Click on *Send Settings to Drive*, to update the drive values. If *Continuous* is selected, set *Final Speed* field to approximately one third (1/3) of the motor's rated speed. Set the *Speed Ramp Time* to about three seconds to allow the motor adequate time to come up to the final velocity smoothly. For larger inertia system, it may require longer *Speed Ramp Time* value. Click on *Send Settings to Drive*, to update the drive values.
7. Enable the drive. Click on *Execute Auto-phase*, to start auto-phasing process.

Note: During the auto-phasing process, the motor will have slight movement if *Step* is selected, and would spin up to and stay at *Final Speed* for an extended period of time if *Continuous* mode is selected. The *Status* box in the Commutation Auto-Phasing dialog will be flashing during execution time, then return to green when finished. The duration lasts up to 60 seconds.

8. Click on *Status -> Drive Status*, to display the operation status of the drive. If Commutation is green (No Fault), then go to step 11. If it is red (Fault), then proceed to the next step.



9. Verify that the motor phase wires are connected properly, number of poles (this is not pole pairs), and line per revolution (not the quadrature count) are set correctly. If all were correct, increase *Final Current* value to 60% of motor rated current. Click on Send Settings to Drive. Click on Tools -> Control Panel. Click on Fault Reset in the Control Panel dialog to clear all faults.
10. Repeat from Step 7.
11. In the Control Panel dialog, slowly increase (positive) the current until the motor starts to spin. Verify that motor shaft is rotating in the desired direction. If the motor is rotating in the desired direction, go to step 15. If the motor is running in opposite direction, the parameter “FHR” needs to be modified in the Terminal dialog of MotionMaestro.
12. Click on DISABLE DRIVE, to disable the drive. At the Terminal window, type “FHR” and press the Enter key to query for the value.
13. If the “FHR” value is “0”, then type “FHR-1” and press the Enter key to change the “FHR” value from 0 to -1. If the “FHR” value is “-1”, then type “FHR0” and press the Enter key to change the “FHR” value to 0. Click on Setup -> Send to NVM. Click on yes to save.



14. Enable the drive. Repeat from Step 11.
15. Click on STOP. The command will go to zero (0), and the motor will stop.
16. Click on DISABLE DRIVE, to disable the drive.
17. Click on Setup -> Send to NVM. Click on yes to save.

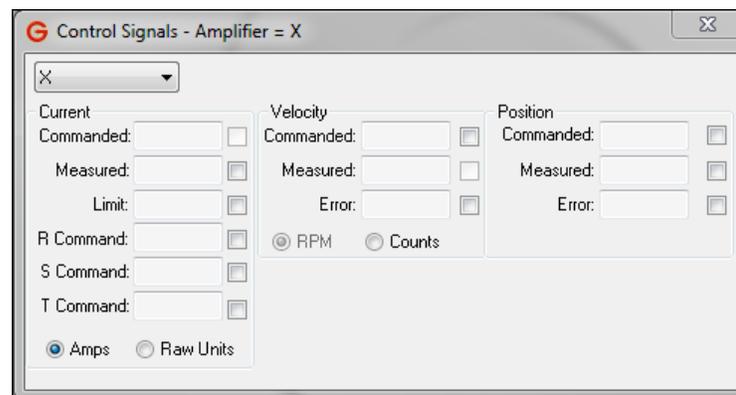
The system is now aligned. You can create a Backup File, and then restore to identical systems. Systems must be identical and connected exactly the same.

6.3 Determining Encoder Specs and Number of Motor Poles

6.3.1 Encoder Resolution

From the MotionMaestro *Status* menu, open the *Control Loop Signals* window. Check the box that allows you to monitor “Measured” “position” of the encoder. Then mark a start position on the motor shaft. Turn the shaft 360° clockwise and monitor the encoder position in the *Control Loop Signals* window. Note the change in encoder counts. Take the change in encoder counts per 1 revolution (360°) and divide by four (4). This is the *Lines of Resolution* that you will enter in the *Commutation* window. (**Note:** For better accuracy, you may rotate 10 turns and divide by 40 instead of dividing by 4.)

Common encoder line counts include but are not limited to 250, 256, 500, 512, 1000, 1024, 2000, 2048, 2500, 4096, 5000, 8192, and 10,000 lines/revolution.



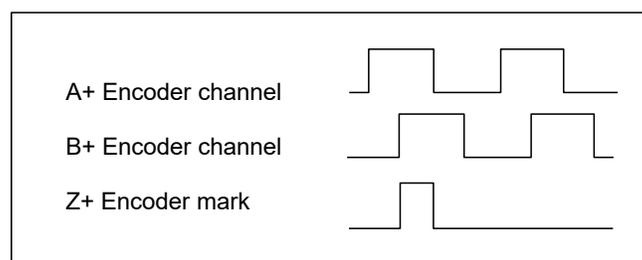
6.3.2 Encoder Reverse

Disable the drive. Go to **Status -> Motor and Other Status** and **Status -> Control Loop Signals**. Check the box for *Position, Measured* on the *Control Loop Signals* window. Spin the motor shaft by hand while looking at the *Hall U, Hall V, and Hall W* status lamps. Spin the motor shaft in the direction which produces the sequence of Hall U, U&V, V, V&W, W, W&U, and U. The number in the *Position, Measured* field should increment positively when the motor shaft spins in this direction. If it increments negatively, select **Setup -> Commutation**, then select the *Feedback Config* tab. Then check the *Encoder Reverse* box. Press **Send Settings To drive** and **Save to NVM**.

6.3.3 Encoder Outputs

The following illustrates the encoder signals for a standard Glentek motor that is correctly commutated.

Figure 6-1 Glentek Standard Commutated Encoder Signals



6.3.4 Number of Poles (Note: Requires Hall sensors)

Enable the drive. Mark a start position on the motor shaft. From the MotionMaestro® *Status* menu, select the *Drive Status* window. Monitoring the *Hall U*, *Hall V*, and *Hall W* display in the *Drive Status* window. Note the lit *Hall* segment(s) before rotating the motor shaft. Now turn the shaft 360° either clockwise or counterclockwise. While rotating the shaft, count the number of times the Hall segments display goes through a full rotation (e.g. if you start with only *Hall U* lit, a full rotation would involve the Hall segment cycles through Hall U, U&V, V, V&W, W, W&U, and U). Take the number of full Hall cycles and multiply it by two. This is the *Number of Poles* that you will enter in the *Commutation* window.

Status Lamps Window - Amplifier = X	
HS ECB	Bus Under Volt
LS ECB	CPLD
Bus Over Volt	NV RAM
Amp Over Temp	Pos Follow Err
Motor Temp	Over Speed
Resolver	Power On Reset
Hall	Commutation Init
Commutation	Foldback
Enc. Index Sensed	Limit+
Amp Enabled	Limit-
HW Inhibit	Fault In
Soft Inhibit	Hardware Inhibit
Balancing	Motor Temp
Commutated	Amp Temp
Fault	External Reset
At Speed	Hall U
At Zero	Hall V
	Hall W

6.4 Replacement for Alpha Series Drives

(Coming Soon)

6.5 Drive Terms and Technology

This appendix contains information that describes and explains the terms and concepts referred to in this manual. The information contained here is generic to drives and motion control technology in general. The TERMS section is a glossary that defines the terms used when discussing drives. The TECHNOLOGY section describes methods or concepts that involve the usage of multiple terms.

6.5.1 Terms

Analog Current Command Mode

Analog current mode, also called torque mode or current mode, indicates that the drive is being commanded by an analog signal and that the drive's control loop is controlling current. This command mode is used when one needs to control torque. The analog signal, in volts, is a scaled representation of desired current as measure at the output. For instance -10 Volts to 10 Volts at the analog input becomes -15 Amps to 15 Amps at the drives output. The scaling is different for different drives.

Analog Velocity Command Mode

Analog velocity mode indicates that the drive is being commanded by an analog signal and that the drive's control loop is controlling velocity. This command mode is used when one needs to control the speed of some device. The analog signal, in volts, is a scaled representation of desired velocity as measured at the output. For instance -10 Volts to 10 Volts at the analog input becomes -3000 rpm to 3000 rpm at the device being moved. The scaling is can often be configured by the application engineer.

Command Mode

A term used to refer to the method by which a command is given to the drive. The drive uses this command in its control loop as a target to be achieved. The command mode usually includes how the drive is to interpret the command. That is, whether the command is to represent current, velocity, or position. There are many forms and methods by which commands are submitted to the drive. Traditionally the command was given as an analog voltage input to the drive. Today there is analog, digital, serial communications, or some combination of these.

Commutation

Commutation is the term used to describe the method by which current is applied to the windings of a motor such that the applied current moves the motor in a desired direction, or to a desired position, with the minimum current. Brushes are the method of commutation in a brush motor. In a three phase brushless motor, sinusoidal commutation is the usual method of commutation. See *Sinusoidal Commutation*.

Commutation Initialization Method

In order to properly commutate a brushless motor, the drive must know the absolute position of the rotor with respect to the motor windings in the stator. Since incremental shaft encoders only supply "relative" rotor position, the drive must perform a power-on, phase-finding scheme to determine the absolute position of the shaft. This is known as commutation initialization. Once the absolute position is determined, the position from the encoder can be used to maintain the absolute position. The SMB/SMC 9G16 drives have two power-on commutation initialization methods available for finding the absolute position of the rotor. The Smart-Comm method requires the rotor to move; the second scheme, Hall, does not require motion. The Hall method does require the addition of Hall sensors or commutation tracks. Commutation tracks are simulated Hall sensors built into the shaft encoder.

Hall Commutation Initialization

Hall commutation initialization is a method that relies on sensors to give an approximation of the initial commutation angle of a motor. Hall initialization uses Hall sensors or commutation tracks (simulated Hall sensors built into the shaft encoder) to determine the rotor angle. In a brushless motor, three Hall sensors are used to detect rotor position. The three Hall sensors employed are commonly named U, V and W; S1, S2 and S3; or A, B and C. The I sensors are digital (on/off) devices and therefore the combination of the three can result in eight different states. The sensors are aligned with the motor in a way that causes the output of the sensors to transition through six of the eight possible states as the motor is rotated through 360 electrical degrees. Each Hall state corresponds to 60 electrical degrees. Only one sensor changes states at any given transition.

At power up, the drive reads the state of the Hall sensors and from this state can determine within ± 30 electrical degrees where the motor shaft is located. This is close enough to start commutating the motor, so the drive uses this approximation as the actual rotor position. Once motion is commanded (position, velocity, or torque), the drive starts commutating with this value and watches for a transition of the Halls state. Upon this transition, the drive knows the exact location of the rotor shaft and updates the commutation angle based on this known location.

The hall method does not move the rotor shaft at power up. Instead, it uses a non-optimal commutation angle at start-up and corrects to the optimal commutation angle upon the first Hall state transition once motion is commanded.

Phase Lead

Glentek's advanced algorithms provide automatic phase lead and eliminate the need to manually specify phase lead. These advanced algorithms ensure that the system is operating at the highest possible speed and with maximum efficiency.

Sinusoidal Commutation

In sinusoidal commutation a sinusoidal current is applied to each phase of the motor to cause the motor to rotate. In a three phase motor, the relationship of the currents applied in the three phases for a positive rotation of the rotor is:

$$I_R(\theta_e) = I * \sin(\theta_e),$$

$$I_S(\theta_e) = I * \sin(\theta_e - 120^\circ),$$

$$I_T(\theta_e) = I * \sin(\theta_e - 240^\circ);$$

where:

I_R , I_S , and I_T are the currents applied to phase R, S, and T respectively,

I is the amplitude of the commanded current,

θ_e is the "electrical angle" of the applied currents.

The relationship between the electrical angle, θ_e , and the mechanical angle (the angle of the rotor), θ_m , is:

$$\theta_m = \theta_e \times 2/N,$$

Note: N is the number of poles in the motor.

For example, a 4-pole motor (two north poles and two south poles) will rotate 180 mechanical degrees as the currents applied are varied through 360 electrical degrees.

6.5.2 Technology

Selection of a Commutation Initialization Method

The first step in selecting a commutation initialization method is to determine whether motion can be tolerated upon power up. If motion is not acceptable, then the motor must be equipped with Hall sensors or commutation tracks, and Hall initialization should be used. If motion is acceptable at power up, then the second item, which will prevent Smart-Comm initialization from working properly, is the presence of large external torque applied on the motor rotor. If large external torque exist which either resist rotor motion (such as a brake or excessive friction), or cause the rotor to rotate (such as a gravity), then Smart-Comm can result in a non-optimal commutation angle. This occurs because these modes both rely upon finding equilibrium between the applied motor current and the rotor position; an external torque will alter this equilibrium position. If a large enough current is applied during initialization, this external torque can be overcome and an acceptable commutation angle can be achieved.

If Smart-Comm is selected, the amount of current to the motor during initialization must be set. The values such as the initial current and the final current need to be set for commutation initialization to occur. The default value can be used as a basis. After following the process outlined in the MotionMaestro chapter these values can be tuned to the application necessary.

FOC (Field Oriented Control)

This is a math-intensive technique for controlling brushless DC and AC induction motors that consists of controlling the stator currents represented by a vector. This control is based on projections, which transform a three-phase time and speed dependent system into a two co-ordinate (d and q co-ordinates) time invariant system. This makes the control accurate in every working operation (steady state and transient) and independent of the limited bandwidth mathematical model. This reduces motor size, cost and power consumption.

SVPWM (Space Vector Pulse Width Modulation)

This is an algorithm for the control of pulse width modulation (PWM). It is used for the creation of alternating current (AC) waveforms, most commonly to drive 3 phase AC powered motors at varying speeds from DC using multiple class-D drives. The SVPWM generates minimum harmonic distortion of the currents in the winding of 3-phase AC motor. SVPWM also provides a more efficient use of the supply voltage in comparison with sinusoidal modulation methods.

Smart-Comm

Smart-Comm commutation is a method that does not rely on encoder commutation tracks or hall sensors for motor commutation. It is important to note that the Smart-Comm algorithm always returns the motor shaft to its initial starting position after moving the motor shaft a few encoder counts to determine the correct commutation angle. The following gain variables listed below can be used to additionally tune the algorithm if it is desired.

Note: For the Smart-Comm commutation method, the commutation tracks are not needed (only incremental encoder is needed) as shown in the *Current Loop Control Diagram Gamma Series*.

If you are planning to use Smart-Comm, be sure to contact your Glentek sales agent first, and he/she can have these following variables preset at the factory before shipment. However, the default value in the drive will work for most cases.

Proportional Gain: This value should initially be set to a low value. The default value is 1024 and this should be a low enough value to start off with in most situations. Depending on the shaft size or the inertia of the motor, the beginning *Proportional Gain* may need to be set lower than the default value. The higher the *Proportional Gain* value is set to, the less movement the shaft will have during commutation initialization. The max value for this value is 32767.

Integral Gain: This value can be initially set to 0. If a high *Proportional Gain* can be achieved, there will be very little movement during commutation initialization, and the *Integral Gain* may not be necessary. However, any value of *Integral Gain* will pull the motor back to its original position. The higher the *Integral Gain*, the faster this will happen. This value should be relatively low and the max value should be no more than 100.

Derivative Gain: This value can be initially zero but after the *Proportional Gain* is set, the *Derivative Gain* can be set as high as possible, typically 1/2 of the *Proportional Gain*.

Initial Current: This value can always be 0. The only reason to use it would be to reduce the total initialization time by giving the current a head start. This is especially true if the *Final Current* is a large number.

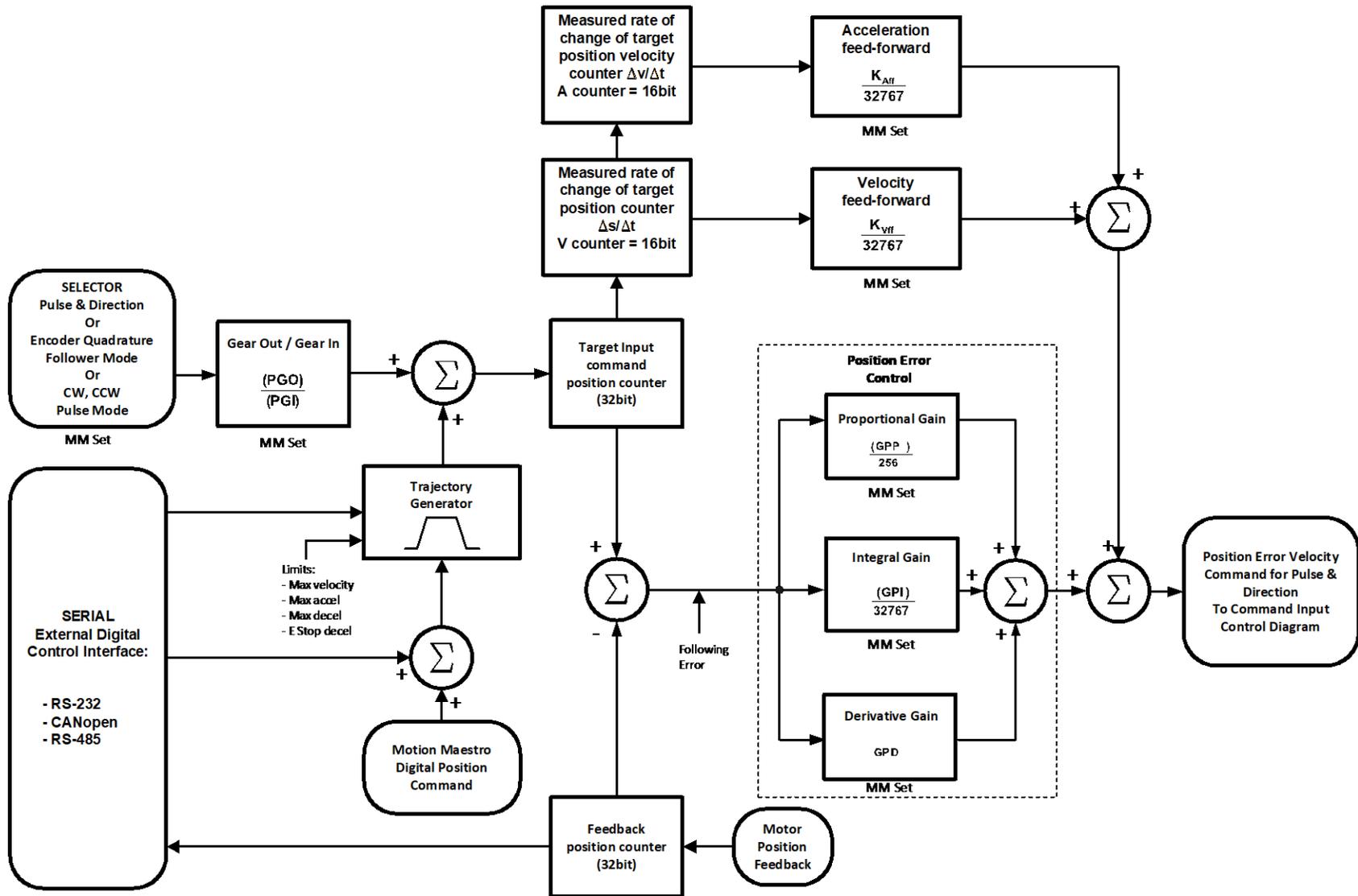
Final Current: This value must be greater than the *Initial Current*. The *Final Current* should be enough to make the motor shaft move or enough current to make the load move. Typically, the *Final Current* is set at the motor's rated stall current.

Ramping Time: This value is the amount of time that it will take to change the *Initial Current* to the *Final Current*. This value is in seconds.

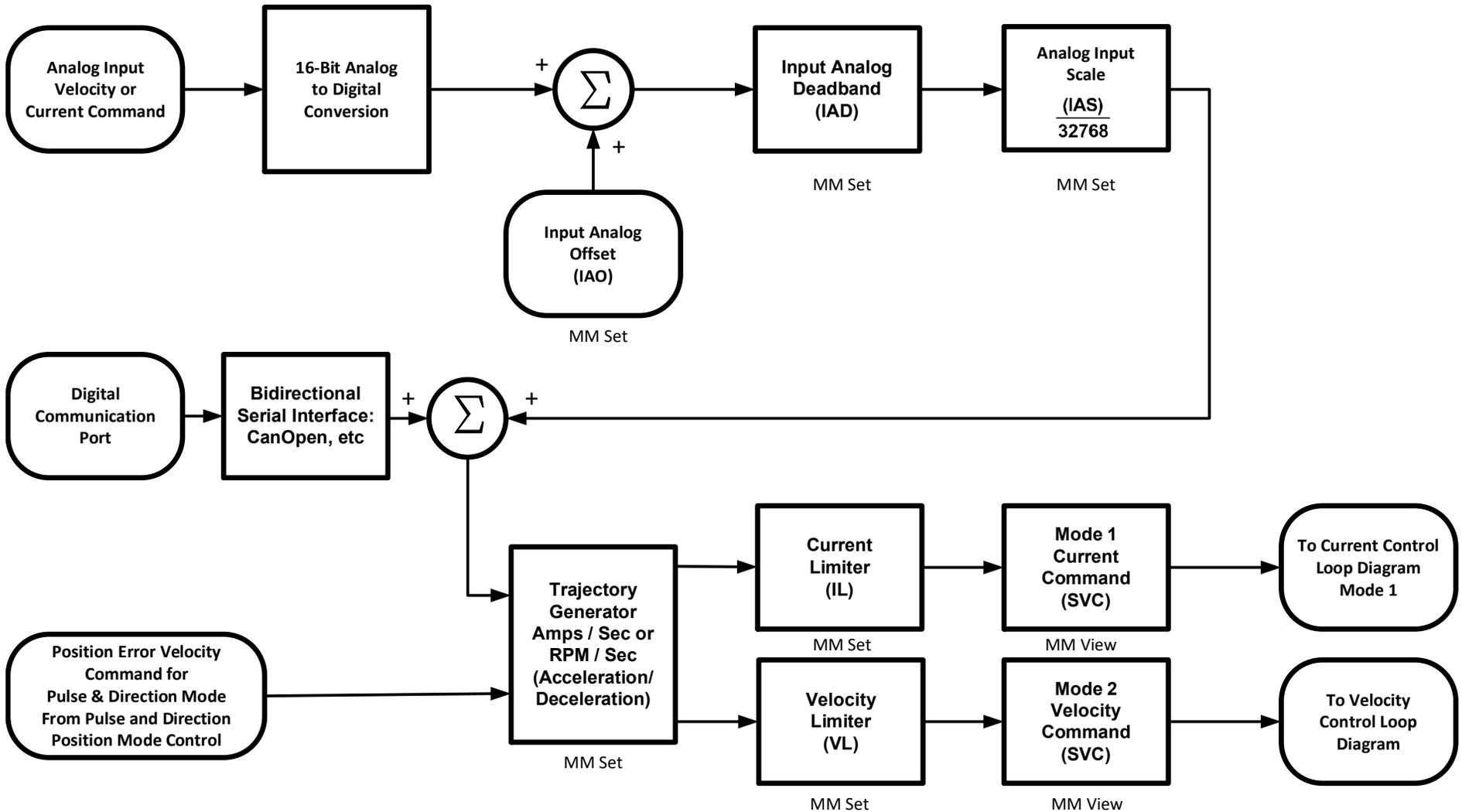
Timer Ticks: This value is the amount of time that the commutation initialization will take. This value must be greater than the *Ramping Time*. This value is in seconds.

6.6 Control Block Diagrams

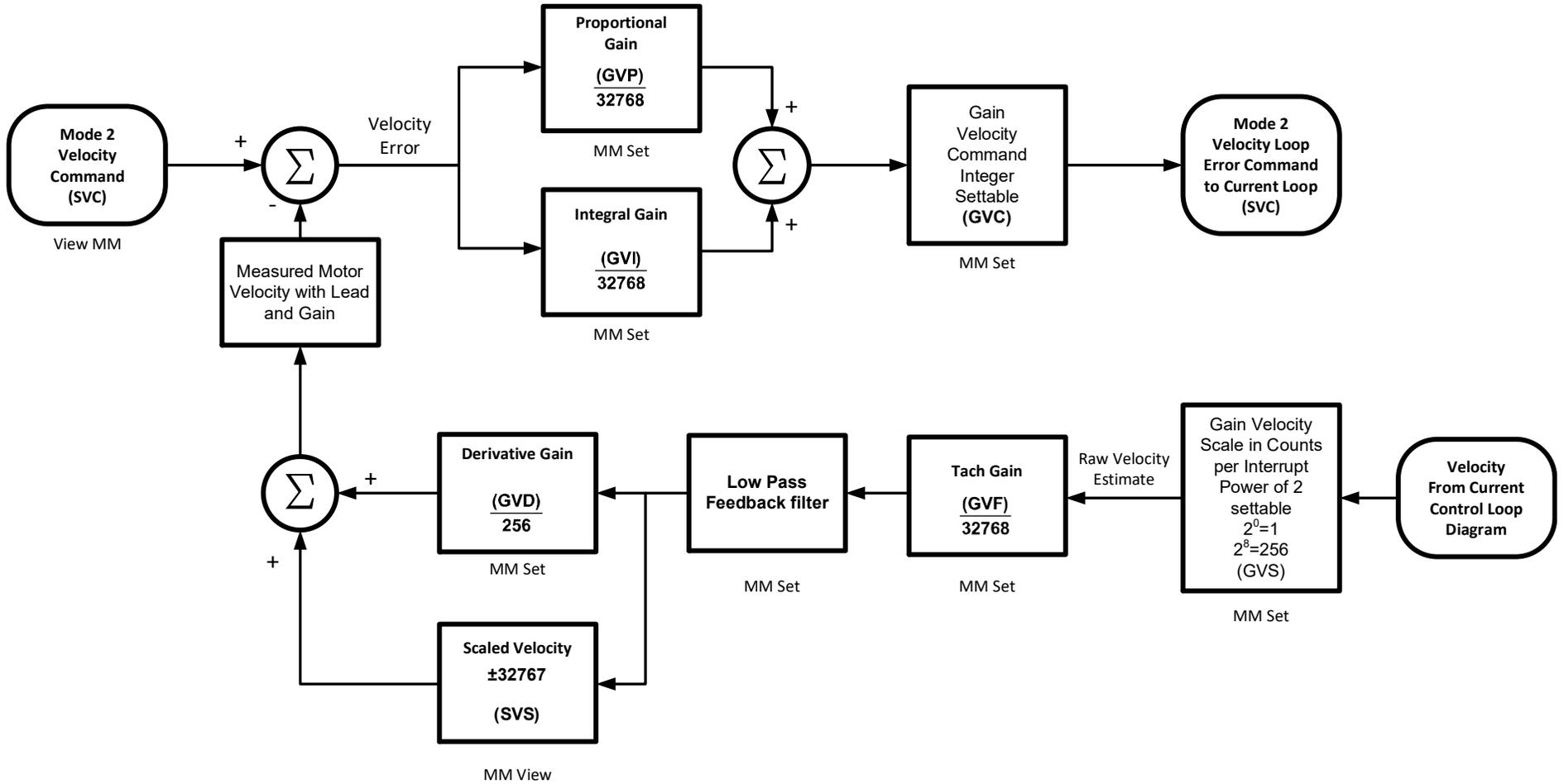
6.6.1 Position Mode Control Diagram



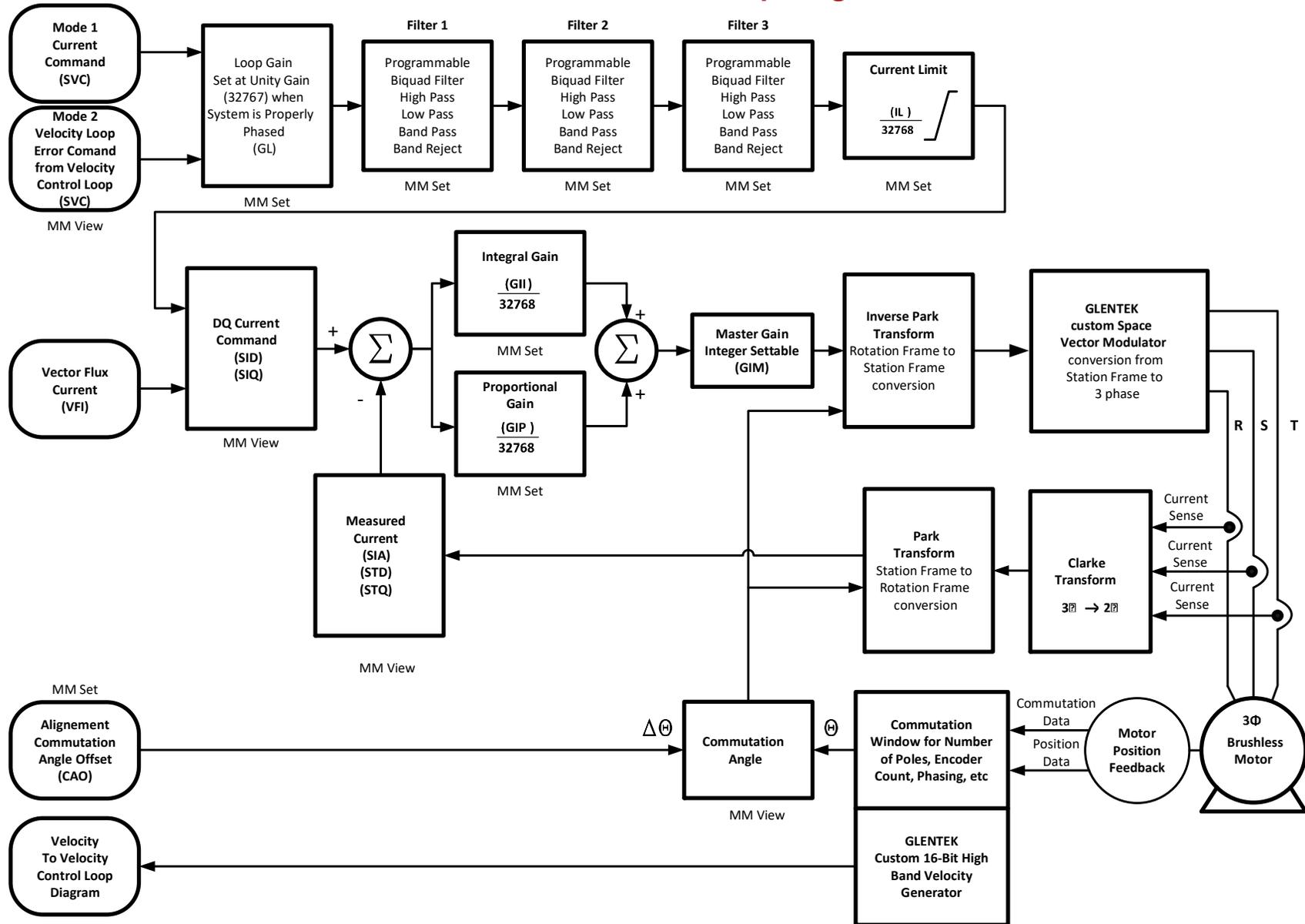
6.6.2 Command Input Control Diagram



6.6.3 Velocity Control Loop Diagram

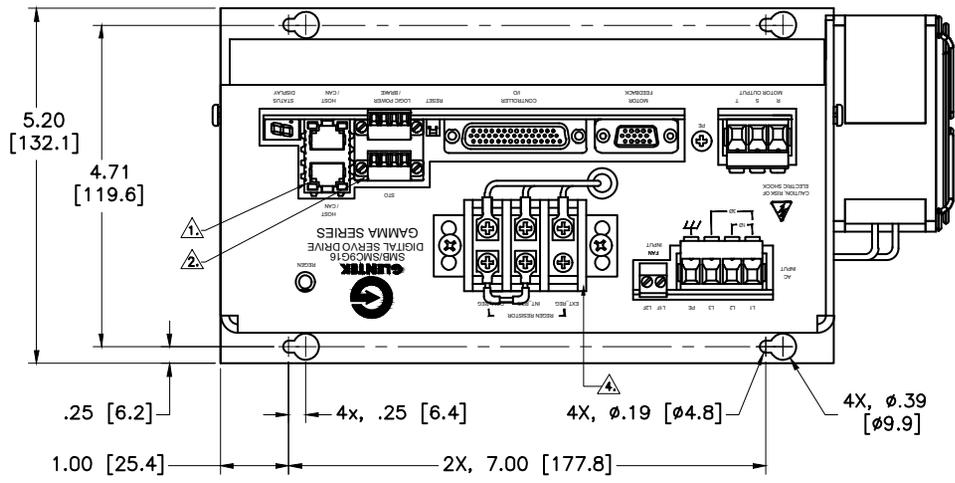


6.6.4 Current Control Loop Diagram

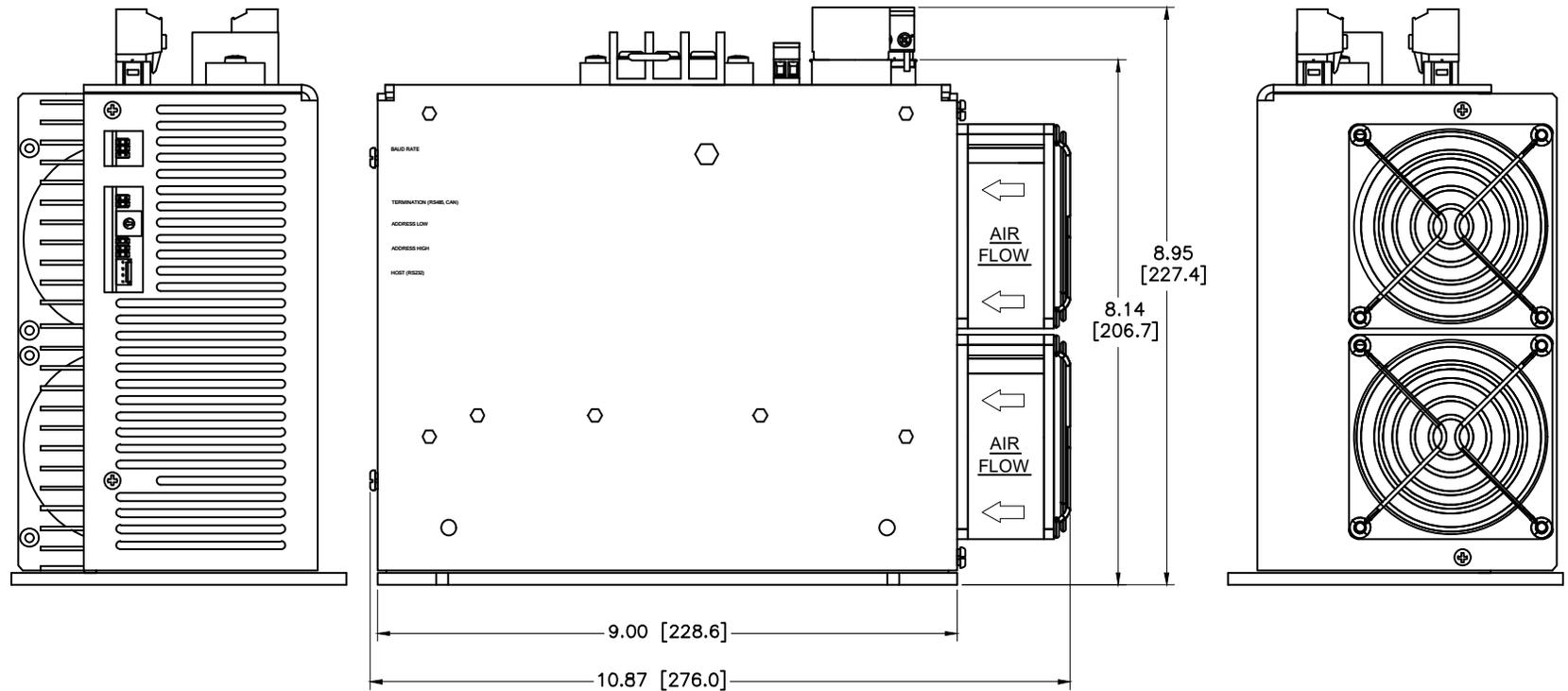


6.7 Dimensions

9G16-1A/1B STANDALONE: SHORT FIN HEATSINK (NON-UL)



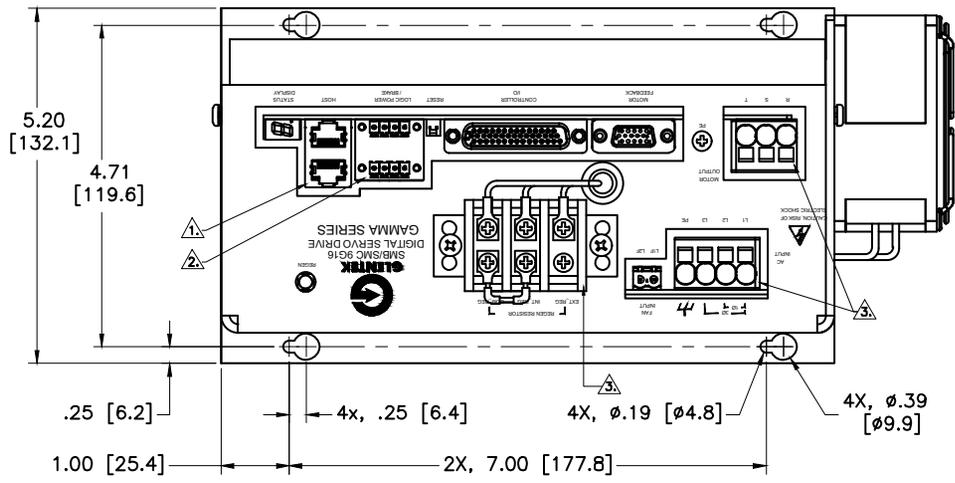
Mating Connectors			
Description	Glentek P/N	Manufacturer P/N	Provided
Controller I/O, 44 Pin, solder	EJH23M44	FCI P/N: 10090769-P444ALF	No
Controller I/O, 44 Pin, crimp	N/A	TE P/N: 1658672-1	No
Backshell (solder or crimp)	EJH23S25	FCI P/N: 8655MH2501BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Mtr Feedback, 15 Pin, solder	EJH23M15	FCI P/N: 10090769-P154ALF	No
Mtr Feedback, 15 Pin, crimp	N/A	TE P/N: 748364-1	No
Backshell (solder or crimp)	EJH23S09	FCI P/N: 8655MH0901BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Module Logic Power, 4 Pin	EJ521E04	Phoenix P/N: 1827729	Yes
Host, RJ45	EJ018083	Molex P/N: 87522-8012	No
Motor Output, 3 Pin	EJ531F03	Phoenix P/N: 1777736	Yes
AC Input, 4 Pin	EJ531F04	Phoenix P/N: 1777749	Yes
Fan Input, 2 Pin	EJ741V02	Phoenix P/N: 1792757	Yes
Reset, 2 Pin	EJ381F02	Molex P/N: 22-01-3027	Yes
Host, RS232	EJ381F04	Molex P/N: 22-01-3047	Yes
Crimp Pin	EH042260	Molex P/N: 08-55-0102 2759	Yes



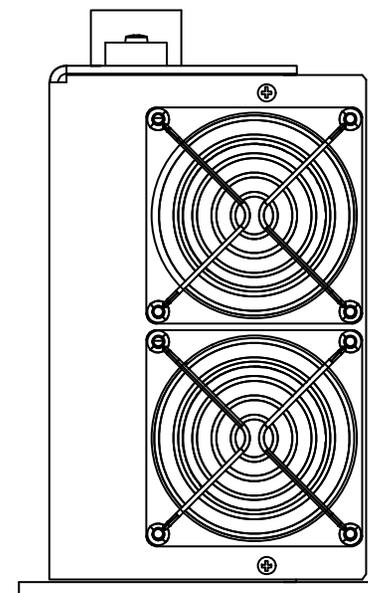
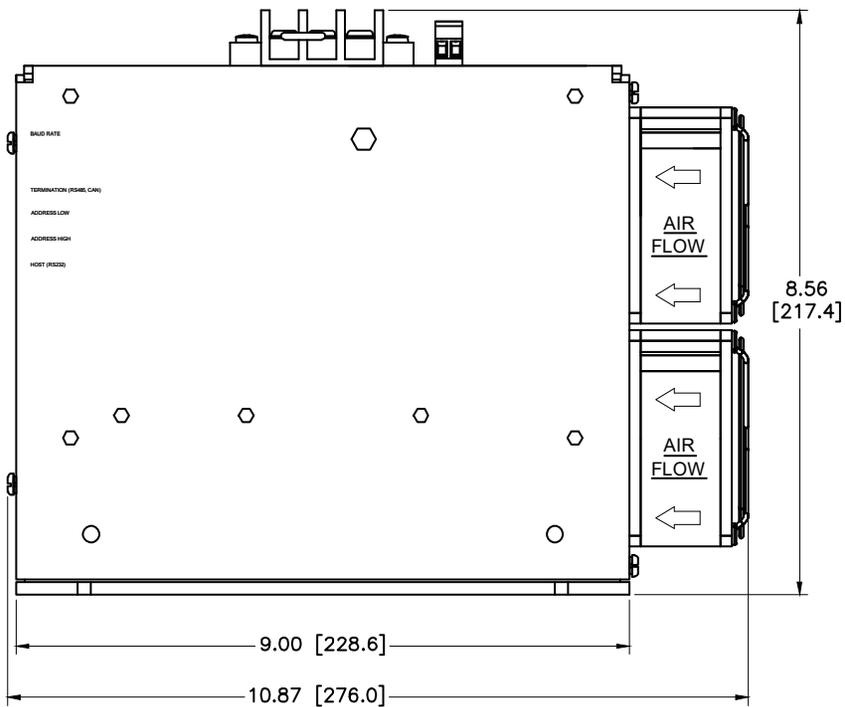
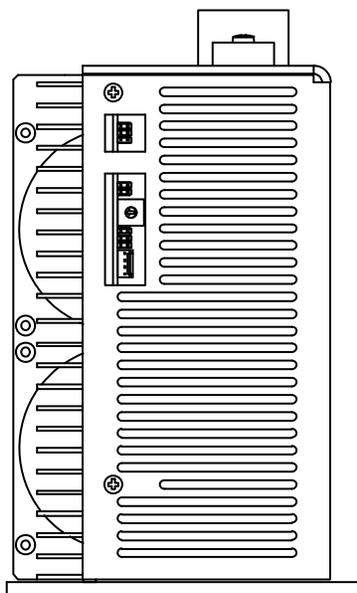
- NOTES:**
- 1. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "HOST" FEATURE & DOUBLE ROW FOR ADDITIONAL "CAN" FEATURE. ALL SIDE CONNECTORS ARE PROVIDED FOR "CAN" FEATURE ONLY.
 - 2. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "LOGIC POWER / BRAKE" FEATURE & DOUBLE ROW FOR ADDITIONAL "STO" FEATURE.
 - 3. THESE CONNECTORS ARE SUITABLE FOR FIELD WIRING OF 24AWG TO 10AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.
 - 4. EXTERNAL REGEN IS OPTIONAL.

DRAWING # 9G16-100Z-002-2	SCALE: .75:1	DRAWN BY: D.C.R.	DATE: 19JUN20	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	TOLERANCES AS FOLLOWS: DECIMAL: .XX ±0.01 ANGULAR < ±0.5° .XXX ±0.005
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9G16-1A/1B STANDALONE: SHORT FIN HEATSINK (UL)



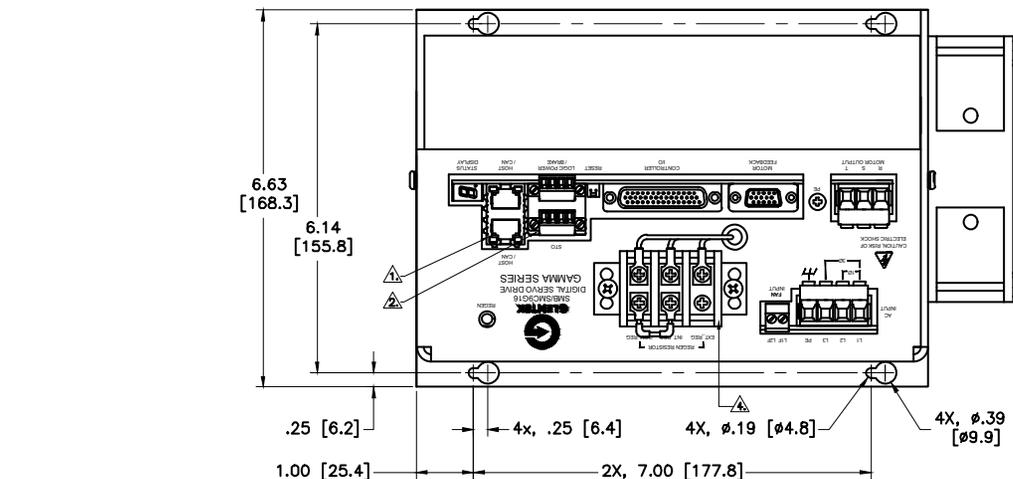
Mating Connectors			
Description	Glentek P/N	Manufacturer P/N	Provided
Controller I/O, 44 Pin, solder	EJH23M44	FCI P/N: 10090769-P444ALF	No
Controller I/O, 44 Pin, crimp	N/A	TE P/N: 1658672-1	No
Backshell (solder or crimp)	EJH23S25	FCI P/N: 8655MH2501BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Mtr Feedback, 15 Pin, solder	EJH23M15	FCI P/N: 10090769-P154ALF	No
Mtr Feedback, 15 Pin, crimp	N/A	TE P/N: 748364-1	No
Backshell (solder or crimp)	EJH23S09	FCI P/N: 8655MH0901BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Host, RJ45	EJ018083	Molex P/N: 87522-8012	No
Fan Input, 2 Pin	EJ741V02	Phoenix P/N: 1792757	Yes
Reset, 2 Pin	EJ381F02	Molex P/N: 22-01-3027	Yes
Host, RS232	EJ381F04	Molex P/N: 22-01-3047	Yes
Crimp Pin	EH042260	Molex P/N: 08-55-0102 2759	Yes



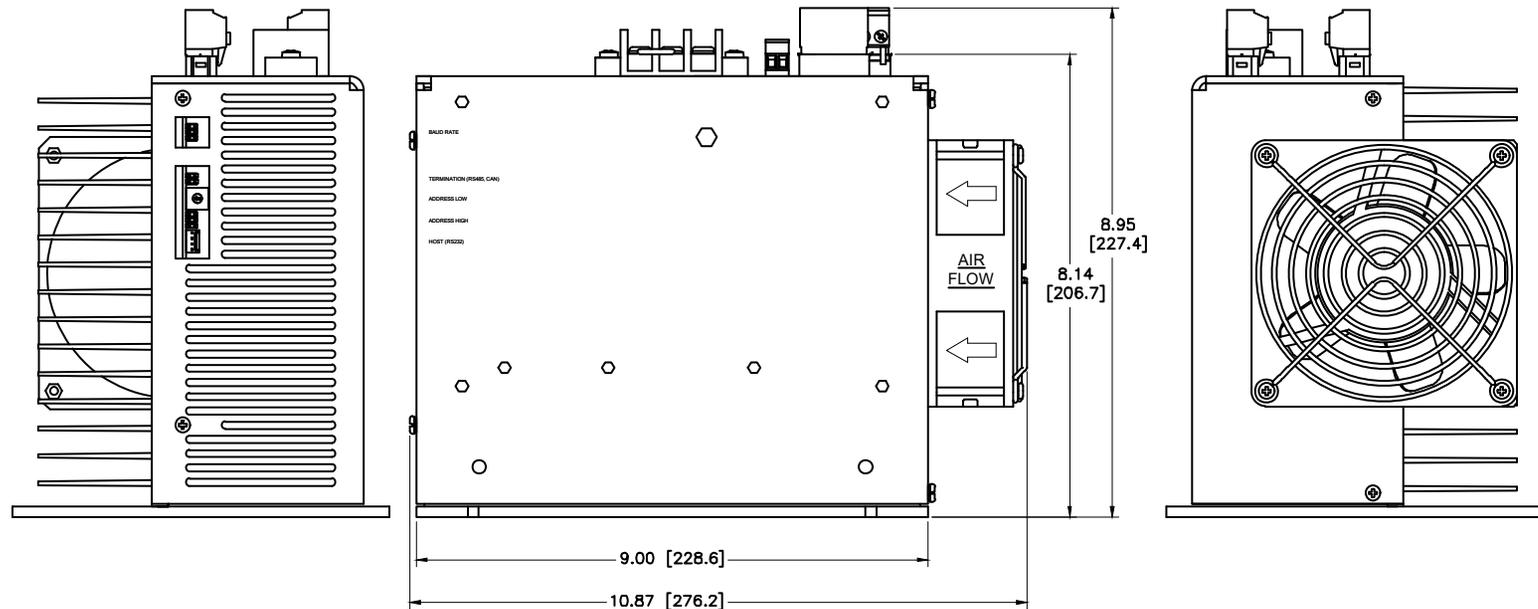
- NOTES:**
- 1. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "HOST" FEATURE & DOUBLE ROW FOR ADDITIONAL "CAN" FEATURE. ALL SIDE CONNECTORS ARE PROVIDED FOR "CAN" FEATURE ONLY.
 - 2. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "LOGIC POWER / BRAKE" FEATURE & DOUBLE ROW FOR ADDITIONAL "STO" FEATURE.
 - 3. THESE CONNECTORS ARE SUITABLE FOR FIELD WIRING OF 24AWG TO 8AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.
 - 4. EXTERNAL REGEN IS OPTIONAL.

DRAWING # 9G16-100Z-012-1	SCALE: .75:1	DRAWN BY: D.C.R.	DATE: 19JUN20	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	TOLERANCES AS FOLLOWS:	DECIMAL: .XX ±0.01 .XXX ±0.005	ANGULAR < ±0.5°
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9G16-1A/1B STANDALONE: LONG FIN HEATSINK (NON-UL)

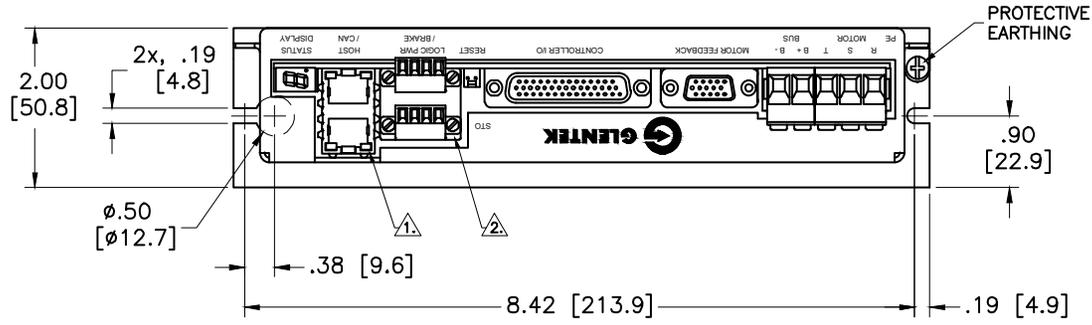


Mating Connectors			
Description	Glentek P/N	Manufacturer P/N	Provided
Controller I/O, 44 Pin, solder	EJH23M44	FCI P/N: 10090769-P444ALF	No
Controller I/O, 44 Pin, crimp	N/A	TE P/N: 1658672-1	No
Backshell (solder or crimp)	EJH23S25	FCI P/N: 8655MH2501BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Mtr Feedback, 15 Pin, solder	EJH23M15	FCI P/N: 10090769-P154ALF	No
Mtr Feedback, 15 Pin, crimp	N/A	TE P/N: 748364-1	No
Backshell (solder or crimp)	EJH23S09	FCI P/N: 8655MH0901BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Module Logic Power, 4 Pin	EJ521E04	Phoenix P/N: 1827729	Yes
Host, RJ45	EJ018083	Molex P/N: 87522-8012	No
Motor Output, 3 Pin	EJ531F03	Phoenix P/N: 1777736	Yes
AC Input, 4 Pin	EJ531F04	Phoenix P/N: 1777749	Yes
Fan Input, 2 Pin	EJ741V02	Phoenix P/N: 1792757	Yes
Reset, 2 Pin	EJ381F02	Molex P/N: 22-01-3027	Yes
Host, RS232	EJ381F04	Molex P/N: 22-01-3047	Yes
Crimp Pin	EH042260	Molex P/N: 08-55-0102 2759	Yes

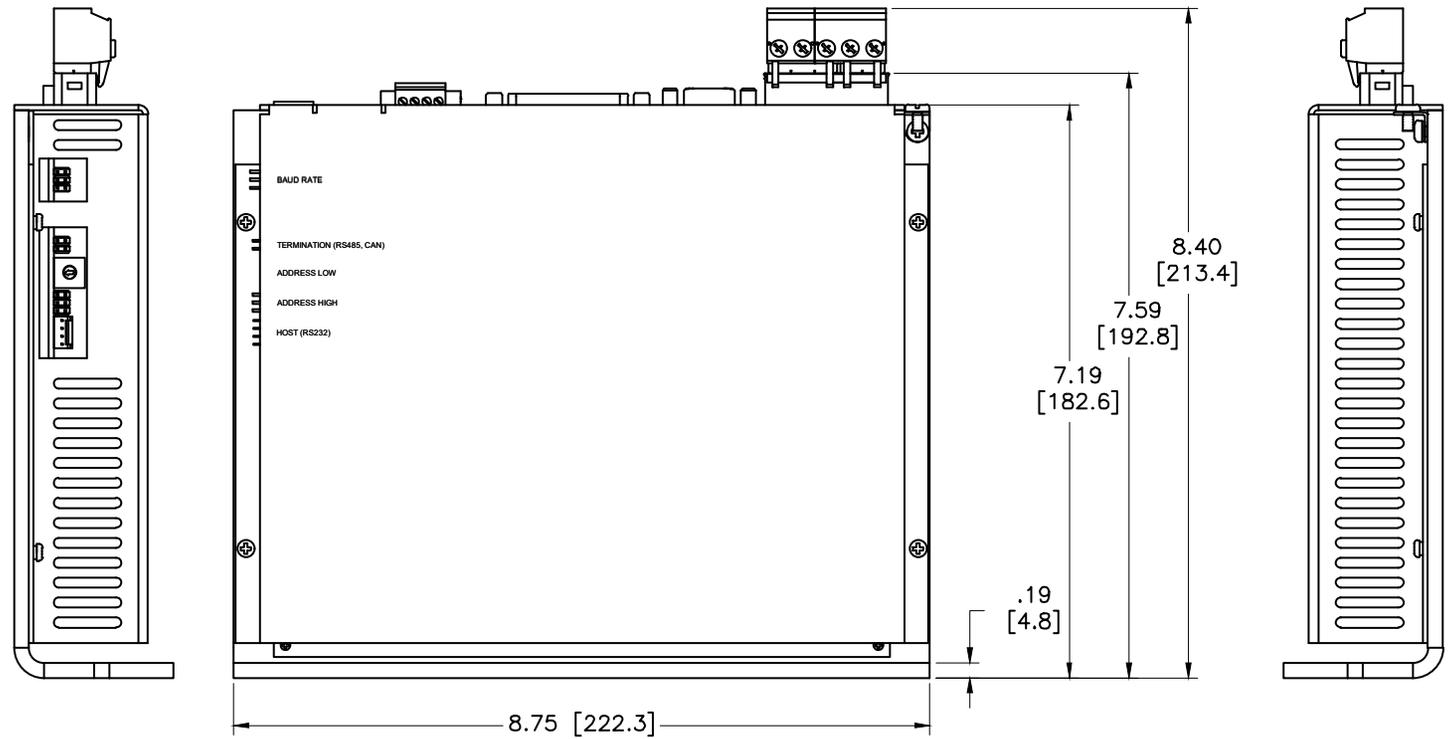


- NOTES:**
- 1. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "HOST" FEATURE & DOUBLE ROW FOR ADDITIONAL "CAN" FEATURE. ALL SIDE CONNECTORS ARE PROVIDED FOR "CAN" FEATURE ONLY.
 - 2. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "LOGIC POWER / BRAKE" FEATURE & DOUBLE ROW FOR ADDITIONAL "STO" FEATURE.
 - 3. THESE CONNECTORS ARE SUITABLE FOR FIELD WIRING OF 24AWG TO 10AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.
 - 4. EXTERNAL REGEN IS OPTIONAL.

9G16 MODULE: L-BRACKET HEATSINK (NON-UL)



Mating Connectors			
Description	Glentek P/N	Manufacturer P/N	Provided
Controller I/O, 44 Pin, solder	EJH23M44	FCI P/N: 10090769-P444ALF	No
Controller I/O, 44 Pin, crimp	N/A	TE P/N: 1658672-1	No
Backshell (solder or crimp)	EJH23S25	FCI P/N: 8655MH2501BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Mtr Feedback, 15 Pin, solder	EJH23M15	FCI P/N: 10090769-P154ALF	No
Mtr Feedback, 15 Pin, crimp	N/A	TE P/N: 748364-1	No
Backshell (solder or crimp)	EJH23S09	FCI P/N: 8655MH0901BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Module Logic Power, 4 Pin	EJ521E04	Phoenix P/N: 1827729	Yes
Host, RJ45	EJ018083	Molex P/N: 87522-8012	No
Motor, 3 Pin	EJ531F03	Phoenix P/N: 1777736	Yes
Power, 2 Pin	EJ531F02	Phoenix P/N: 1777723	Yes
Reset, 2 Pin	EJ381F02	Molex P/N: 22-01-3027	Yes
Host, RS232	EJ381F04	Molex P/N: 22-01-3047	Yes
Crimp Pin	EH042260	Molex P/N: 08-55-0102 2759	Yes

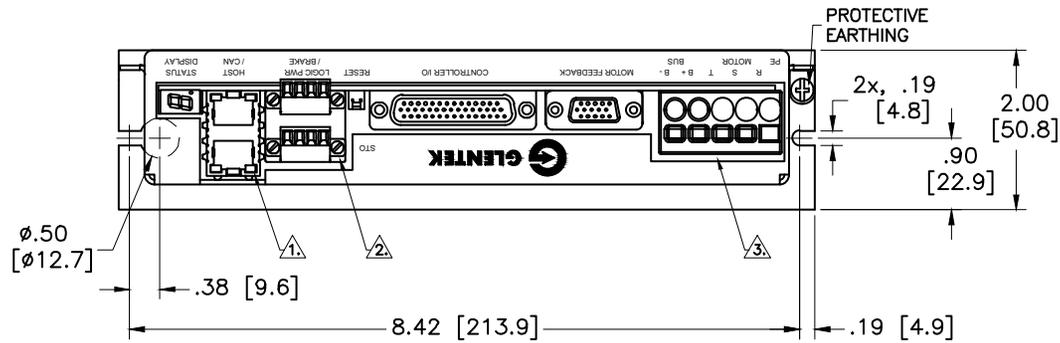


NOTES:

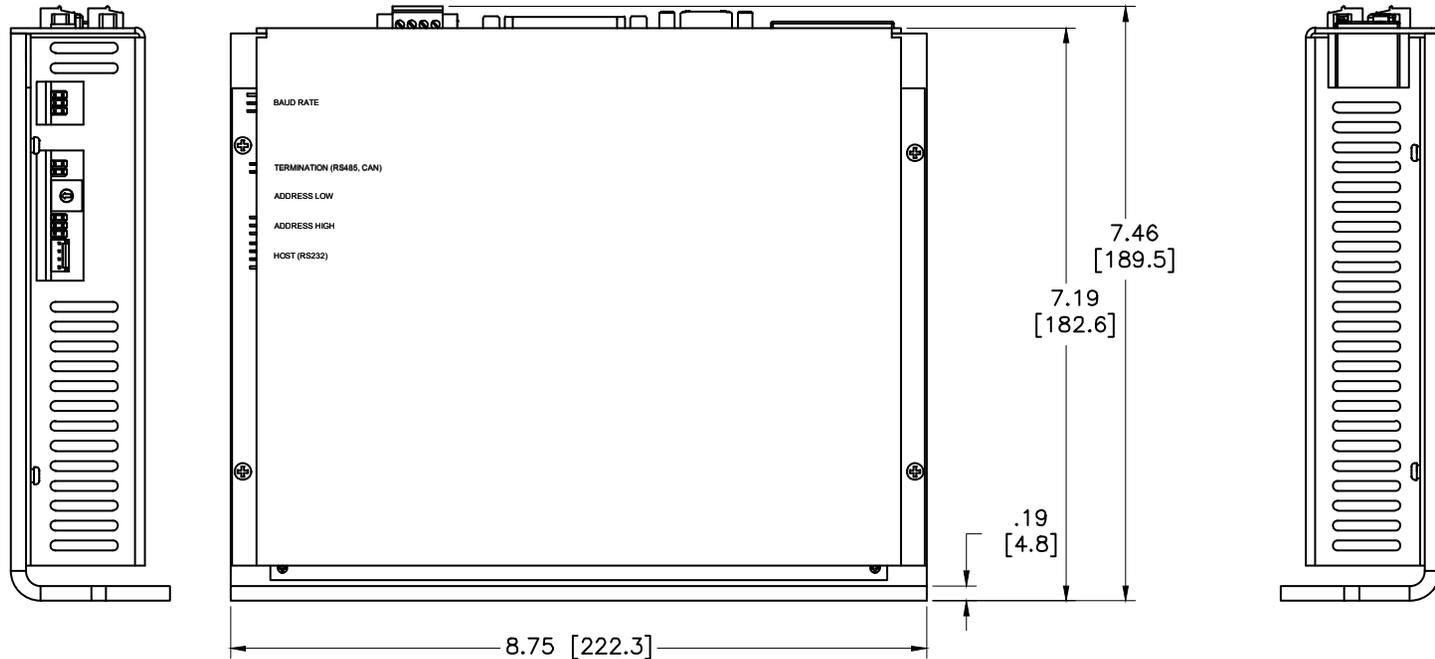
- 1. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "HOST" FEATURE & DOUBLE ROW FOR ADDITIONAL "CAN" FEATURE. ALL SIDE CONNECTORS ARE PROVIDED FOR "CAN" FEATURE ONLY.
- 2. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "LOGIC POWER / BRAKE" FEATURE & DOUBLE ROW FOR ADDITIONAL "STO" FEATURE.
- 3. THESE CONNECTORS ARE SUITABLE FOR FIELD WIRING OF 24AWG TO 10AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.

DRAWING # 9G16-100Z-000-2	SCALE: .875:1	DRAWN BY: D.C.R.	DATE: 19MAY20	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	TOLERANCES AS FOLLOWS: DECIMAL: .XX ±0.01 ANGULAR < ±0.5° .XXX ±0.005
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9G16 MODULE: L-BRACKET HEATSINK (UL)



Mating Connectors			
Description	Glentek P/N	Manufacturer P/N	Provided
Controller I/O, 44 Pin, solder	EJH23M44	FCI P/N: 10090769-P444ALF	No
Controller I/O, 44 Pin, crimp	N/A	TE P/N: 1658672-1	No
Backshell (solder or crimp)	EJH23S25	FCI P/N: 8655MH2501BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Mtr Feedback, 15 Pin, solder	EJH23M15	FCI P/N: 10090769-P154ALF	No
Mtr Feedback, 15 Pin, crimp	N/A	TE P/N: 748364-1	No
Backshell (solder or crimp)	EJH23S09	FCI P/N: 8655MH0901BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Module Logic Power, 4 Pin	EJ521E04	Phoenix P/N: 1827729	Yes
Host, RJ45	EJ018083	Molex P/N: 87522-8012	No
Reset, 2 Pin	EJ381F02	Molex P/N: 22-01-3027	Yes
Host, RS232	EJ381F04	Molex P/N: 22-01-3047	Yes
Crimp Pin	EH042260	Molex P/N: 08-55-0102 2759	Yes



NOTES:

- 1. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "HOST" FEATURE & DOUBLE ROW FOR ADDITIONAL "CAN" FEATURE. ALL SIDE CONNECTORS ARE PROVIDED FOR "CAN" FEATURE ONLY.
- 2. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "LOGIC POWER / BRAKE" FEATURE & DOUBLE ROW FOR ADDITIONAL "STO" FEATURE.
- 3. THESE CONNECTORS ARE SUITABLE FOR FIELD WIRING OF 24AWG TO 8AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.

DRAWING # 9G16-100Z-010-1

SCALE: .875:1

DRAWN BY: D.C.R.

DATE: 19MAY20

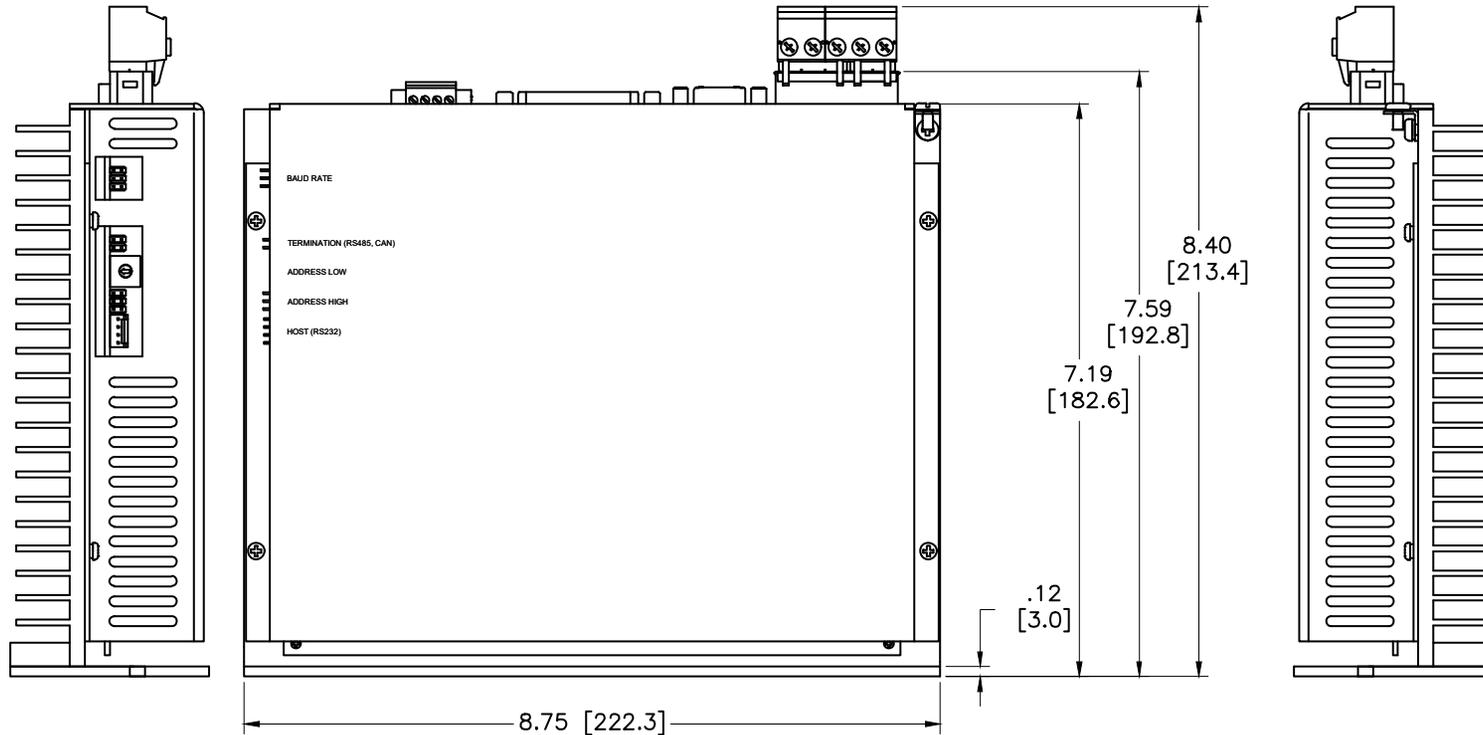
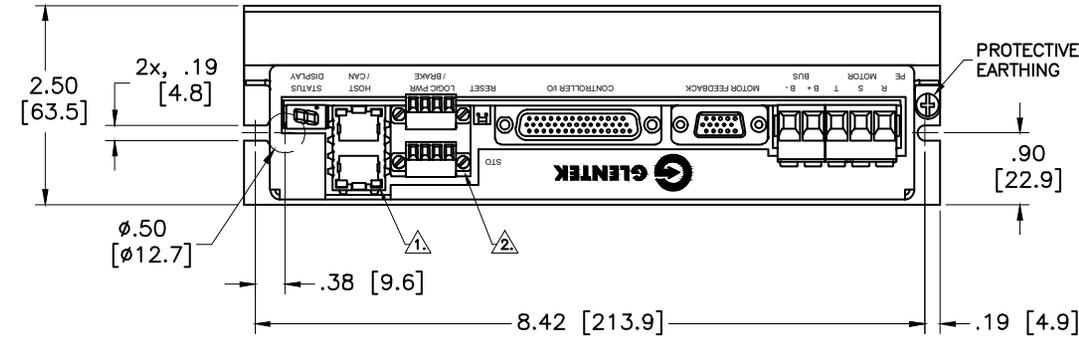
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES AS FOLLOWS:

DECIMAL: .XX ± 0.01
.XXX ± 0.005

ANGULAR < ± 0.5°

9G16 MODULE: SHORT FIN HEATSINK (NON-UL)



Mating Connectors			
Description	Glentek P/N	Manufacturer P/N	Provided
Controller I/O, 44 Pin, solder	EJH23M44	FCI P/N: 10090769-P444ALF	No
Controller I/O, 44 Pin, crimp	N/A	TE P/N: 1658672-1	No
Backshell (solder or crimp)	EJH23S25	FCI P/N: 8655MH2501BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Mtr Feedback, 15 Pin, solder	EJH23M15	FCI P/N: 10090769-P154ALF	No
Mtr Feedback, 15 Pin, crimp	N/A	TE P/N: 748364-1	No
Backshell (solder or crimp)	EJH23S09	FCI P/N: 8655MH0901BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Module Logic Power, 4 Pin	EJ521E04	Phoenix P/N: 1827729	Yes
Host, RJ45	EJ018083	Molex P/N: 87522-8012	No
Motor, 3 Pin	EJ531F03	Phoenix P/N: 1777736	Yes
Power, 2 Pin	EJ531F02	Phoenix P/N: 1777723	Yes
Reset, 2 Pin	EJ381F02	Molex P/N: 22-01-3027	Yes
Host, RS232	EJ381F04	Molex P/N: 22-01-3047	Yes
Crimp Pin	EH042260	Molex P/N: 08-55-0102 2759	Yes

NOTES:

- 1. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "HOST" FEATURE & DOUBLE ROW FOR ADDITIONAL "CAN" FEATURE. ALL SIDE CONNECTORS ARE PROVIDED FOR "CAN" FEATURE ONLY.
- 2. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "LOGIC POWER / BRAKE" FEATURE & DOUBLE ROW FOR ADDITIONAL "STO" FEATURE.
- 3. THESE CONNECTORS ARE SUITABLE FOR FIELD WIRING OF 24AWG TO 10AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.

DRAWING # 9G16-100Z-001-2

SCALE: .875:1

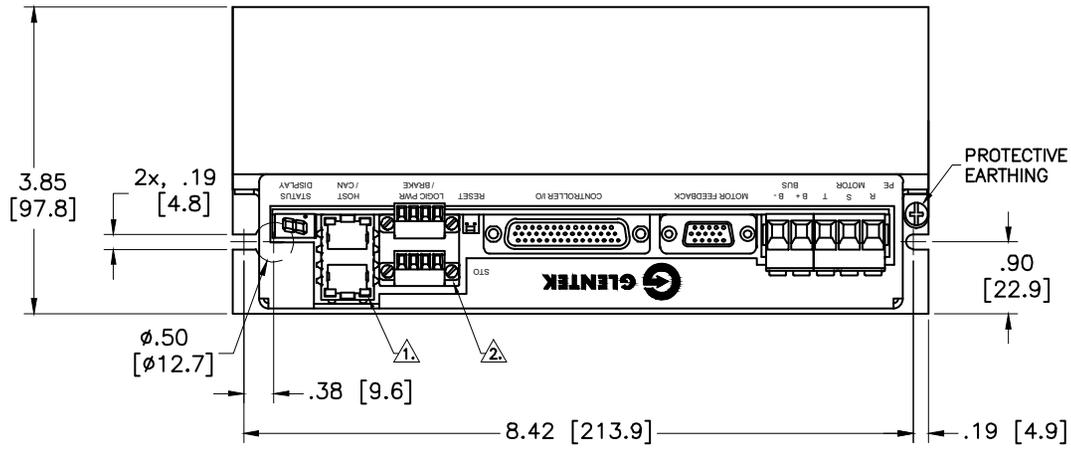
DRAWN BY: D.C.R.

DATE: 19JUN20

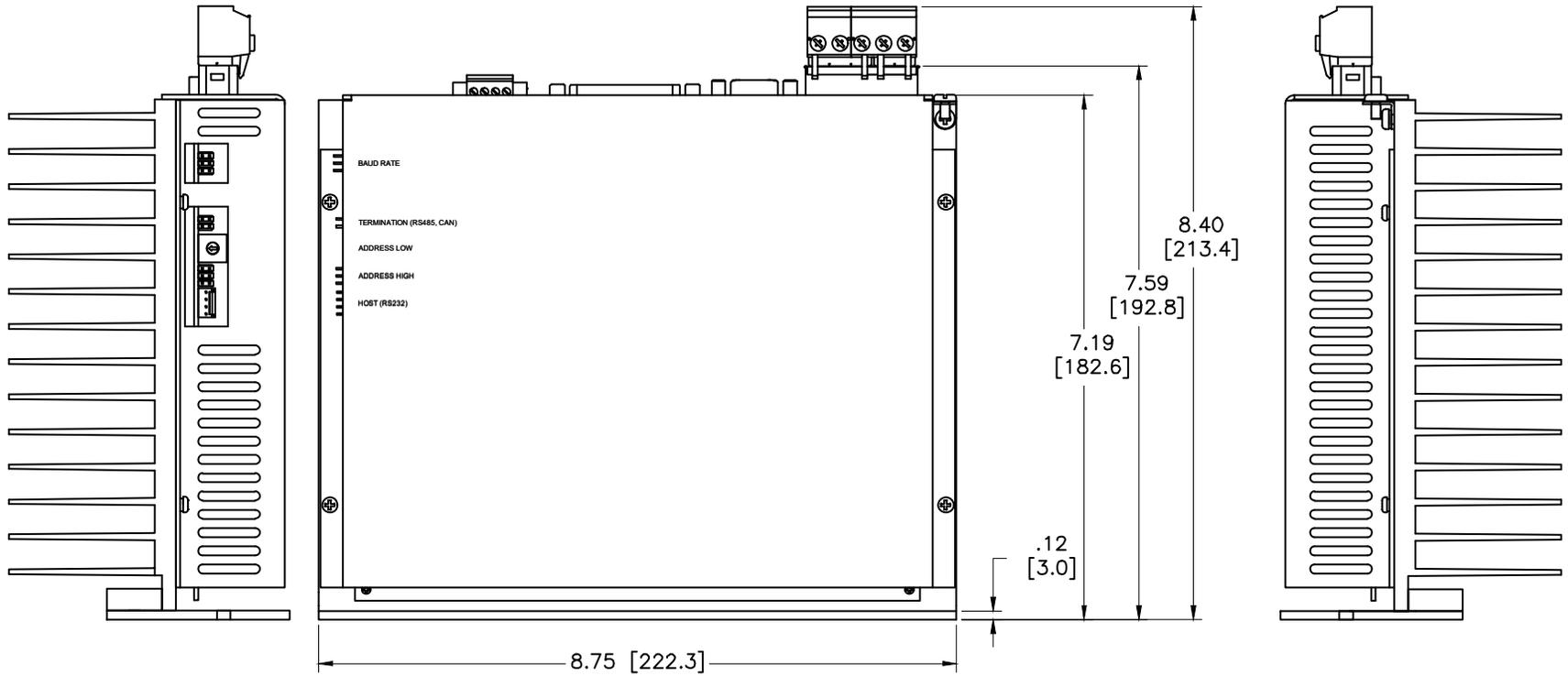
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES DECIMAL: .XX = ± 0.01 ANGULAR < = 0.5° AS FOLLOWS: .XXX = ± 0.005

9G16 MODULE: LONG FIN HEATSINK (NON-UL)



Mating Connectors			
Description	Glentek P/N	Manufacturer P/N	Provided
Controller I/O, 44 Pin, solder	EJH23M44	FCI P/N: 10090769-P444ALF	No
Controller I/O, 44 Pin, crimp	N/A	TE P/N: 1658672-1	No
Backshell (solder or crimp)	EJH23S25	FCI P/N: 8655MH2501BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Mtr Feedback, 15 Pin, solder	EJH23M15	FCI P/N: 10090769-P154ALF	No
Mtr Feedback, 15 Pin, crimp	N/A	TE P/N: 748364-1	No
Backshell (solder or crimp)	EJH23S09	FCI P/N: 8655MH0901BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Module Logic Power, 4 Pin	EJ521E04	Phoenix P/N: 1827729	Yes
Host, RJ45	EJ018083	Molex P/N: 87522-8012	No
Motor, 3 Pin	EJ531F03	Phoenix P/N: 1777736	Yes
Power, 2 Pin	EJ531F02	Phoenix P/N: 1777723	Yes
Reset, 2 Pin	EJ381F02	Molex P/N: 22-01-3027	Yes
Host, RS232	EJ381F04	Molex P/N: 22-01-3047	Yes
Crimp Pin	EH042260	Molex P/N: 08-55-0102 2759	Yes

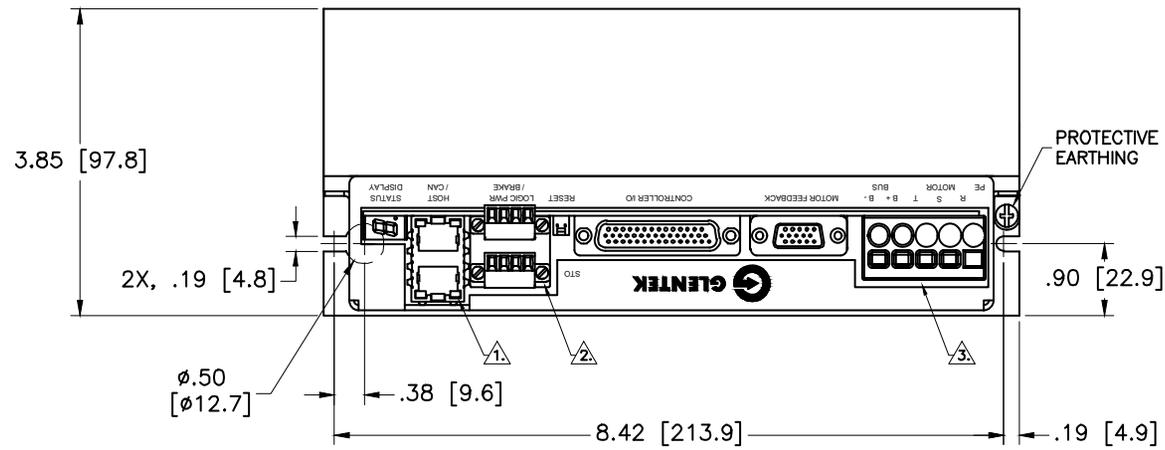


NOTES:

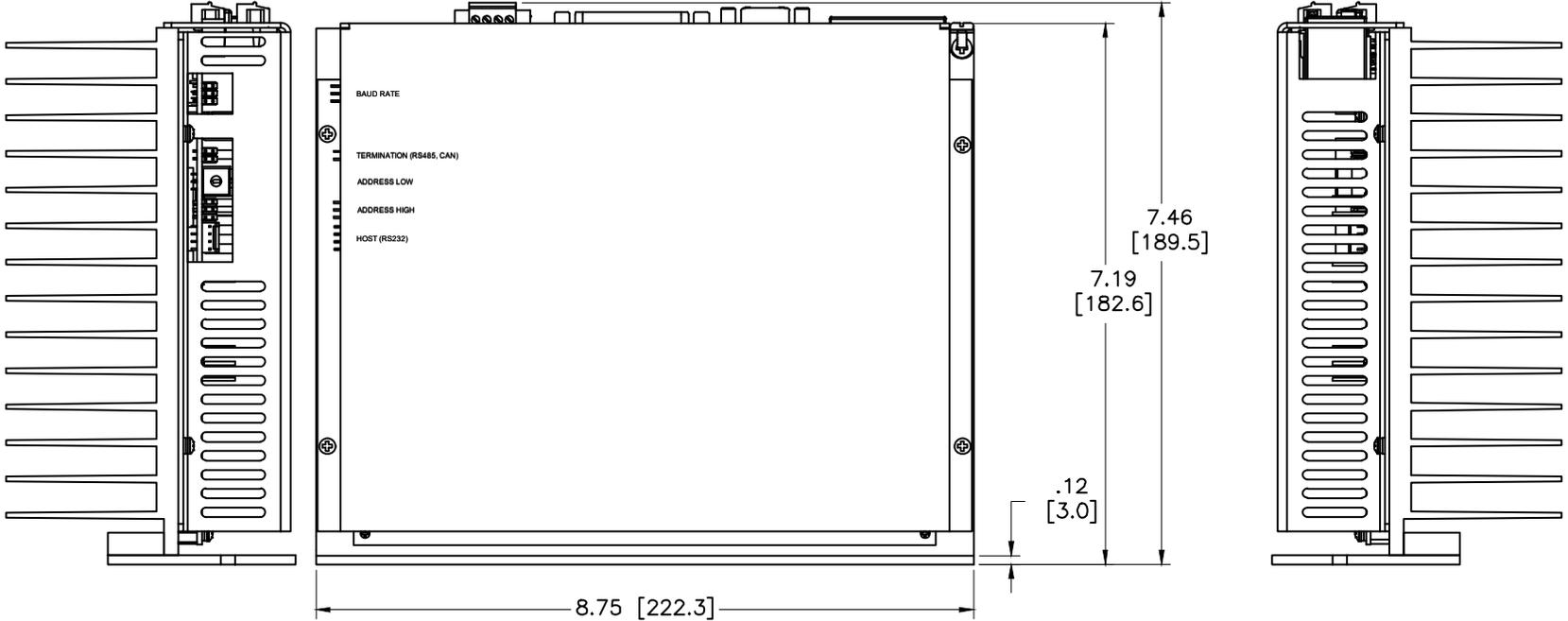
- 1. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "HOST" FEATURE & DOUBLE ROW FOR ADDITIONAL "CAN" FEATURE. ALL SIDE CONNECTORS ARE PROVIDED FOR "CAN" FEATURE ONLY.
- 2. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "LOGIC POWER / BRAKE" FEATURE & DOUBLE ROW FOR ADDITIONAL "STO" FEATURE.
- 3. THESE CONNECTORS ARE SUITABLE FOR FIELD WIRING OF 24AWG TO 10AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.

DRAWING # 9G16-100Z-007-2	SCALE: .875:1	DRAWN BY: D.C.R.	DATE: 19MAY20	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	TOLERANCES AS FOLLOWS: DECIMAL: .XX ±0.01 .XXX ±0.005 ANGULAR < ±0.5°
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9G16 MODULE: LONG FIN HEATSINK (UL)



Mating Connectors			
Description	Glentek P/N	Manufacturer P/N	Provided
Controller I/O, 44 Pin, solder	EJH23M44	FCI P/N: 10090769-P444ALF	No
Controller I/O, 44 Pin, crimp	N/A	TE P/N: 1658672-1	No
Backshell (solder or crimp)	EJH23S25	FCI P/N: 8655MH2501BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Mtr Feedback, 15 Pin, solder	EJH23M15	FCI P/N: 10090769-P154ALF	No
Mtr Feedback, 15 Pin, crimp	N/A	TE P/N: 748364-1	No
Backshell (solder or crimp)	EJH23S09	FCI P/N: 8655MH0901BLF	No
Crimp Pin	N/A	TE P/N 1658670-2	No
Module Logic Power, 4 Pin	EJ521E04	Phoenix P/N: 1827729	Yes
Host, RJ45	EJ018083	Molex P/N: 87522-8012	No
Reset, 2 Pin	EJ381F02	Molex P/N: 22-01-3027	Yes
Host, RS232	EJ381F04	Molex P/N: 22-01-3047	Yes
Crimp Pin	EH042260	Molex P/N: 08-55-0102 2759	Yes

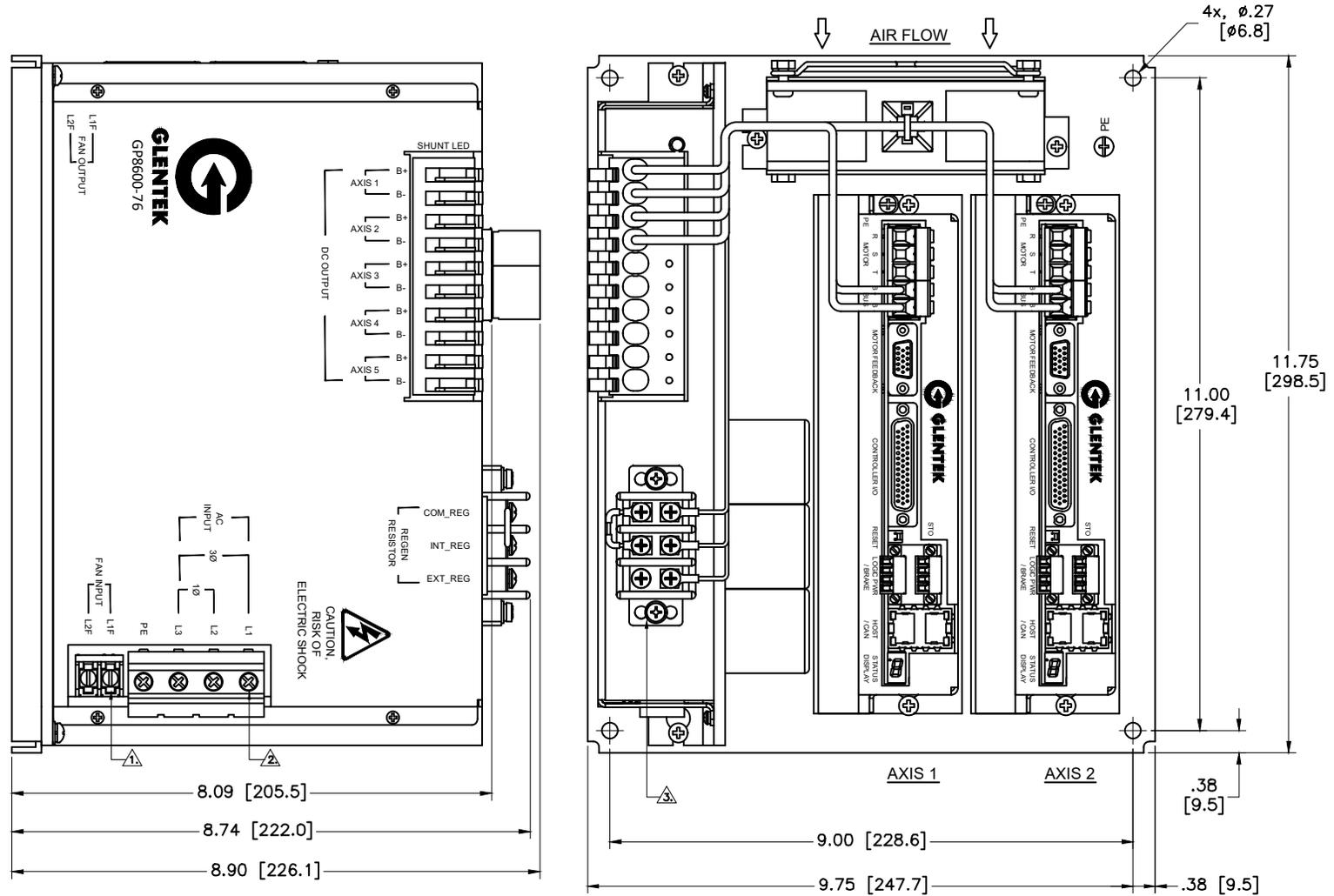


NOTES:

- 1. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "HOST" FEATURE & DOUBLE ROW FOR ADDITIONAL "CAN" FEATURE. ALL SIDE CONNECTORS ARE PROVIDED FOR "CAN" FEATURE ONLY.
- 2. THIS CONNECTOR COMES AS SINGLE ROW FOR STANDARD "LOGIC POWER / BRAKE" FEATURE & DOUBLE ROW FOR ADDITIONAL "STO" FEATURE.
- 3. THESE CONNECTORS ARE SUITABLE FOR FIELD WIRING OF 24AWG TO 8AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.

DRAWING # 9G16-100Z-017-1	SCALE: .875:1	DRAWN BY: D.C.R.	DATE: 19MAY20	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	TOLERANCES AS FOLLOWS:	DECIMAL: .XX ±0.01 .XXX ±0.005	ANGULAR < ±0.5°
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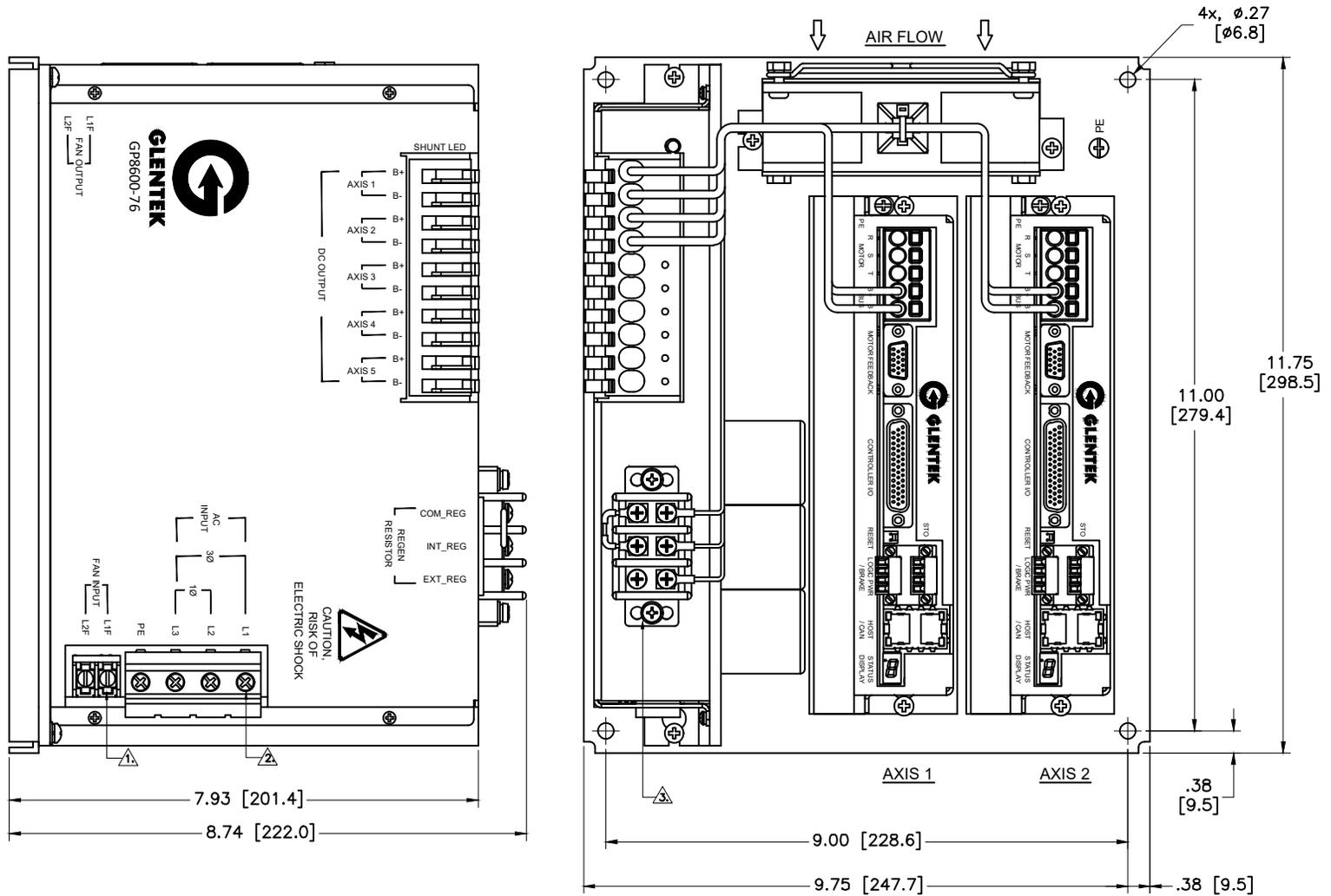
9G16 2-AXIS PACKAGE: L-BRACKET OR SHORT FIN MODULES (NON-UL)



NOTES:

- 1. THIS CONNECTOR USES #6 (2 PLACES) SCREWS FOR 120/220VAC.
- 2. THIS CONNECTOR IS SUITABLE FOR FIELD WIRING OF 16AWG TO 4AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.
- 3. EXTERNAL REGEN IS OPTIONAL.

9G16 2-AXIS PACKAGE: L-BRACKET OR SHORT FIN MODULES (UL)



NOTES:

- ⚠ THIS CONNECTOR USES #6 (2 PLACES) SCREWS FOR 120/220VAC.
- ⚠ THIS CONNECTOR IS SUITABLE FOR FIELD WIRING OF 16AWG TO 4AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.
- ⚠ EXTERNAL REGEN IS OPTIONAL.

DRAWING # 9G16-100Z-020-1

SCALE: .75:1

DRAWN BY: M.T.

DATE: 26OCT20

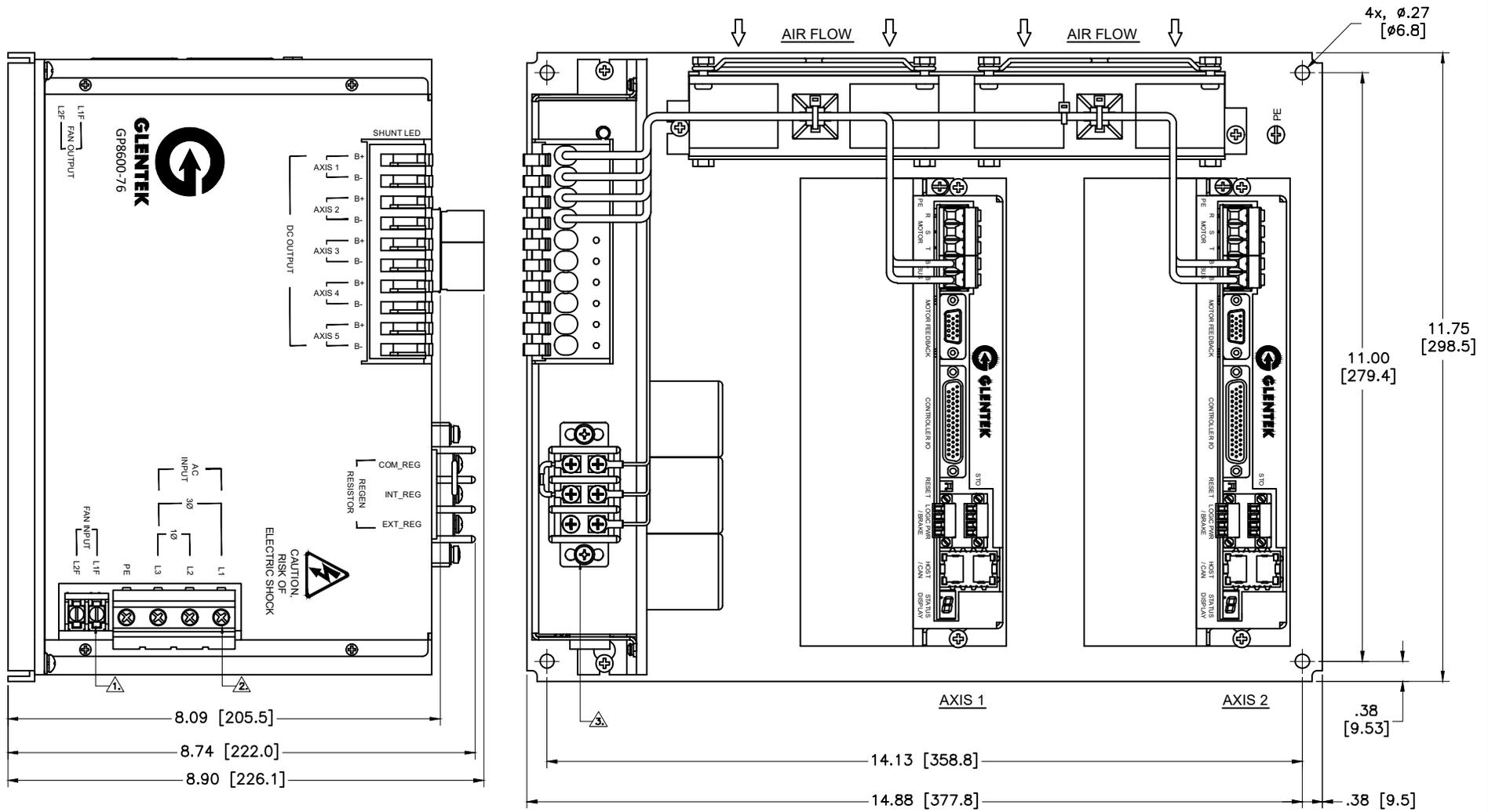
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES AS FOLLOWS:

DECIMAL: .XX ±0.01
.XXX ±0.005

ANGULAR < ±0.5°

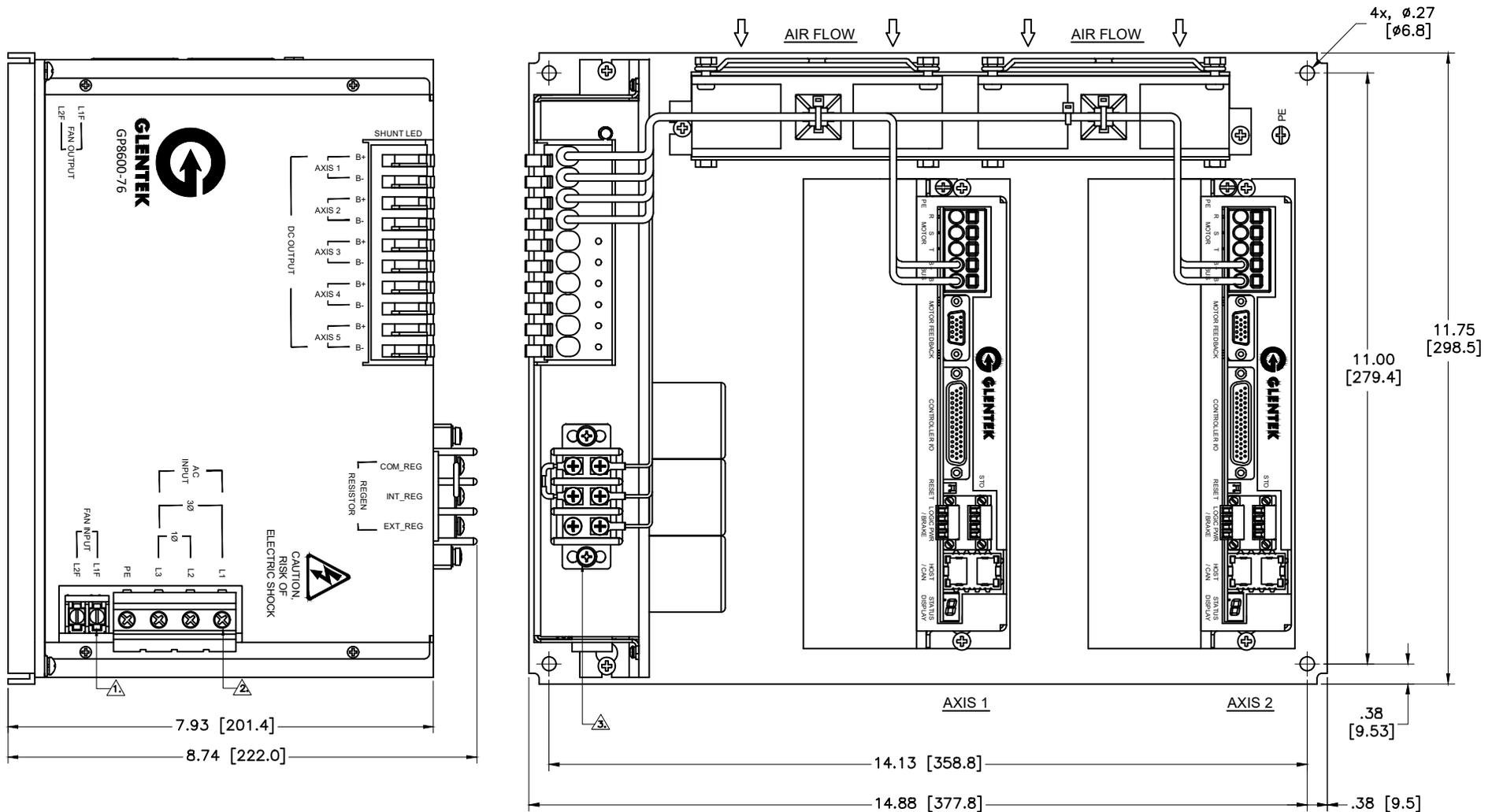
9G16 2-AXIS PACKAGE: LONG FIN MODULES (NON-UL)



NOTES:

- 1. THIS CONNECTOR USES #6 (2 PLACES) SCREWS FOR 120/220VAC.
- 2. THIS CONNECTOR IS SUITABLE FOR FIELD WIRING OF 16AWG TO 4AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.
- 3. EXTERNAL REGEN IS OPTIONAL.

9G16 2-AXIS PACKAGE: LONG FIN MODULES (UL)



NOTES:

- 1. THIS CONNECTOR USES #6 (2 PLACES) SCREWS FOR 120/220VAC.
- 2. THIS CONNECTOR IS SUITABLE FOR FIELD WIRING OF 16AWG TO 4AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.
- 3. EXTERNAL REGEN IS OPTIONAL.

DRAWING # 9G16-100Z-021-1

SCALE: .75:1

DRAWN BY: M.T.

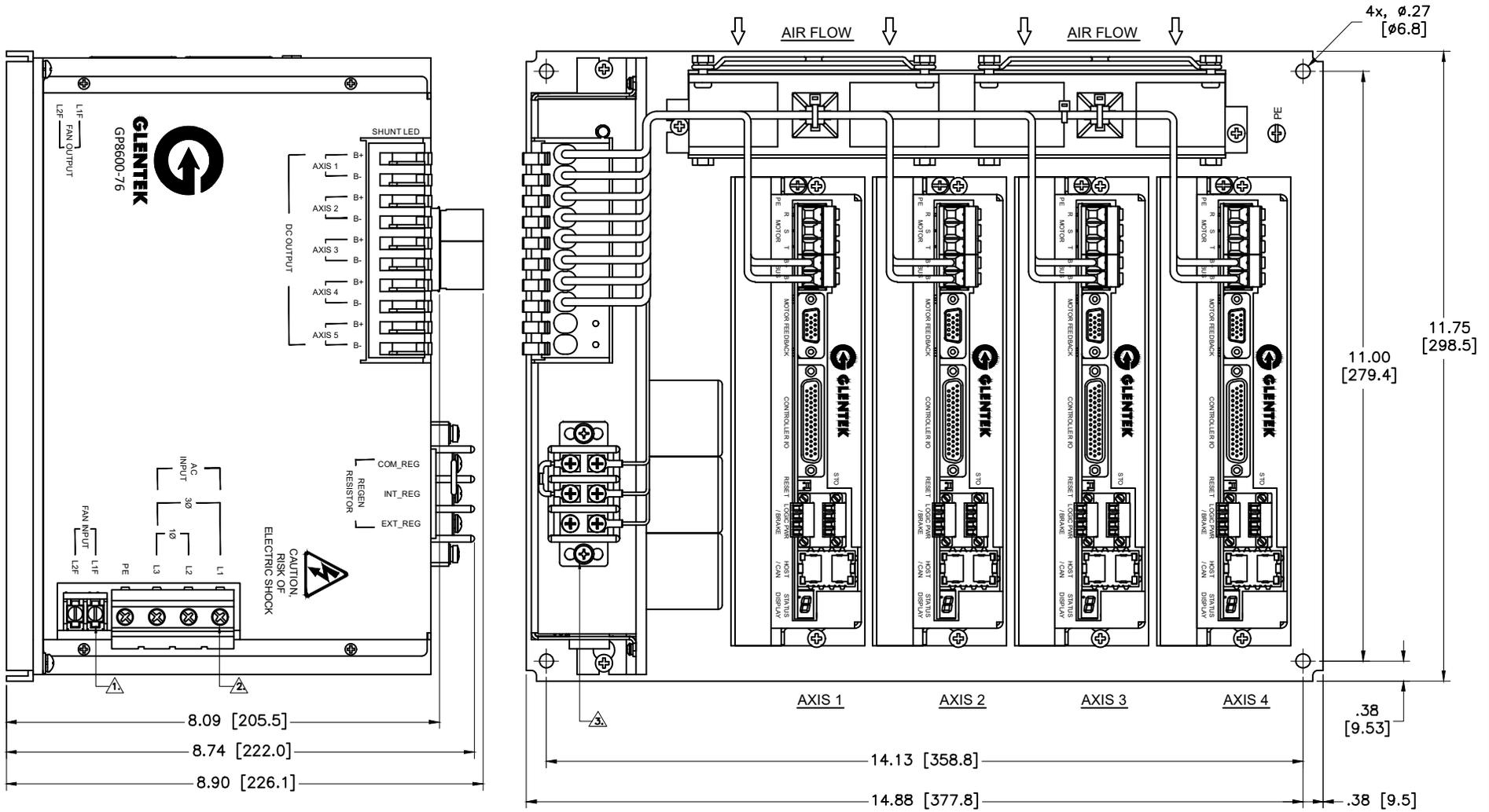
DATE: 26OCT20

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES AS FOLLOWS:

DECIMAL: .XX ±0.01 ANGULAR < ±0.5°
.XXX ±0.005

9G16 4-AXIS PACKAGE: L-BRACKET OR SHORT FIN MODULES (NON-UL)



NOTES:

- 1. THIS CONNECTOR USES #6 (2 PLACES) SCREWS FOR 120/220VAC.
- 2. THIS CONNECTOR IS SUITABLE FOR FIELD WIRING OF 16AWG TO 4AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.
- 3. EXTERNAL REGEN IS OPTIONAL.

DRAWING # 9G16-100Z-004-3

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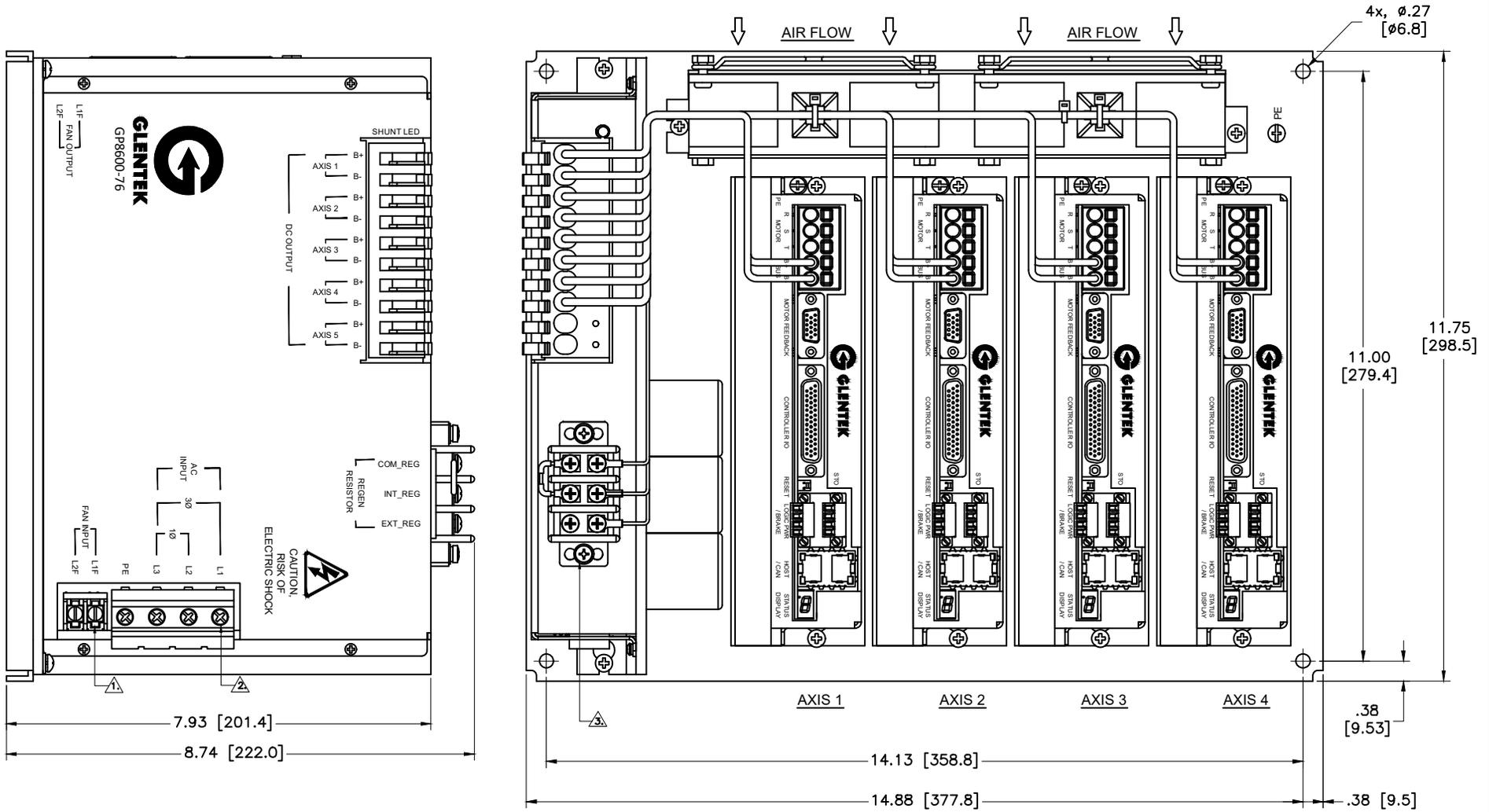
DRAWN BY: M.T.

DATE: 26OCT20

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES AS FOLLOWS: DECIMAL: .XX = ±0.01 ANGULAR < = ±0.5° .XXX = 0.005

9G16 4-AXIS PACKAGE: L-BRACKET OR SHORT FIN MODULES (UL)



NOTES:

- 1. THIS CONNECTOR USES #6 (2 PLACES) SCREWS FOR 120/220VAC.
- 2. THIS CONNECTOR IS SUITABLE FOR FIELD WIRING OF 16AWG TO 4AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.
- 3. EXTERNAL REGEN IS OPTIONAL.

DRAWING # 9G16-100Z-019-1

SCALE: .75:1

DRAWN BY: M.T.

DATE: 26OCT20

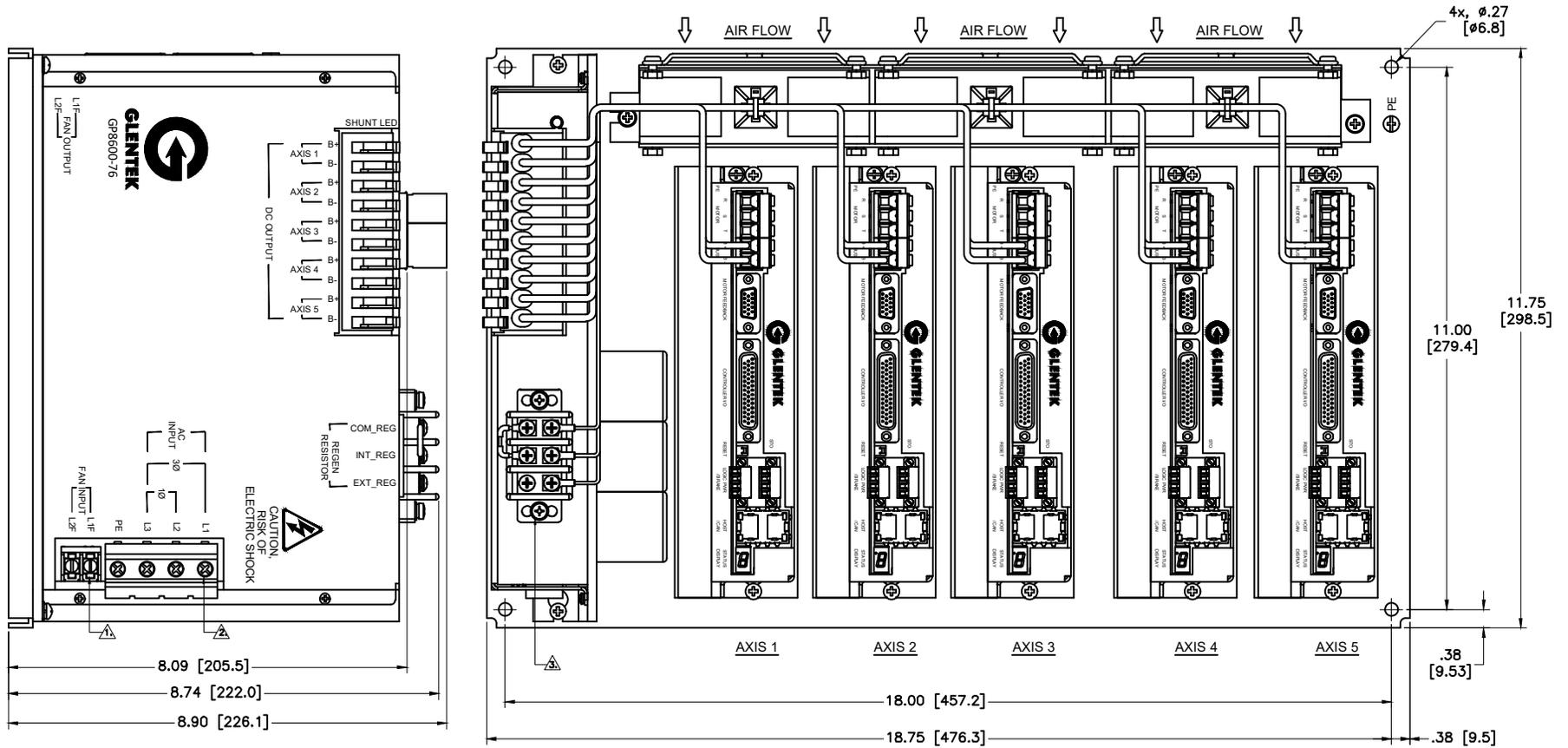
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES AS FOLLOWS:

DECIMAL: .XX = ±0.01
.XXX = ±0.005

ANGULAR < = ±0.5°

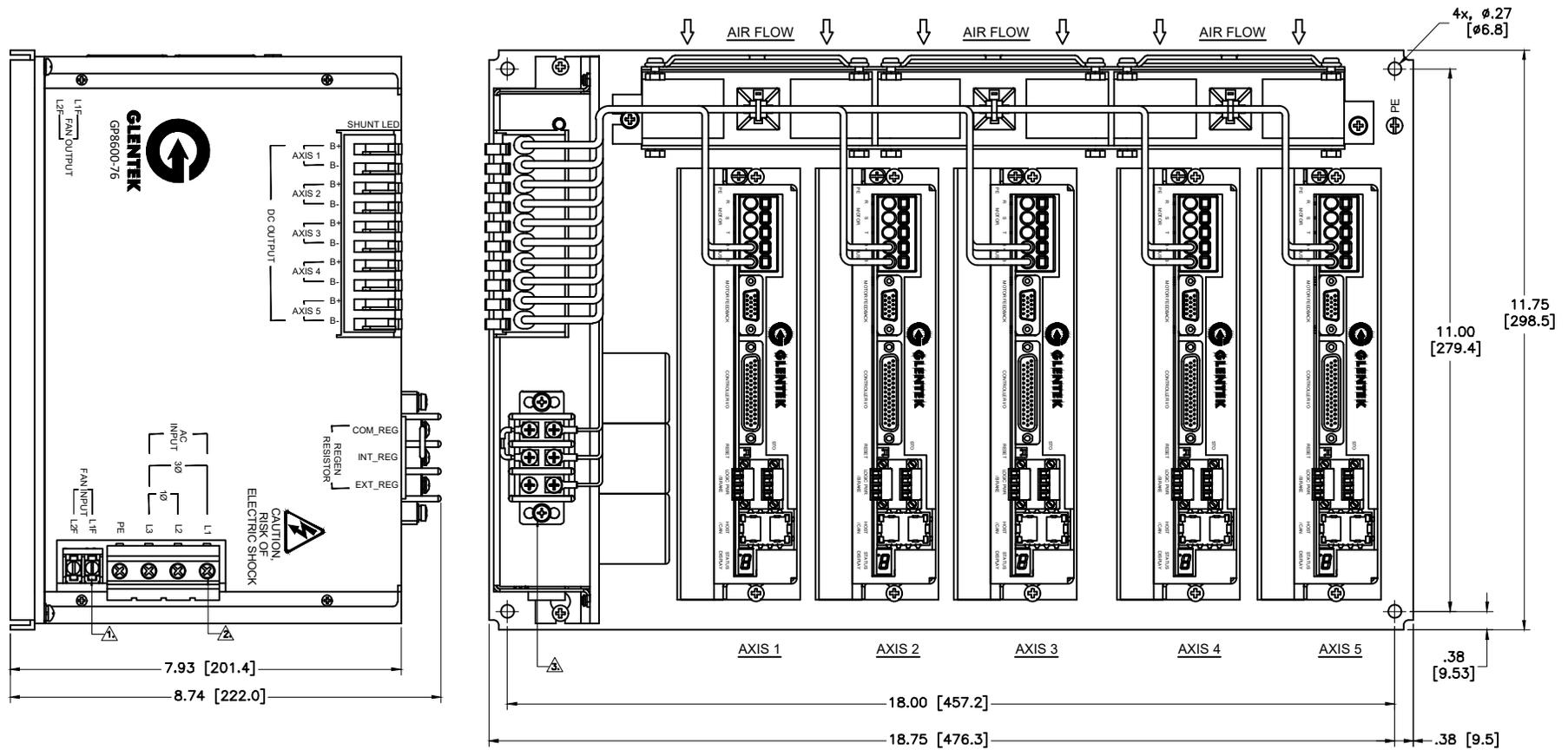
9G16 5-AXIS PACKAGE: L-BRACKET OR LONG FIN MODULES (NON-UL)



NOTES:

1. THIS CONNECTOR USES #6 (2 PLACES) SCREWS FOR 120/220VAC.
2. THIS CONNECTOR IS SUITABLE FOR FIELD WIRING OF 16AWG TO 4AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.
3. EXTERNAL REGEN IS OPTIONAL.

9G16 5-AXIS PACKAGE: L-BRACKET OR LONG FIN MODULES (UL)



NOTES:

- 1 THIS CONNECTOR USES #6 (2 PLACES) SCREWS FOR 120/220VAC.
- 2 THIS CONNECTOR IS SUITABLE FOR FIELD WIRING OF 16AWG TO 4AWG SOLID/STRANDED WIRE. SELECT WIRE GAUGE BASED ON CONTINUOUS CURRENT REQUIREMENT.
- 3 EXTERNAL REGEN IS OPTIONAL.

DRAWING # 9G16-100Z-018-1

SCALE: .625:1

DRAWN BY: M.T.

DATE: 26OCT20

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES

TOLERANCES
AS FOLLOWS:

DECIMAL: .XX ± 0.01
.XXX ± 0.005

ANGULAR < ± 0.5°

6.8 Factory Repair, Maintenance and Warranty

6.8.1 Factory Repair

Should it become necessary to return a servo drive to Glentek for repair, please follow the procedure described below.

Reassemble the unit, if necessary, making certain that all the hardware is in place.

Tag the unit with the following information:

- a. Serial number and model number.
- b. Company name, phone number, and name of representative returning the unit.
- c. A brief notation explaining the malfunction.
- d. Date the unit is being returned.

Repackage the unit with the same care and fashion in which it was received. Label the container with the appropriate stickers (e.g. FRAGILE: HANDLE WITH CARE).

Contact a Glentek representative, confirm that the unit is being returned to the factory and obtain an RMA (Return Material Authorization) number. The RMA number must accompany the unit upon return to Glentek. Do not ship unit with RMA number. Show RMA number on outside of package.

Return the unit by the best means possible. The method of freight chosen will directly affect the timeliness of its return.

Glentek may offer a 24-48 hour expedited repair service in the unlikely event that your system is down and you do not have a replacement.

6.8.2 Maintenance

There are no field-serviceable or replaceable parts or components in the SMX9G16 drives. Should the drive require a service, please contact Glentek about repairs.

6.8.3 Warranty

Any product, or part thereof, manufactured by Glentek, Inc., which, under normal operating conditions in the plant of the original purchaser thereof, proves defective in material or workmanship within 1 year from the date of shipment by us, as determined by an inspection by us, will be repaired or replaced, at our discretion, free of charge, FOB our factory, El Segundo, California, U.S.A., provided that you promptly send to us notice of the defect and establish that the product has been properly installed, maintained, and operated within the limits of rated and normal usage, and that no factory sealed adjustments have been tampered with. Glentek's liability is limited to repair or replacement of defective parts.

Repaired items will carry a 180-day limited warranty, limited to the area of the repair. It does not cover the product as a whole.

Under no circumstances shall Glentek, Inc. or any of our affiliates have any liability whatsoever for claims or damages arising out of the loss of use of any product or part sold to you. Nor shall we have any liability to yourself or anyone for any indirect or consequential damages such as injuries to person and property caused directly or indirectly by the product or part sold to you, and you agree in accepting our product or part to save us harmless from any and all such claims or damages that may be initiated against us by third parties.

6.9 UL Registered Component

6.9.1 Standards

Glentek Gamma series drives can be ordered that are UL Registered Components according to the following standards:

CNR – Evaluated to the Canadian Standard for Adjustable Speed Drives C22.2. No. 274-17, 2nd Edition.

USR – Evaluated to the Standard for Safety for Adjustable Speed Electrical Power Drive Systems - Part 5-1: Safety Requirements - Electrical, Thermal and Energy, UL 61800-5-1, 1st Edition.

These components have been judged on the basis of the required spacings in the Standard for Adjustable Speed Electrical Power Drive Systems, Pollution Degree 2 applications, which would cover the component itself, if submitted for unrestricted Listing.

For use only in (or with) complete equipment, where the acceptability of the combination is determined by UL LLC.

6.9.2 File Number

E519416

6.9.3 Conditions of Acceptability

- The device shall be mounted in the intended manner in an enclosure having adequate strength and thickness with acceptable spacings being provided.
- The spacings for the exposed live-metal parts to the enclosure wall shall be in accordance with the requirements for the end-use equipment.
- These devices are intended for use within a controlled environment (Pollution Degree 2).
- The drives are suitable for factory wiring only, the suitability of the connections shall be considered in the end-product.
- The Safe Torque Off (STO) feature has not been evaluated as part of the certification, suitability of this feature shall be determined in the end-product.
- The bus capacitors discharge to a voltage level below 50 VDC within 1 minute.
- Motor overtemperature sensing is required. The drives are provided with means to accept and act upon a signal from a thermal sensor mounted in or on the motor.
- Branch Circuit Protection shall be provided as follows:

Multi-Axis/ Stand Alone	Max Load Rating, RMS	Maximum BCP, Fuse Type, Ratings
110-240VAC	10A	Class K5, 250VAC, 40A, 50kA
110-240VAC	32A	Class K5, 250VAC, 125A, 50kA
360-500VAC	11A	Class K5, 600VAC, 40A, 50kA

- Stand alone series was tested with fans and units provided without a fan have to be installed with the same fan construction and installation as in figures 11-14. Fans are made available by the Applicant with installation instructions for proper mounting.
- Drive modules and Rectifier Assemblies were tested together, as multi-axis systems. Drive modules and Rectifier Assemblies that are shipped separately are intended to be installed as a system in the final application. Drive modules and Rectifier Assemblies are to be installed as per figures 1-10 and III. 1, in reference to the heat sinks and fans as described in these figures and illustration. Fans and heat sinks are made available by the Applicant with installation instructions for proper mounting.

6.10 European Union EMC Directives

6.10.1 Electromagnetic Compatibility Guidelines For Machine Design

This section provides background information about Electromagnetic Interference (EMI) and machine design guidelines for Electromagnetic Compatibility (EMC).

Perhaps no other subject related to the installation of industrial electronic equipment is so misunderstood as electrical noise. The subject is complex and theory could easily fill a book. This section provides guidelines that can minimize noise problems.

The majority of installations do not exhibit noise problems. However, these filtering and shielding guidelines are provided as counter measures. The grounding guidelines provided below are simply good grounding practices. They should be followed in all installations.

Electrical noise has two characteristics: generation or emission of electromagnetic interference (EMI) and response or immunity to EMI. The degree to which a device does not emit EMI, and is immune to EMI is called the device's Electromagnetic Compatibility (EMC).

Equipment which is to be brought into the European Union legally requires a specific level of EMC. Since this applies when the equipment is brought into use, it is of considerable importance that a drive system, as a component of a machine, be correctly installed.

The *EMI Source-Victim Model* (Figure 6-3) shows the commonly used EMI model. The model consists of an EMI source, a coupling mechanism and an EMI victim. Devices, such as servo drives and computers, which contain switching power supplies and microprocessors, are EMI sources. The mechanisms for the coupling of energy between the source and victim are conduction and radiation. Victim equipment can be any electromagnetic device that is adversely affected by the EMI coupled to it.

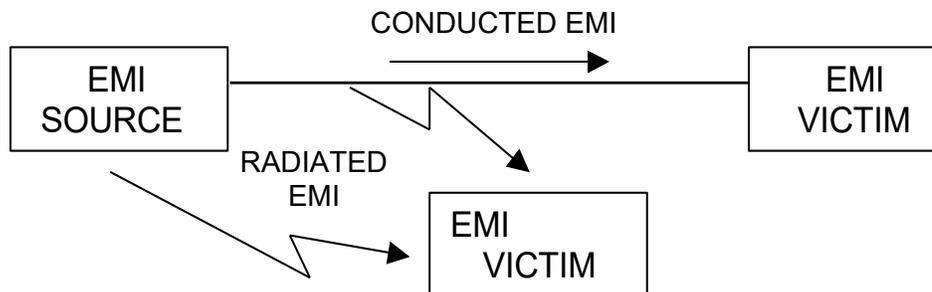


Figure 6-2 EMI Source-Victim Model

Immunity to EMI is primarily determined by equipment design, but how you wire and ground the device is also critical to achieving EMI immunity. Therefore, it is important to select equipment that has been designed and tested for industrial environments. The EMI standards for industrial equipment include the EN61000-4-X series (IEC 1000-4-X and IEC801-X), EN55011 (CISPR11), ANSI C62 and C63 and MIL-STD-461. Also, in industrial environments, you should use encoders with differential driver outputs rather than single ended outputs, and digital inputs/outputs with electrical isolation, such as those provided with optocouplers.

The EMI model provides only three options for eliminating the EMC problem:

- Reduce the EMI at the source
- Increase the victim's immunity to EMI (harden the victim)
- Reduce or eliminate the coupling mechanism

In the case of servo drives, reducing the EMI source requires slowing power semiconductor switching speeds. However, this adversely affects drive performance with respect to heat dissipation and speed/torque regulation. Hardening the victim equipment may not be possible, or practical. The final and often the most realistic solution is to reduce the coupling mechanism between the source and victim. Filtering, shielding, and grounding can achieve this.

6.10.2 Filtering

As mentioned above, high frequency energy can be coupled between circuits via radiation or conduction. The AC power wiring is one of the most important paths for both types of coupling mechanisms. The AC line can conduct noise into the drive from other devices, or it can conduct noise directly from the drive into other devices. It can also act as an antenna and transmit or receive radiated noise between the drive and other devices.

One method to improve the EMC characteristics of a drive is to use an isolation AC power transformer on the drive's input power. This minimizes inrush currents on power-up and provides electrical isolation. In addition, it provides common mode filtering, although the effect is limited in frequency by the inter-winding capacitance. Use of a Faraday shield between the windings can increase the common mode rejection bandwidth, (shield terminated to ground) or provide differential mode shielding (shield terminated to the winding). In some cases, an AC line filter will not be required unless other sensitive circuits are powered off the same AC branch circuit.

Note: "Common mode" noise is present on all conductors that are referenced to ground. "Differential mode" noise is present on one conductor referenced to another conductor.

The use of properly matched AC line filters to reduce the conducted EMI emitting from the drive is essential in most cases. This allows nearby equipment to operate undisturbed. The basic operating principle is to minimize the high frequency power transfer through the filter. An effective filter achieves this by using capacitors and inductors to mismatch the source impedance (AC line) and the load impedance (drive) at high frequencies.

For drives brought for use in Europe, use of the correct filter is essential to meet emission requirements. Detailed information on filters is included in this manual and transformers should be used where specified in this manual.

6.10.3 AC Line Filter Selection

Selection of the proper filter is only the first step in reducing conducted emissions. Correct filter installation is crucial both to achieving EMI attenuation and to ensuring safety. All of the following guidelines should be met for effective filter use.

The filter should be mounted to a grounded conductive surface.

The filter must be mounted close to the drive-input terminals, particularly with higher frequency emissions (5-30 MHz). If the distance exceeds 600mm (2 feet), a strap should be used to connect the drive and filter, rather than a wire.

The wires connecting the AC source to the filter should be shielded from, or at least separated from the wires (or strap) that connects the drive to the filter. If the connections are not segregated from each other, then the EMI on the drive side of the filter can couple over to the source side of the filter, thereby reducing, or eliminating the filter effectiveness. The coupling mechanism can be radiation or stray capacitance between the wires. The best method of achieving this is to mount the filter where the AC power enters the enclosure. *AC Line Filter Installation* shows a good installation and a poor installation.

When multiple power cables enter an unfiltered line can contaminate a filtered line external to the enclosure. Therefore, all lines must be filtered to be effective. The situation is similar to a leaky boat. All the holes must be plugged to prevent sinking.

If the filter is mounted excessively far from the drive, it may be necessary to mount it to a grounded conductive surface, such as the enclosure, to establish a high frequency (HF) connection to that surface. To achieve the HF ground, direct contact between the mounting surface and the filter must be achieved. This may require removal of paint or other insulating material from the cabinet or panel.

The only reasonable filtering at the drive output terminals is the use of inductance. Capacitors would slow the output switching and deteriorate the drive performance. A common mode choke can be used to reduce the HF voltage at the drive output. This will reduce emission coupling through the drive back to the AC line. However, the motor cable still carries a large HF voltage and current. Therefore, it is very important to segregate the motor cable from the AC power cable. More information on cable shielding and segregation is contained in the section on shielding.

AC line filters for single-phase applications

- 1A-15A input current, 120-250 VAC use: Schaffner FN2070-16 or equivalent.
- 15A-25A input current, 120-250 VAC use: Schaffner FN2070-25 or equivalent.
- 25A-36A input current, 120-250 VAC use: Schaffner FN2070-36 or equivalent.

AC line filters for 3-phase applications

- 1A-15A input current, 120-250 VAC use: Schaffner FN258-16 or equivalent.
- 15A-25A input current, 120-250 VAC use: Schaffner FN258-30 or equivalent.
- 25A-36A input current, 120-250 VAC use: Schaffner FN258-42 or equivalent.
- 36A-50A input current, 120-250 VAC use: Schaffner FN258-55 or equivalent.
- 50A-75A input current, 120-250 VAC use: Schaffner FN258-75 or equivalent.
- 75A-100A input current, 120-250 VAC use: Schaffner FN258-100 or equivalent.

	WARNING
<p style="text-align: center;">Large leakage currents exist in AC line filters. They must be grounded properly before applying power. Filter capacitors retain high voltages after power removal. Before handling the equipment, voltages should be measured to determine safe levels prior to handling the equipment. Failure to observe this precaution could result in severe bodily injury.</p>	

6.10.4 Grounding

High frequency (HF) grounding is different from safety grounding. A long wire is sufficient for a safety ground, but is completely ineffective as a HF ground due to the wire inductance. As a rule of thumb, a wire has an inductance of 8 nH/in regardless of diameter. At low frequencies, it acts as constant impedance, at intermediate frequencies as an inductor, and at high frequencies as an antenna. The use of ground straps is a better alternative to wires. However, the length to width ratio must be 5:1, or better yet 3:1, to remain a good high frequency connection.

The ground system's primary purpose is to function as a return current path. It is commonly thought of as an equipotential circuit reference point, but different locations in a ground system may be at different potentials. This is due to the return current flowing through the ground systems finite impedance. In a sense, ground systems are the sewer systems of electronics and as such are sometimes neglected.

The primary objective of a high frequency ground system is to provide a well-defined path for HF currents and to minimize the loop area of the HF current paths. It is also important to separate HF grounds from sensitive circuit grounds. *Single Point Ground Types* (Figure 6-4) shows single point grounds for both series (daisy chain) and parallel (separate) connections. A single point, parallel connected ground system is recommended.

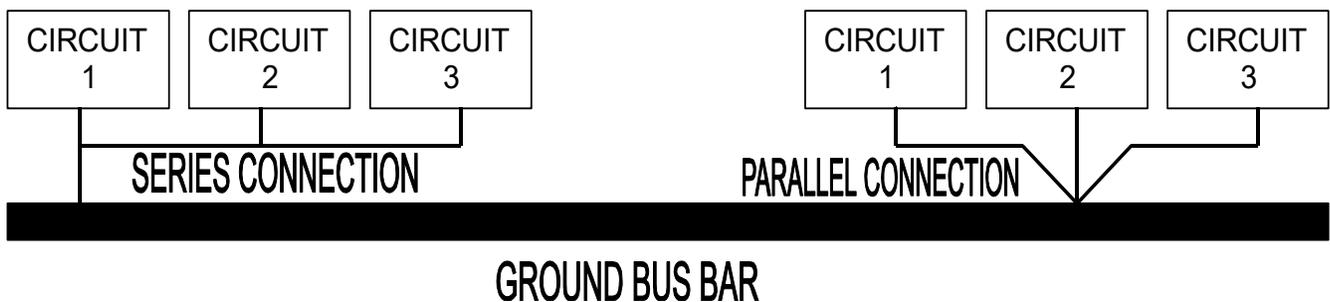


Figure 6-3 Single Point Ground Types

A ground bus bar or plane should be used as the “single point” where circuits are grounded. This will minimize common (ground) impedance noise coupling. The ground bus bar (GBB) should be connected to the AC ground, and if necessary, to the enclosure. All circuits or subsystems should be connected to the GBB by separate connections. These connections should be as short as possible and straps should be used when possible. The motor ground conductor must return to the ground terminal on the drive, not the GBB.

6.10.5 Shielding and Segregation

The EMI radiating from the drive enclosure drops off very quickly over distance. Mounting the drive in an enclosure, such as an industrial cabinet, further reduces the radiated emissions. The cabinet should have a high frequency ground and the size of the openings should be minimized. In addition, the drive is considered an “open” device that does not provide the proper IP rating for the environment in which it is installed. For this reason, the enclosure must provide the necessary degree of protection. An IP rating or Nema rating (which is similar to IP) specifies the degree of protection that an enclosure provides.

The primary propagation route for EMI emissions from a drive is through cabling. The cables conduct the EMI to other devices and can also radiate the EMI. For this reason, cable segregation and shielding are important factors in reducing emissions. Cable shielding can also increase the level of immunity for a drive.

For example:

- Shield termination at both ends is extremely important. The common misconception that shields should be terminated at only one end originates from audio applications with frequencies <20 KHz. RF applications must be terminated with the shield at both ends, and possibly at intermediate points for exceptionally long cables.
- When shielded cables are not terminated at the cable connection and pass through the wall of a cabinet, the shield must be bonded to the cabinet wall to prevent noise acquired inside the cabinet from radiating outside the cabinet, and vice versa.
- When shielded cables are terminated to connectors, the shield must be able to provide complete 360° coverage and terminate through the connector backshell. The shield must not be grounded inside the connector through a drain wire. Grounding the shield inside the connector couples the noise on the shield to the signal conductors sharing the connector and virtually guarantees failure to meet European EMC requirements.
- The shield must be continuous. Each intermediate connector must continue the shield connection through the backshell.
- All cables, both power and signal should use twisted wire pairing.

The shield termination described above provides a coaxial type of configuration, which provides magnetic shielding, and the shield provides a return path for HF currents that are capacitively coupled from the motor windings to the frame. If power frequency circulating currents are an issue, a 250 VAC capacitor should be used at one of the connections to block 50/60 Hz current while passing HF currents. Use of a properly shielded motor cable is essential to meet European EMC requirements.

The following suggestions are recommended for all installations.

Motor cables must have a continuous shield and be terminated at both ends. The shield must connect to the ground bus bar or drive chassis at the drive end, and the motor frame at the motor end. Use of a properly shielded motor cable is essential to meet European EMC requirements.

Signal cables (encoder, serial, and analog) should be routed away from the motor cable and power wiring. Separate steel conduit can be used to provide shielding between the signal and power wiring. Do not route signal and power wiring through common junctions or raceways.

Signal cables from other circuits should not pass within 300 mm (1 ft.) of the drive.

The length or parallel runs between other circuit cables and the motor or power cable should be minimized. A rule of thumb is 300 mm (1 ft.) of separation for each 10 m (30 ft.) of parallel run. The 300 mm (1 ft.) separation can be reduced if the parallel run is less than 1 m (3 ft.).

Cable intersections should always occur at right angles to minimize magnetic coupling.

The encoder mounted on the brushless servo motor should be connected to the drive with a cable using multiple twisted wire pairs and an overall cable shield. Encoder cables are offered in various lengths that have correct terminations.

Persistent EMI problems may require additional countermeasures. The following suggestions for system modification may be attempted.

A ferrite toroid or “doughnut” around a signal cable may attenuate common mode noise, particularly RS-232 communication problems. However, a ferrite toroid will not help differential mode noise. Differential mode noise requires twisted wire pairs.

Suppress each switched inductive device near the servo drive. Switch inductive devices include solenoids, relay coils, starter coils, and AC motors (such as motor driven mechanical timers).

DC coils should be suppressed with a “free-wheeling” diode connected across the coil.

AC coils should be suppressed with RC filters (a 200 Ω , 1/2 W resistor in series with a 0.5 μF , 600 V capacitor is common).

Following these guidelines can minimize noise problems. However, equipment EMC performance must meet regulatory requirements in various parts of the world, specifically the European Union. Ultimately, it is the responsibility of the machine builder to ensure that the machine meets the appropriate requirements as installed.

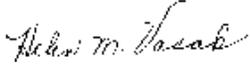
RECOMMENDATIONS FOR GLENTEK DRIVES

All drives installed in a NEMA 12 enclosure or equivalent with wiring in metal conduit or enclosed metal wire trough (see [Shielding and segregation](#)).

Use Glentek shielded feedback and motor cables.

An AC line filter properly installed in a NEMA 12 enclosure or equivalent (see [Filtering](#)).

6.10.6 European Union Declaration of Incorporation Motion Control Systems

	<p>EUROPEAN UNION DECLARATION OF INCORPORATION MOTION CONTROL SYSTEMS</p> <p>Classified as Components of Machinery</p> <p>Model Series SMx9G16</p>									
<p>Council Directive</p>	<p>89/392/EEC</p>	<p>Machinery Directive</p>								
<p>The Products cited below and their accessories comply with the following Safety of Machinery Standards when installed and operated in accordance with the Instructions provided in the Operation & Installation Manuals. The products are declared to comply by virtue of Design Third Party Evaluations and Testing, EMC Testing and Product Safety Evaluations and Risk Assessments were conducted by Intertek ETL SEMKO, an independent Nationally Recognized Test Laboratory, located in Laguna Niguel, CA 92677, USA.</p>										
<p>As components of Machinery, please be advised that:</p>										
<ol style="list-style-type: none"> 1. These are not individually classified as machinery within the scope of directive 89/392/EEC. 2. These are intended to be incorporated into machinery or to be assembled with other machinery to constitute machinery covered by directive 89/392/EEC, as amended. 3. As such, do therefore not in every respect comply with the provisions of directive 89/392/EEC. 										
<p>SAFETY STANDARDS</p>										
<p>EN60204-1 (IEC204-1)</p> <p>EN61000-6-4:2001 EN61000-6-2:2001</p>	<p>Electrical Equipment of Industrial Machines</p> <p>Collateral Test Standards, Specified by EN60204-1</p> <p>EMC – Emission standard for industrial environments EMC – Immunity for industrial environments</p> <p>Collateral Test Standards, Specified by EN61000-6-2</p>									
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Manufacturers Name:</td> <td>GLENTEK INC.</td> </tr> <tr> <td>Manufacturers Address:</td> <td>208 Standard Street El Segundo, CA 90245, USA</td> </tr> <tr> <td>Description of Equipment:</td> <td>Motion Control Systems including Amplifiers and Servo Motors</td> </tr> <tr> <td>Model / Type Reference:</td> <td>Gamma series: SMx9G16-ab-ccc-deff, where x can be B or C, a can be 0, 1, 2, 3, or 4, b can be 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9, c can be 0 or 1, d can be A, B, C, D, E, F, or Z, e can be A, B, C, D, E, or F, and f can be 0 or 1. Stand alone configurations may be followed by 1A-1, 1B-1, or 1C-1. Multi-axis configurations may be followed by gh-j-k, where g can be 2, 4, or 5, h can be A, B, or C, j can be 1, 2, 3, 4, or 5, and k can be 1 or 2.</td> </tr> </table>			Manufacturers Name:	GLENTEK INC.	Manufacturers Address:	208 Standard Street El Segundo, CA 90245, USA	Description of Equipment:	Motion Control Systems including Amplifiers and Servo Motors	Model / Type Reference:	Gamma series: SMx9G16-ab-ccc-deff, where x can be B or C, a can be 0, 1, 2, 3, or 4, b can be 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9, c can be 0 or 1, d can be A, B, C, D, E, F, or Z, e can be A, B, C, D, E, or F, and f can be 0 or 1. Stand alone configurations may be followed by 1A-1, 1B-1, or 1C-1. Multi-axis configurations may be followed by gh-j-k, where g can be 2, 4, or 5, h can be A, B, or C, j can be 1, 2, 3, 4, or 5, and k can be 1 or 2.
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<p>The undersigned hereby declares that the equipment specified above conforms to the noted Directives and Standards.</p>										
<p><u>MANUFACTURER</u></p>										
										
<p>HELEN M. VASAK SECRETARY-TREASURER 1-13-2017</p>										
<p>Prepared By: Intertek Testing Services, Laguna Niguel, CA Confirmed By: John Quigley, Quality Manager</p>										



GLENTEK

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