

ARTISAN®
TECHNOLOGY GROUP

Your **definitive** source for quality pre-owned equipment.

**Artisan Technology Group**
(217) 352-9330 | sales@artisantg.com | artisantg.com

**Full-service, independent repair center**
with experienced engineers and technicians on staff.

**We buy your excess, underutilized, and idle equipment**
along with credit for buybacks and trade-ins.

**Custom engineering**
so your equipment works exactly as you specify.

- Critical and expedited services
- In stock / Ready-to-ship
- Leasing / Rentals / Demos
- ITAR-certified secure asset solutions

**Expert team | Trust guarantee | 100% satisfaction**

All trademarks, brand names, and brands appearing herein are the property of their respective owners.

Find the *OMRON / Delta Tau GPH101* at our website: *Click HERE*

# INSTALLATION MANUAL

# Geo Direct PWM Amplifier




Direct PWM Amplifier

500-603700-xIxx

November 15, 2013

DELTA TAU
Data Systems, Inc.
NEW IDEAS IN MOTION ...

*Single Source Machine Control* ..... *Power // Flexibility // Ease of Use*
***21314 Lassen St. Chatsworth, CA 91311 // Tel. (818) 998-2095 Fax. (818) 998-7807 // www.deltatau.com***

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Copyright Information

© 2013 Delta Tau Data Systems, Inc. All rights reserved.
This document is furnished for the customers of Delta Tau Data Systems, Inc. Other uses are unauthorized without written permission of Delta Tau Data Systems, Inc.
Information contained in this manual may be updated from time-to-time due to product improvements, etc., and may not conform in every respect to former issues.
To report errors or inconsistencies, call or email:

**Delta Tau Data Systems, Inc. Technical Support**
Phone: (818) 717-5656
Fax: (818) 998-7807
Email: support@deltatau.com
Website: http://www.deltatau.com

## Operating Conditions

All Delta Tau Data Systems, Inc. motion controller products, accessories, and amplifiers contain static sensitive components that can be damaged by incorrect handling. When installing or handling Delta Tau Data Systems, Inc. products, avoid contact with highly insulated materials. Only qualified personnel should be allowed to handle this equipment.
In the case of industrial applications, we expect our products to be protected from hazardous or conductive materials and/or environments that could cause harm to the controller by damaging components or causing electrical shorts. When our products are used in an industrial environment, install them into an industrial electrical cabinet or industrial PC to protect them from excessive or corrosive moisture, abnormal ambient temperatures, and conductive materials. If Delta Tau Data Systems, Inc. products are directly exposed to hazardous or conductive materials and/or environments, we cannot guarantee their operation.



**WARNING**

A Warning identifies hazards that could result in personal injury or death. It precedes the discussion of interest.



***Caution***

A Caution identifies hazards that could result in equipment damage. It precedes the discussion of interest.



***Note***

A Note identifies information critical to the understanding or use of the equipment. It follows the discussion of interest.

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

| REVISION HISTORY | | | | |
|---|---|---|---|---|
| **REV.** | **DESCRIPTION** | **DATE** | **CHANGE** | **APPROVAL** |
| 1 | Added Power On/Off procedures,<br>Power PMAC section,<br>Refurbished entire manual | 11/15/2013 | RN | RN |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Table of Contents

**INTRODUCTION ..... 6**

**SPECIFICATIONS ..... 7**

PART NUMBER ..... 7

ENVIRONMENTAL SPECIFICATIONS ..... 7

ELECTRICAL SPECIFICATIONS ..... 8

*230 VAC Drives – Single Axis ..... 8*

*230 VAC Drives – Dual Axis ..... 9*

*480 VAC Drives – Single Axis ..... 10*

*480 VAC Drives – Dual Axis ..... 11*

**RECEIVING AND UNPACKING ..... 12**

USE OF EQUIPMENT ..... 12

**MOUNTING, PHYSICAL LAYOUT ..... 13**

GPX012 ..... 14

*Low Profile, Single Width, No Fan ..... 14*

GPL032 ..... 15

*Single Width, No Fan ..... 15*

GPX05X, GPX102, GPL101, GPH032 ..... 16

*Single Width with Fan ..... 16*

GPX201, GPX301, GPX152, GPH102 ..... 17

*Double Width, Two Fans ..... 17*

**CONNECTOR PINOUTS AND WIRING ..... 18**

J1: MAIN BUS POWER INPUT ..... 18

*Recommended Main Bus Power Wiring/Protection ..... 19*

*Recommended Bus Power Fuse and Wire Gauge ..... 22*

J4: 24 VDC LOGIC CONTROL ..... 23

J2 – J3: MOTOR WIRING ..... 24

*Motor Cable, Noise Elimination ..... 25*

*Motor Selection ..... 26*

J5: EXTERNAL SHUNT RESISTOR ..... 28

*Recommended Shunt Resistors ..... 29*

*Shunt Resistor Layout ..... 30*

X1 – X2: PWM CONNECTORS ..... 31

X3: DISCRETE I/O FOR MOTOR THERMALS ..... 32

X4: SAFETY RELAY ..... 33

**POWER ON/OFF PROCEDURES ..... 34**

*Cycling Main Bus Power ..... 34*



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

**PWM FREQUENCY ..... 36**

**POWER PMAC3 DRIVE SETUP ..... 37**

KEY GATE PARAMETERS ..... 37

KEY CHANNEL PARAMETERS ..... 38

**POWER PMAC2 DRIVE SETUP ..... 40**

KEY GATE PARAMETERS ..... 40

KEY CHANNEL PARAMETERS ..... 41

**TURBO PMAC2 DRIVE SETUP ..... 43**

KEY GATE PARAMETERS ..... 43

KEY CHANNEL PARAMETERS ..... 44

**DRIVE COMMAND STRUCTURE ..... 46**

DEFAULT MODE ..... 46

ENHANCED MODE ..... 47

**TROUBLESHOOTING ..... 49**

LED STATUS ..... 49

7-SEGMENT DISPLAY ..... 49

*Error Codes ..... 50*

**APPENDIX A: CABLE/CONNECTOR KITS ..... 52**

PWM CABLES ..... 52

CONNECTOR KITS ..... 52

CABLE KITS ..... 53



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# INTRODUCTION

The Geo Direct PWM amplifiers provide a 1- or 2-axis motor power using highly integrated IGBT based power circuitry. They support a wide variety of motors and power ranges. The Geo Direct PWM amplifiers interface directly with Delta Tau's PMAC2 or PMAC3 style digital ASICs, typically found in the axis expansion cards inside a Turbo or Power UMAC rack.

The Geo Direct PWM Drive takes the actual power-transistor on/off signals from PMAC, while providing digital phase-current feedback and status for closed-loop operation. The interface to the direct PWM amplifier is through a standard 36-pin Mini-D style cable.

The Geo Direct PWM amplifiers are capable of driving brush, brushless, or induction motors. They operate in the 100 VAC – 480 VAC (156 – 678 DC) range at 50/60Hz, while providing full protection:

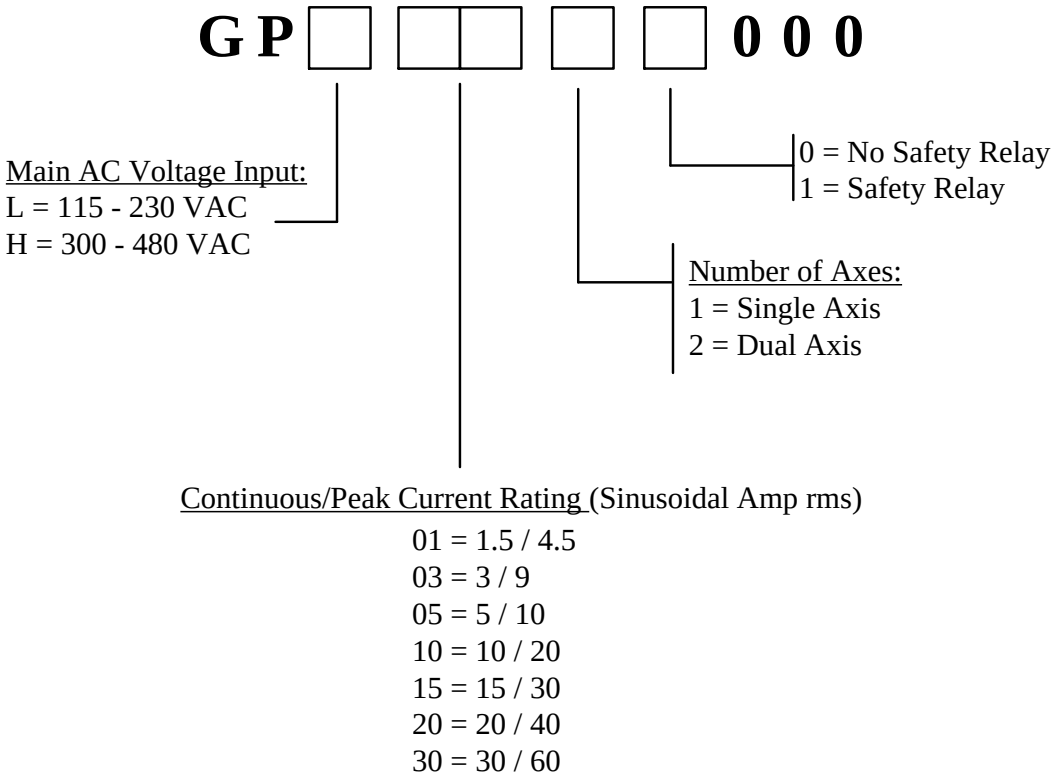
- Over voltage
- Under voltage
- Over temperature
- PWM frequency limit
- Motor over temperature input
- Short circuit (phase – phase)
- Over current
- Safety relay circuit



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# SPECIFICATIONS

## Part Number




## Environmental Specifications

| Description | Specifications |
|---|---|
| Operating Temperature | 0 to 45°C<br>Above 45°C,de-rate current output by 2.5% per °C |
| Storage Temperature | -25°C to +70°C |
| Humidity | 10% to 90% non-condensing |
| Operating Altitude | ~3300 Feet (1000 m)<br>De-rate current output by 1.1% per additional 330 feet (100m) |
| Air Flow Clearances | ~3 inches (76.2mm) above and below unit for air flow |
| Operating Environment | Pollution Degree 2 or equivalent |



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Electrical Specifications

| 230 VAC Drives – Single Axis | | GxL051 | GxL101 | GxL151 | GxL201 | GxL301 |
|---|---|---|---|---|---|---|
| **Main Input Power** | | | | | | |
| Main AC Input | [VAC rms] | $110^{-20\%}$ – $240^{+10\%}$ (~87 – 264) | | | | |
| Rated Input Current @ 240VAC 3ϕ | [A rms] | 3.3 | 6.6 | 9.9 | 13.2 | 19.8 |
| Frequency | [Hz] | 50/60 Hz | | | | |
| Rated Input Power | [Watts] | 1315 | 2629 | 3944 | 5259 | 7888 |
| Main Bus Capacitance | [µf] | 3380 | | | 5020 | 6800 |
| AC Input Phase Requirement | | 1Φ or 3Φ | 3Φ | | | |
| **Output** | | | | | | |
| Continuous Current Output per Axis | [A rms] | 5 | 10 | 15 | 20 | 30 |
| Peak Current Output per Axis @ 2 sec | [A rms] | 10 | 20 | 30 | 40 | 60 |
| Power Output per Axis | [Watts] | 1195 | 2390 | 3585 | 4780 | 7171 |
| **Bus Protection** | | | | | | |
| Nominal DC Bus | [VDC] | 325 | | | | |
| Over-Voltage Trip Level | [VDC] | 410 | | | | |
| Under-Voltage Lockout Level | [VDC] | 137 | | | | |
| **Shunt Resistor** | | | | | | |
| Shunt Turn-On Voltage | [VDC] | 392 | | | | |
| Shunt Turn-Off Voltage | [VDC] | 372 | | | | |
| Shunt Resistor (300 W max) | | GAR78 | GAR48 | | GAR48-3 | |
| **Logic Power** | | | | | | |
| Input Voltage | [VDC] | 20 – 27 | | | | |
| Input Current | [A rms] | 2 | | | | |
| Inrush Current | [A] | 4 | | | | |
| **Current Feedback** | | | | | | |
| Full Scale Reading | [A] | 16.26 | 32.53 | 48.79 | 65.05 | 97.58 |
| Resolution | [bits] | 12 | | | | |
| **Transistor Control** | | | | | | |
| Recommended PWM Frequency | [KHz] | 12 | | 10 | 8 | |
| Minimum Dead time | [µs] | 1 | | | | |
| Charge Pump Time (% of PWM Period) | | 5 | | | | |



***Note***

All values are at ambient temperature of 0 – 45°C (113 F) unless otherwise stated.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

| **230 VAC Drives – Dual Axis** | | GxL012 | GxL032 | GxL052 | GxL102 | GxL152 |
|---|---|---|---|---|---|---|
| **Main Input Power** | | | | | | |
| Main AC Input | [VAC rms] | $110^{-20\%}$ – $240^{+10\%}$ (~87 – 264) | | | | |
| Rated Input Current @ 240VAC 3ϕ | [A rms] | 1.98 | 3.96 | 6.6 | 13.2 | 19.8 |
| Frequency | [Hz] | 50/60 Hz | | | | |
| Rated Input Power | [Watts] | 789 | 1578 | 2629 | 5259 | 7888 |
| Main Bus Capacitance | [µf] | 3380 | | | | 5020 |
| AC Input Phase Requirement | | 1Φ or 3Φ | | 3Φ | | |
| **Output** | | | | | | |
| Continuous Current Output per Axis | [A rms] | 1.5 | 3 | 5 | 10 | 15 |
| Peak Current Output per Axis @ 2 sec | [A rms] | 4.5 | 9 | 10 | 20 | 30 |
| Power Output per Axis | [Watts] | 359 | 717 | 1195 | 2390 | 3585 |
| **Bus Protection** | | | | | | |
| Nominal DC Bus | [VDC] | 325 | | | | |
| Over-Voltage Trip Level | [VDC] | 410 | | | | |
| Under-Voltage Lockout Level | [VDC] | 137 | | | | |
| **Shunt Resistor** | | | | | | |
| Shunt Turn-On Voltage | [VDC] | 392 | | | | |
| Shunt Turn-Off Voltage | [VDC] | 372 | | | | |
| Shunt Resistor (300 W max) | | GAR78 | | | GAR48 | |
| **Logic Power** | | | | | | |
| Input Voltage | [VDC] | 20 – 27 | | | | |
| Input Current | [A rms] | 2 | | | | |
| Inrush Current | [A] | 4 | | | | |
| **Current Feedback** | | | | | | |
| Full Scale Reading | [A] | 7.32 | 14.64 | 16.26 | 32.53 | 48.79 |
| Resolution | [bits] | 12 | | | | |
| **Transistor Control** | | | | | | |
| Recommended PWM Frequency | [KHz] | 16 | | 12 | | 10 |
| Minimum Dead time | [µs] | 1 | | | | |
| Charge Pump Time (% of PWM Period) | | 5 | | | | |



***Note***

All values are at ambient temperature of 0–45°C (113 F) unless otherwise stated.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

| **480 VAC Drives – Single Axis** | | GxH051 | GxH101 | GxH151 | GxH201 | GxH301 |
|---|---|---|---|---|---|---|
| **Main Input Power** | | | | | | |
| Main AC Input | [VAC rms] | $375^{-20\%}$ – $480^{+10\%}$ (~300 – 525) | | | | |
| Rated Input Current | [A rms] | 3.3 | 6.6 | 9.9 | 13.2 | 19.8 |
| Frequency | [Hz] | 50/60 Hz | | | | |
| Rated Input Power | [Watts] | 2744 | 5487 | 8231 | 10974 | 16461 |
| Main Bus Capacitance | [µf] | 845 | | | 1255 | 1700 |
| AC Input Phase Requirement | | 1Φ or 3Φ | 3Φ | | | |
| **Output** | | | | | | |
| Continuous Current Output per Axis | [A rms] | 5 | 10 | 15 | 20 | 30 |
| Peak Current Output per Axis @ 2 sec | [A rms] | 10 | 20 | 30 | 40 | 60 |
| Power Output per Axis | [Watts] | 2494 | 4988 | 7482 | 9977 | 14965 |
| **Bus Protection** | | | | | | |
| Nominal DC Bus | [VDC] | 678 | | | | |
| Over-Voltage Trip Level | [VDC] | 828 | | | | |
| Under-Voltage Lockout Level | [VDC] | 137 | | | | |
| **Shunt Resistor** | | | | | | |
| Shunt Turn-On Voltage | [VDC] | 784 | | | | |
| Shunt Turn-Off Voltage | [VDC] | 744 | | | | |
| Shunt Resistor (300 W max) | | GAR78 | GAR48 | | GAR48-3 | |
| **Logic Power** | | | | | | |
| Input Voltage | [VDC] | 20 – 27 | | | | |
| Input Current | [A rms] | 2 | | | | |
| Inrush Current | [A] | 4 | | | | |
| **Current Feedback** | | | | | | |
| Full Scale Reading | [A] | 16.26 | 32.53 | 48.79 | 65.05 | 97.58 |
| Resolution | [bits] | 12 | | | | |
| **Transistor Control** | | | | | | |
| Recommended PWM Frequency | [KHz] | 12 | 10 | 8 | | |
| Minimum Dead time | [µs] | 1.6 | | | | |
| Charge Pump Time (% of PWM Period) | | 5 | | | | |



***Note***

All values are at ambient temperature of 0–45°C (113 F) unless otherwise stated.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

| **480 VAC Drives – Dual Axis** | | GxH012 | GxH032 | GxH052 | GxH102 | GxH152 |
|---|---|---|---|---|---|---|
| **Main Input Power** | | | | | | |
| Main AC Input | [VAC rms] | $375^{-20\%}$ – $480^{+10\%}$ (~300 – 525) | | | | |
| Rated Input Current @ 240VAC 3ϕ | [A rms] | 1.98 | 3.96 | 6.6 | 13.2 | 19.8 |
| Frequency | [Hz] | 50/60 Hz | | | | |
| Rated Input Power | [Watts] | 1646 | 3292 | 5487 | 10974 | 16461 |
| Main Bus Capacitance | [µf] | 845 | | | | 1255 |
| AC Input Phase Requirement | | 1Φ or 3Φ | | 3Φ | | |
| **Output** | | | | | | |
| Continuous Current Output per Axis | [A rms] | 1.5 | 3 | 5 | 10 | 15 |
| Peak Current Output per Axis @ 2 sec | [A rms] | 4.5 | 9 | 10 | 20 | 30 |
| Power Output per Axis | [Watts] | 748 | 1496 | 2494 | 4988 | 7482 |
| **Bus Protection** | | | | | | |
| Nominal DC Bus | [VDC] | 678 | | | | |
| Over-Voltage Trip Level | [VDC] | 828 | | | | |
| Under-Voltage Lockout Level | [VDC] | 137 | | | | |
| **Shunt Resistor** | | | | | | |
| Shunt Turn-On Voltage | [VDC] | 784 | | | | |
| Shunt Turn-Off Voltage | [VDC] | 744 | | | | |
| Shunt Resistor (300 W max) | | GAR78 | | | GAR48 | |
| **Logic Power** | | | | | | |
| Input Voltage | [VDC] | 20 – 27 | | | | |
| Input Current | [A rms] | 2 | | | | |
| Inrush Current | [A] | 4 | | | | |
| **Current Feedback** | | | | | | |
| Full Scale Reading | [A] | 7.32 | 14.64 | 16.26 | 32.53 | 48.79 |
| Resolution | [bits] | 12 | | | | |
| **Transistor Control** | | | | | | |
| Recommended PWM Frequency | [KHz] | 12 | | 10 | 8 | |
| Minimum Dead time | [µs] | 1.6 | | | | |
| Charge Pump Time (% of PWM Period) | | 5 | | | | |



***Note***

All values are at ambient temperature of 0–45°C (113 F) unless otherwise stated.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# RECEIVING AND UNPACKING

Delta Tau products are thoroughly tested at the factory and carefully packaged for shipment. When the Geo Direct PWM Drive is received, there are several things to be done immediately:

- Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered the drive.
- Remove the drive from the shipping container and remove all packing materials. Check all shipping material for connector kits, documentation, or other small pieces of equipment. Be aware that some connector kits and other equipment pieces may be quite small and can be accidentally discarded if care is not used when unpacking the equipment. The container and packing materials may be retained for future shipment.
- Verify that the part number of the drive received is the same as the part number listed on the purchase order.
- Inspect the drive for external physical damage that may have been sustained during shipment and report any damage immediately to the commercial carrier that delivered the drive.
- Electronic components in this product are design-hardened to reduce static sensitivity. However, use proper procedures when handling the equipment.
- If the Geo Direct PWM Drive is to be stored for several weeks before use, be sure that it is stored in a location that conforms to published storage humidity and temperature specifications.

## Use of Equipment

The following restrictions will ensure the proper use of the Geo Direct PWM Drive:

- The components built into electrical equipment or machines can be used only as integral components of such equipment.
- The Geo Direct PWM Drive must not be operated on power supply networks without a ground or with an asymmetrical ground.
- If the Geo Direct PWM Drive is used in residential areas, or in business or commercial premises, implement additional filtering measures.
- The Geo Direct PWM Drive may be operated only in a closed switchgear cabinet, taking into account the ambient conditions defined in the environmental specifications.

Delta Tau guarantees the conformance of the Geo Direct PWM Drives with the standards for industrial areas stated in this manual, only if Delta Tau components (cables, controllers, etc.) are used.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# MOUNTING, PHYSICAL LAYOUT

The location of the Geo Direct PWM Drive is important. Installation should be in an area that is protected from direct sunlight, corrosives, harmful gases or liquids, dust, metallic particles, and other contaminants. Exposure to these can reduce the operating life and degrade performance of the drive.

Several other factors should be carefully evaluated when selecting a location for installation:

- For effective cooling and maintenance, the Geo Direct PWM Drive should be mounted on a smooth, non- flammable vertical surface.
- At least 76 mm (3 inches) top and bottom clearance must be provided for air flow. At least 10 mm (0.4 inches) clearance is required between units (each side).
- Temperature, humidity and Vibration specifications should also be taken in account.



***Caution***

Unit must be installed in an enclosure that meets the environmental IP rating of the end product (ventilation or cooling may be necessary to prevent enclosure ambient from exceeding 45° C [113° F]).

The Geo Direct PWM Drive can be mounted with a traditional 4-hole panel mount, two U shape/notches on the bottom and two pear shaped holes on top.

If multiple Geo Direct PWM Drives are used, they can be mounted side-by-side, leaving at least a 122 mm clearance between drives. This means a 122 mm center-to-center distance (0.4 inches) with the 4-axis Drives. 8- and 6-axis Geo Direct PWM Drives can be mounted side by side at 214 mm center-to-center distance (8.4 inches). It is extremely important that the airflow is not obstructed by the placement of conduit tracks or other devices in the enclosure.

If the drive is mounted to a back panel, the back panel should be unpainted and electrically conductive to allow for reduced electrical noise interference. The back panel should be machined to accept the mounting bolt pattern of the drive.

The Geo Direct PWM Drive can be mounted to the back panel using four M4 screws and internal-tooth lock washers. It is important that the teeth break through any anodization on the drive's mounting gears to provide a good electrically conductive path in as many places as possible. Mount the drive on the back panel so there is airflow at both the top and bottom areas of the drive (at least three inches).

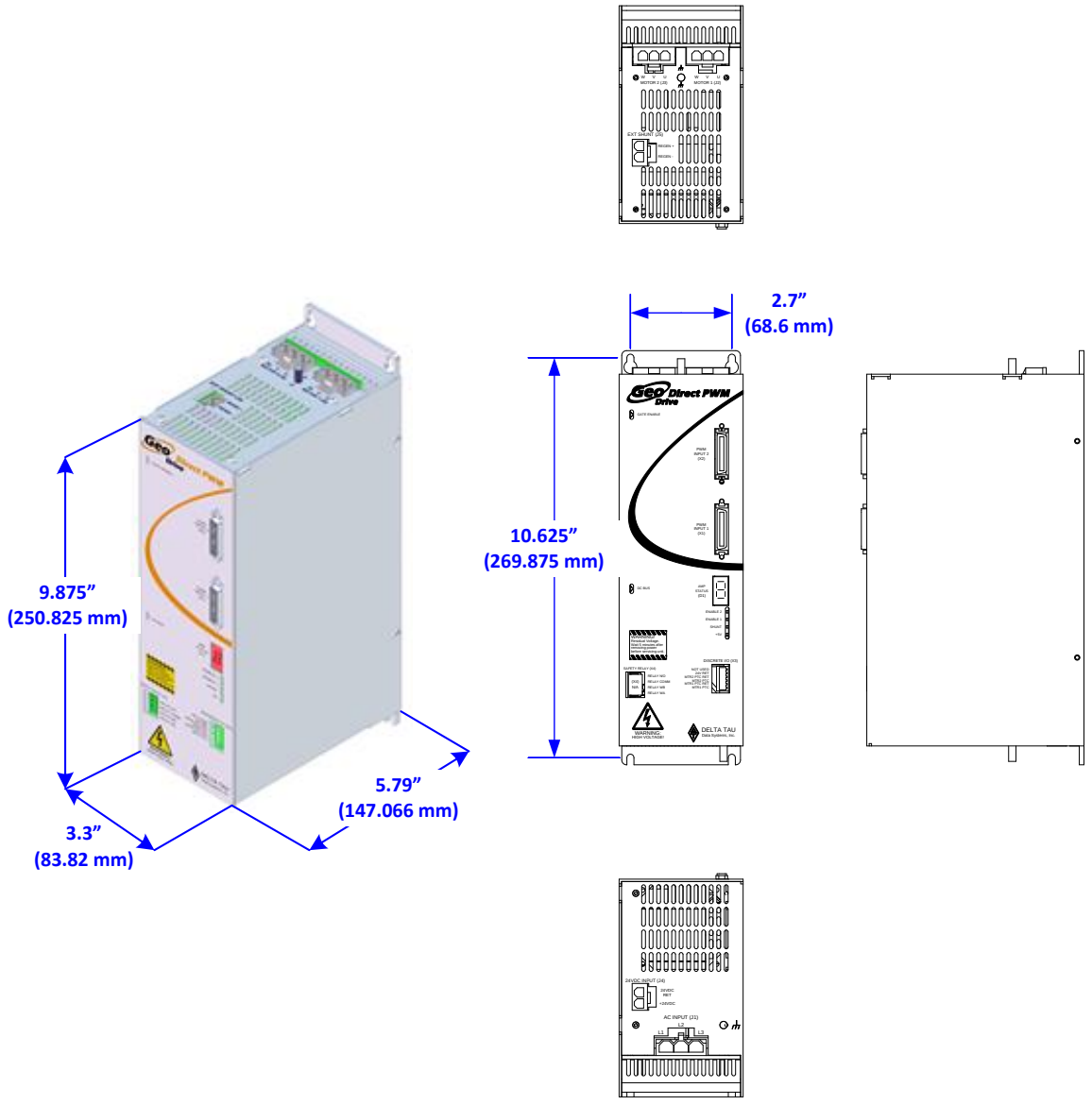


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## GPx012

| Width | Height | Depth | Weight |
|---|---|---|---|
| 3.30 in. / 84 mm | 11.00 in. / 280 mm | 5.80 in. / 147 mm | 4.2 lbs / 1.9 kgs |

### Low Profile, Single Width, No Fan



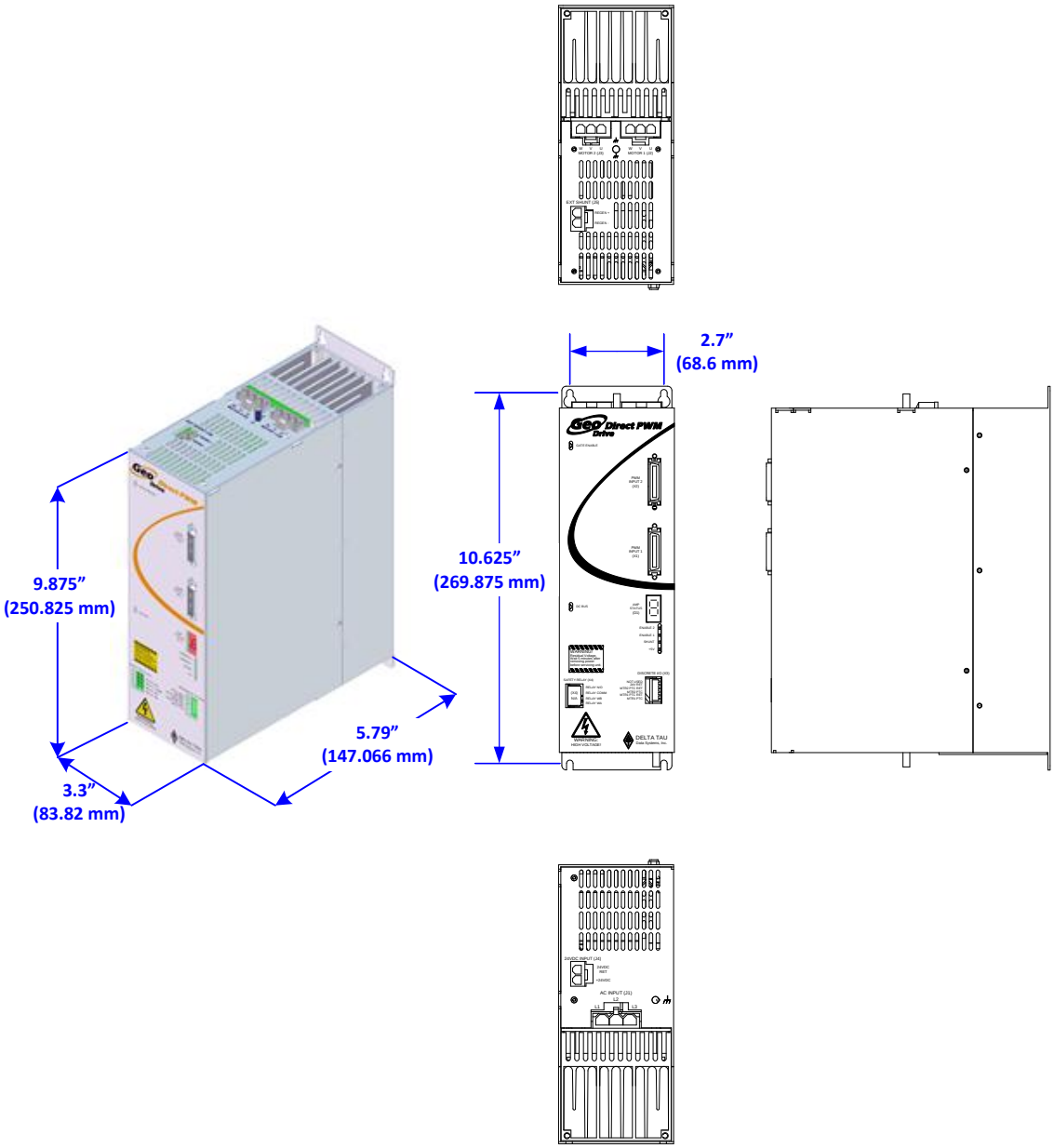



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## GPL032

| Width | Height | Depth | Weight |
|---|---|---|---|
| 3.30 in./ 84 mm | 11.00 in./ 280 mm | 8.00 in./ 203 mm | 5.4 lbs/ 2.45 kgs |

### Single Width, No Fan



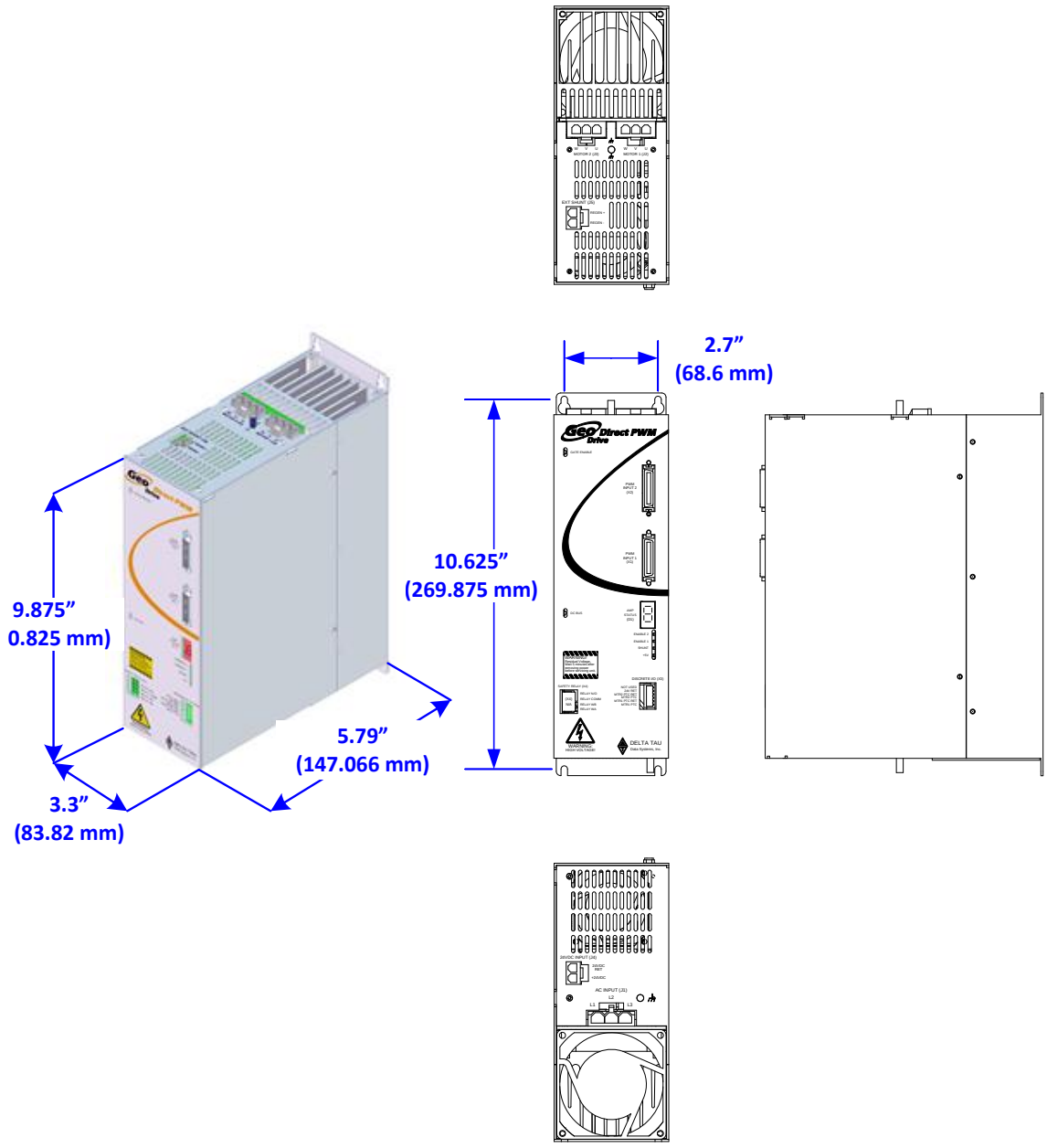



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## GPx05x, GPx102, GPL101, GPH032

| Width | Height | Depth | Weight |
|---|---|---|---|
| 3.30 in./ 84 mm | 11.00 in./ 280 mm | 8.00 in./ 203 mm | 5.5 lbs/ 2.5 kgs |

### Single Width with Fan



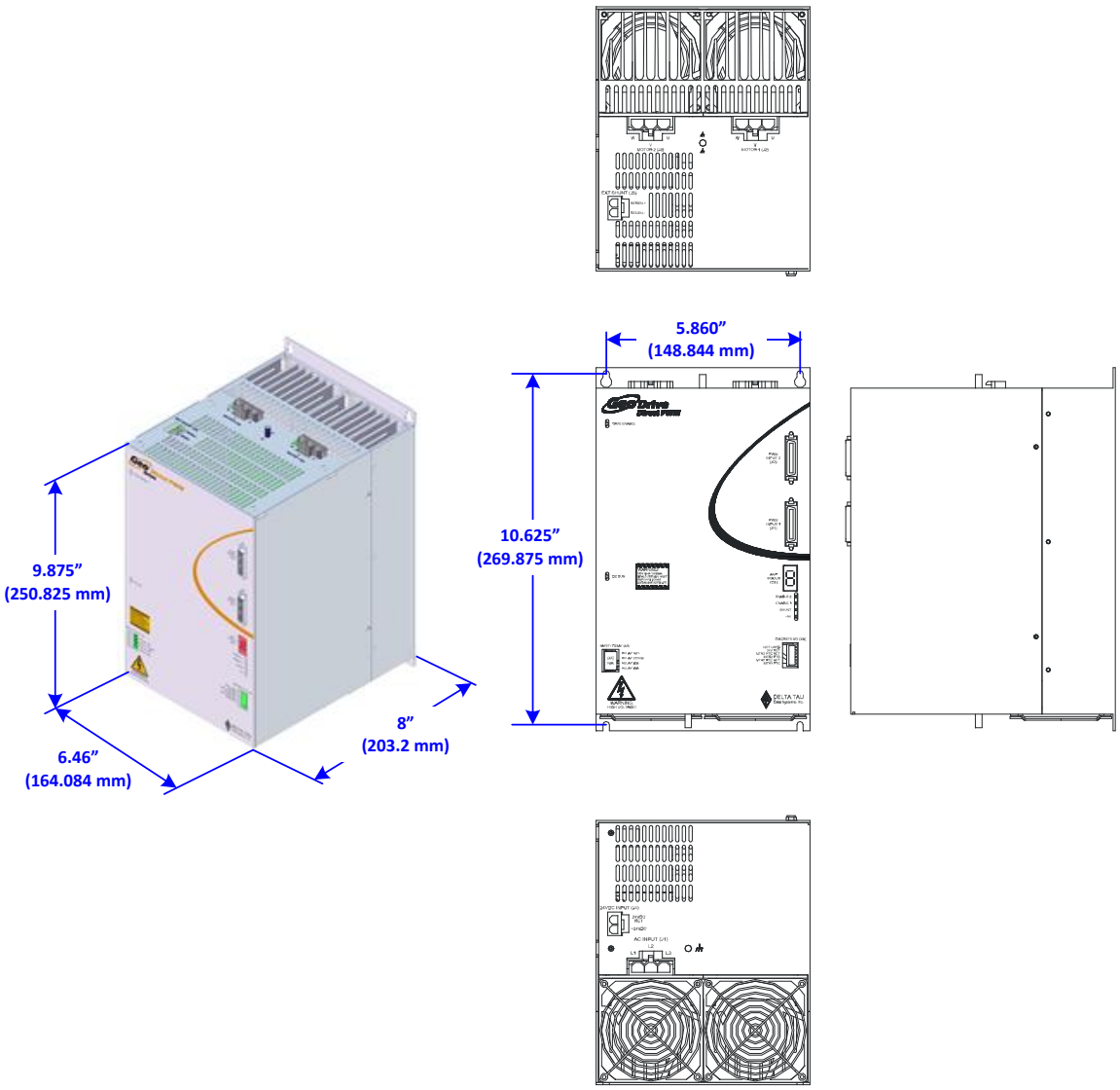



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## GPx201, GPx301, GPx152, GPH102

| Width | Height | Depth | Weight |
|---|---|---|---|
| 6.50 in./ 165 mm | 11.00 in./ 280 mm | 8.00 in./ 203 mm | 11.5 lbs/ 5.2 kgs |

### Double Width, Two Fans






Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

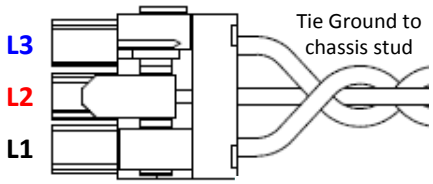
# CONNECTOR PINOUTS AND WIRING

**WARNING**

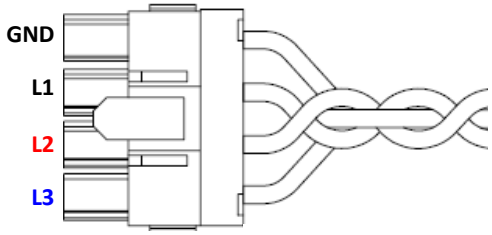
Installation of electrical control equipment is subject to many regulations including national, state, local, and industry guidelines and rules. General recommendations can be stated but it is important that the installation be carried out in accordance with all regulations pertaining to the installation.

## J1: Main Bus Power Input

J1 is used to bring the main AC/DC bus power into the Geo Direct PWM Drive.

| **J1: Molex 3-pin Female**<br>**Mating: Molex 3-pin Male** | | |  | | |
|---|---|---|---|---|---|
| **Pin #** | **Symbol** | **Function** | **Three Phase** | **Single Phase** | **DC** |
| 1 | L3 | Input | AC Line Phase 3 | Line | DC+ |
| 2 | L2 | Input | AC Line Phase 2 | Neutral | DC Return |
| 3 | L1 | Input | AC Line Phase 1 | Not connected | Not connected |
| DT Housing pn: 014-H00F03-049<br>DT Pins pn: 014-042815-0031 | | | Molex housing pn: 42816-0312<br>Molex pins pn: 42815-0031 | | |

**GPx201 and GPx301**

| **J1: Molex 4-pin Female**<br>**Mating: Molex 4-pin Male** | | |  | | |
|---|---|---|---|---|---|
| **Pin #** | **Symbol** | **Function** | **Three Phase** | **Single Phase** | **DC** |
| 1 | L3 | Input | AC Line Phase 3 | Line | DC+ |
| 2 | L2 | Input | AC Line Phase 2 | Neutral | DC Return |
| 3 | L1 | Input | AC Line Phase 1 | Not connected | Not connected |
| 4 | GND | Common Ground | | | |
| DT Housing pn: 014-H00F04-049<br>DT Pins pn: 014-042815-0031 | | | Molex housing pn: 42816-0412<br>Molex pins pn: 42815-0031 | | |



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com



***Note***

AC input wires must be twisted together to eliminate as much noise radiation as possible.

## Recommended Main Bus Power Wiring/Protection



***Caution***

Main bus power lines should run in a separate duct (at least 12” or 30 cm away) from and should never be bundled with the I/O signal, communication, or encoder cables.

### Grounding, Bonding

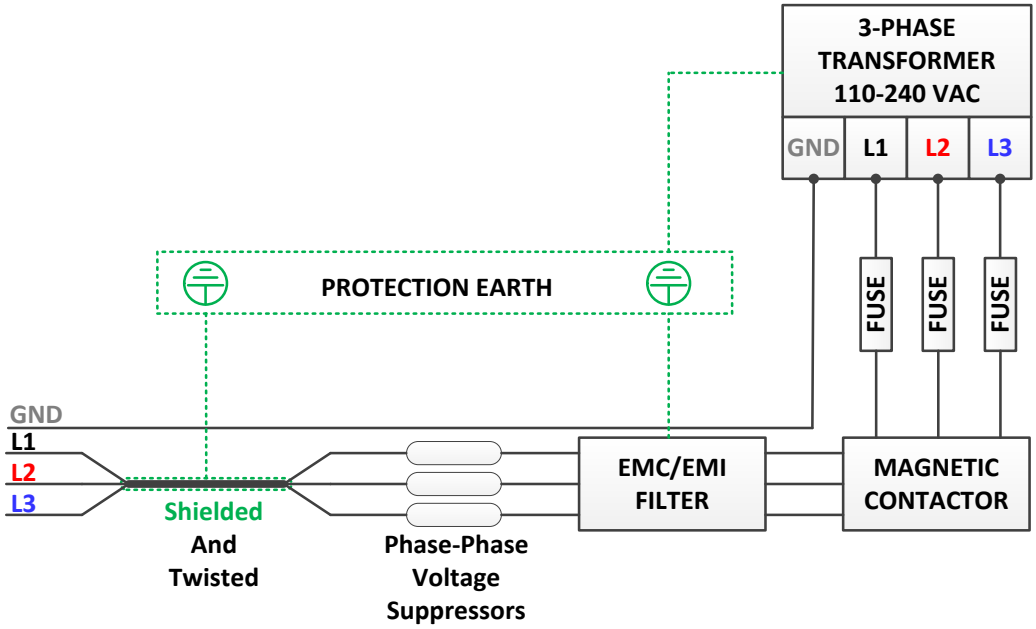
System grounding is crucial for proper performance of the Geo Direct PWM Drive. Panel wiring requires that a central earth-ground (also known as ground bus bar) location be installed at one part of the panel. The ground bus bar is usually a copper plate directly bonded to the back panel. This electrical ground connection allows for each device within the enclosure to have a separate wire brought back to the central earth-ground.

- Motor shields are best grounded at both ends of the cable. Motor cable shields should be bonded to the back panel using 360-degree clamps at the point they enter or exit the panel. Always use metal shells.
- Implement a star point ground connection scheme; so that each device wired to earth ground has its own conductor brought directly back to the central earth ground plate (bus bar).
- Use an unpainted back panel. This allows a wide area of contact for all metallic surfaces, reducing frequency impedances.
- Use a heavy gauge ground earth conductors made up of many strands of fine conducts.
- The Geo Direct PWM Drive is brought to the earth-ground via one or two wire(s) connected to the M4 mounting stud(s) through a heavy gauge multi-strand conductor to the central earth-ground.

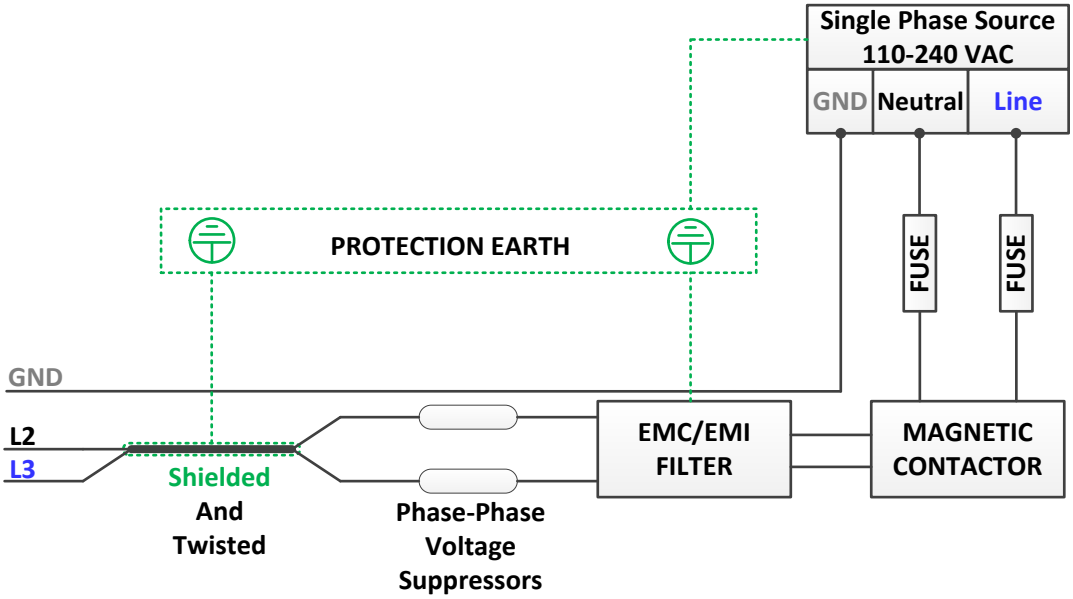


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

**Three-Phase Main AC Power Wiring Diagram**




**Single-Phase Main AC Power Wiring Diagram**




*Note*

If the Geo Direct PWM Drive model does not have a ground pin on the bus input connector, then the transformer ground (GND) can be tied to the grounding stud or chassis ground.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Transformers

Y-Y or Y-Δ transformers should be used.

Δ-Δ Transformers are NOT advised. They try to balance phases dynamically, creating instances of instability in the Geo Direct PWM Drive's rectifying circuitry.



***Note***

A line reactor should be installed if a transformer or reliable source of power is not available. Line reactors suppress harmonics bi-directionally, eliminating low frequency spikes.

## Fuses

High peak currents and high inrush currents demand the use of slow blow time delayed type fuses. RK1 or RK5 (i.e. current limiting) classes are recommended. **FRN-R** and **LPN-RK** from **Cooper Bussmann** or similar fuses can be used.

## Magnetic Contactors

**SC-E series** from **Fuji Electric** or similar contactor can be used.

## Line Filters

Line filters eliminate electromagnetic noise in a bi-directional manner (from and into the system). T type filters are NOT recommended. PI type line filters are highly advised:

- Filter should be mounted on the same panel as the drive and power source.
- Filter should be mounted as close as possible to the power source.
- Filter should be mounted as close as possible to incoming cabinet power.

**FN-258 series** from **Schaffner** or similar filter can be used.

## Voltage Suppressors

Voltage suppressors eliminate undesirable voltage spikes typically generated by the magnetic contactor or external machinery in the plant.

This 3-phase **voltage arrester** from **Phoenix Contact** or similar suppressor can be used.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Recommended Bus Power Fuse and Wire Gauge

Geo Drive electronics create a DC bus by rectifying the incoming AC lines. The current flow into the drive is not sinusoidal but rather a series of narrow, high-peak pulses. Keep the incoming impedance small so that these current pulses are not hindered. Conductor size, transformer size, and fuse size recommendations may seem larger than normally expected.

| **Model** | GPL012 | GPL032<br>GPL051<br>GPL052<br>GPL101<br>GPL102 | GPL151<br>GPL152<br>GPL201 | GPL301 | GPH012 | GPH032<br>GPH051<br>GPH052<br>GPH101<br>GPH102 | GPH151<br>GPH152<br>GPH201 | GPH301 |
|---|---|---|---|---|---|---|---|---|
| **Fuse (FRN/LPN)** | 15 | 20 | 25 | 30 | 15 | 20 | 25 | 30 |
| **Wire Gauge** | 14 | 12 | 10 | 8 | 14 | 12 | 25 | 30 |



***Note***

All ground conductors should be 8AWG minimum using wires constructed of many strands of small gauge wire. This ensures the lowest impedance to high-frequency noises.



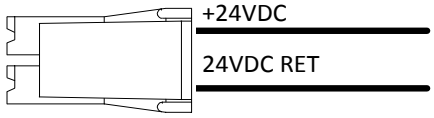
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## J4: 24 VDC Logic Control

J4 is used to bring the 24VDC logic power into the Geo Direct PWM Drive. This power can remain on, regardless of the main AC/DC bus power input, allowing the digital control electronics to be active while the main motor power control is passive.

It is recommended to use a protected power supply. In situations where the power supply is shared with other devices, it may be desirable to insert a filter before applying it to the Geo Direct PWM Drive.

If multiple drives are driven out of the same 24VDC power supply, it is recommended that each Geo Direct PWM Drive be wired back to the power supply terminals independently. It is also recommended that the power supply be sized to handle the instantaneous inrush current required to start up the DC-to-DC converter action inside the Drive(s). See electrical specifications.

| **J4: Molex 2-pin Female**<br>**Mating: Molex 2-pin Male** | | |  | |
|---|---|---|---|---|
| **Pin #** | **Symbol** | **Function** | **Description** | **Notes** |
| 1 | 24VDC RET | Common | Control power return | |
| 2 | +24VDC | Input | Control power input | 24V+/-10%, @ 2A |
| DT Housing pn: 014-000F02-HSG<br>DT Pins pn: 014-043375-001 | | | Molex housing pn: 44441-2002<br>Molex pins pn: 43375-0001 | |



***Note***

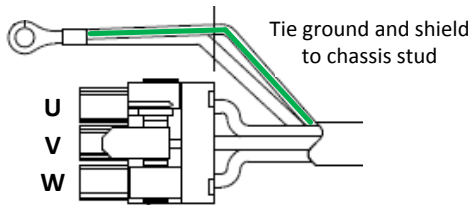
This connection can be made using 16 AWG wire.



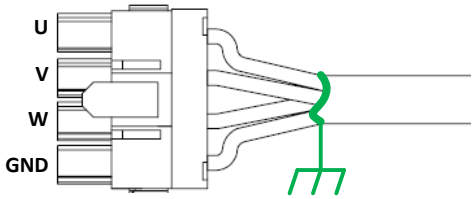
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## J2 – J3: Motor Wiring

The cable wiring must be shielded and have a separate conductor connecting the motor frame back to the Geo Direct PWM Drive's chassis.

| **J2 – J3: Molex 3-Pin Female**<br>**Mating: Molex 3-Pin Male** | |  |
|---|---|---|
| **Symbol** | **Function** | **Description** |
| U | Motor Output | Axis 1 Phase 1 |
| V | Motor Output | Axis 1 Phase 2 |
| W | Motor Output | Axis 1 Phase 3 |
| DT Housing pn: 014-H00F03-049<br>DT Pins pn: 014-042815-0031 | | Molex housing pn: 42816-0312<br>Molex pins pn: 42815-0031 |

**GPx201, GPx301**

| **J2 – J3: Molex 4-pin Female**<br>**Mating: Molex 4-pin Male** | |  |
|---|---|---|
| **Symbol** | **Function** | **Description** |
| U | Motor Output | Axis 1 Phase 1 |
| V | Motor Output | Axis 1 Phase 2 |
| W | Motor Output | Axis 1 Phase 3 |
| GND | Ground | |
| DT Housing pn: 014-H00F04-049<br>DT Pins pn: 014-042815-0031 | | Molex housing pn: 42816-0412<br>Molex pins pn: 42815-0031 |



***Note***

The Geo Direct PWM Drive endorses the U, V, and W nomenclature for phases 1 through 3 respectively. Some motor manufacturers will call them A, B, and C. Others may call them L1, L2, and L3.



***Note***

For wiring DC brush motors, use phases U and W, and leave V floating.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

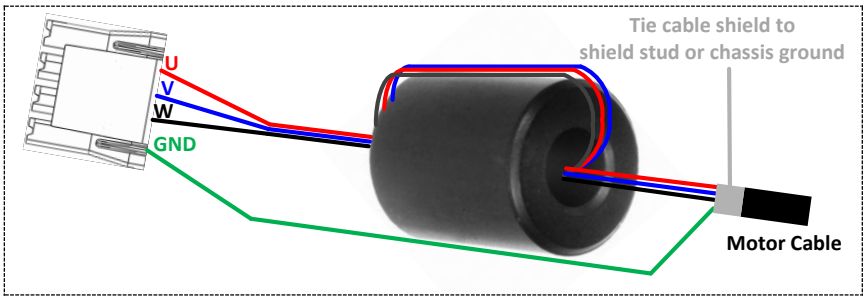
*Note*

The motor thermostats are brought in through connector X3.

## Motor Cable, Noise Elimination

The Geo Direct PWM Drives' voltage output has a fundamental frequency and amplitude that corresponds to motor speed, torque, and number of poles. The Geo Direct PWM Drive produces higher frequency voltage components corresponding to the rise, fall and repetition rate of the fast switching PWM signals. Subsequently, it could naturally couple current noise to nearby conductors. This electrical coupling can be problematic, especially in noise-sensitive applications such as using high-resolution sinusoidal encoders, or high rate of communication which could suffer from Electro-Magnetic Interference EMI. Proper grounding, shielding, and filtering can alleviate most noise issues. Some applications may require additional measures such as PWM edge filters. The following; are general guidelines for proper motor cabling:

- Use a motor cable with **high quality shield**. A combination braid-and-foil is best.
- **The motor drain wires and cable shield should be tied together, and attached at both ends of the motor and Geo Direct PWM Drive chassis**. At the motor end, make a 360 degree connection between the shield and motor frame. If the motor has a metal shell connector, then you can tie the shield directly to the metal shell of the mating connector. The connection between the cable shield and the motor frame should be as short as possible). At the Geo Direct PWM Drive end, make a 360 degree connection between the shield and the provided studs or grounded chassis (protection earth) at the M4 mounting screws.
- The motor cable should have a **separate conductor (drain wire) tying the motor frame to the Geo Direct PWM drive**'s chassis.
- **Keep the motor cable as short as possible** to maintain lower capacitance (desirable). A capacitance of up to 50 PicoFarads per foot (0.3048 m), and runs of up to 200 feet (60 m) are acceptable with 240VAC. Exceeding these lengths requires the installation of a Snubber at the motor end or an in-series inductor at the Geo Direct PWM Drive end.
- If the grounding/shielding techniques are insufficient, you may **install chokes in the motor phases at the Geo Direct PWM Drive end** such as wrapping individual motor leads several times through a ferrite core ring. DigiKey, Micro-Metals (T400-26D), Fair Rite (2643540002), or equivalent ferrite cores are recommended. This adds high-frequency impedance to the outgoing motor cable thereby making it harder for high-frequency noise to leave the control area.






Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com



***Note***

Ferrite cores are also commonly used with lower inductance motors to enhance compatibility with the Geo Direct PWM Drive, which is specified to a minimum of 2 mH.

- **Do not use a motor wire gauge less than 14 AWG for 5/10A or 8/16A axes, and 10 AWG for 15/30A or 30/60A axes** unless otherwise specified by the motor manufacturer. Refer to Motor manufacturer and local code recommendations.

- Avoid running sensitive signal cables (i.e. encoders, small signal transducers) in the same cable bundle as the motor cable(s).

- Install dv/dt filter, Trans-coil V1K series (Optional).

## Motor Selection

The Geo Direct PWM Drive interfaces with a wide variety of motors. It supports virtually any kind of three-phase AC/DC rotary, linear brushless, or induction motors. Using two out of the three phases, it is also possible to drive permanent magnet DC brush motors.

### Motor Inductance

Digital direct PWM control requires a significant amount of motor inductance to drive the on-off voltage signals resulting smooth current flow with minimal ripple. Typically, servomotors' phase inductance ranges from 2 to 15mH. The lower the inductance, the higher is the suitable PWM frequency.
Low inductance motors (less than 2 mH) can see large ripple currents causing excessive energy waste and overheating. Additional in-series inductance is recommended in these cases.
High inductance motors (greater than 15 mH) are slower to react and generally not considered high performance servo motors.

### Motor Resistance

Motor resistance is not typically a determining factor in the drive/system performance but rather comes into play when extracting a desired torque or horsepower out of the motor is a requirement.

### Motor Inertia

Motor inertia is an important parameter in motor sizing. Considering the reflected load inertia back to the motor in this process is important. In general, the higher the motor inertia, the more stable the system will inherently be. A high ratio of load to motor inertia shrinks the operating bandwidth (gain limited) of the system, especially in applications using belt or rubber based couplings. The ratio of load to motor inertia is typically around 3:1. Mechanical gearing is often used to reduce reflected inertial load going back to the shaft of the motor.

### Motor Speed

In some applications, it is realistically impossible to achieve the motors' specified maximum velocity. Fundamentally, providing sufficient voltage and proper current-loop tuning should allow attaining motor maximum speeds. Consider feedback devices being a limitation in some cases, as well as the load attached to the motor. In general, the maximum speed can be determined dividing the line-to-line input voltage by the back EMF constant Kb of the motor. Input voltage headroom of about 20% is recommended for good servo control at maximum speed.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Motor Torque

Torque requirements in an application can be viewed as both instantaneous and average
Typically, the instantaneous or peak torque is the sum of machining, and frictional forces required to accelerate the inertial load. The energy required to accelerate a load follows the equation T=JA where T is the torque, J is the inertia, and A is the acceleration. The required instantaneous torque is then divided by the motor torque constant (Kt) to determine the necessary peak current of the Geo Direct PWM Drive. Headroom of about 10% is always desirable to account for miscellaneous losses (aging, wear and tear, calculation roundups).
The continuous torque rating of the motor is bound by thermal limitation. If the motor applies more torque than the specified threshold, it will overheat. Typically, the continuous torque ceiling is the RMS current rating of the motor, also known as torque output per ampere of input current.

## Required Bus Voltage for Speed and Torque

For a required motor Speed, and continuous Torque, the minimum DC Bus Voltage ($V_{DC}$) can be estimated by looking at the equivalent single phase circuit:

The vector sum of back EMF, voltage across resistor and inductor should be less than $V_{DC}/\sqrt{6}$.

**For a Rotary Motor:**

$$\sqrt{V_L{}^2 + \left(V_R + V_{BEMF}\right)^2} = \sqrt{\left(\frac{R_{RPM}}{60}\cdot N_p \cdot 2\cdot\pi\cdot L_p \cdot \frac{T_M}{K_t}\right)^2 + \left(\frac{T_M}{K_t}R_p + \frac{R_{RPM}}{60}\cdot\frac{K_t}{3}\cdot 2\cdot\pi\right)^2} \le M_{derate}\frac{V_{DC}}{\sqrt{6}}$$

Where:

| | | | |
|---|---|---|---|
| $V_L$ | : Voltage Across equivalent inductor | $L_P$ | : Phase Inductance [H] |
| $V_R$ | : Voltage Across equivalent resistor | $R_P$ | : Phase Resistance [Ω] |
| $V_{BEMF}$ | : Back electromotive force voltage | $T_M$ | : Required Continuous Torque [N.M] |
| $R_{RPM}$ | : Required Motor Speed [rpm] | $K_T$ | : Motor Torque Constant RMS [N.M/A] |
| $N_P$ | : Number of pole pairs | $M_{derate}$ | : De-rate parameter (typically 0.8) |

**For a Linear Motor:**

$$\sqrt{V_L{}^2 + \left(V_R + V_{BEMF}\right)^2} = \sqrt{\left(\frac{V_{motor}}{D_{pitch}}\cdot L_p \cdot \frac{F_M}{K_t}\right)^2 + \left(\frac{F_M}{K_t}R_p + \frac{V_{motor}}{D_{pitch}}\cdot\frac{K_t}{3}\right)^2} \le M_{derate}\frac{V_{DC}}{\sqrt{6}}$$

Where:

| | | | |
|---|---|---|---|
| $V_L$ | : Voltage across equivalent inductor | $L_P$ | : Phase Inductance [H] |
| $V_R$ | : Voltage across equivalent resistor | $R_P$ | : Phase Resistance [Ω] |
| $V_{BEMF}$ | : Back electromotive Force voltage | $F_M$ | : Required Motor Force RMS [N] |
| $V_{motor}$ | : Required Motor Speed [m/s] | $K_t$ | : Motor Force Constant RMS [N/A] |
| $M_{derate}$ | : De-rate parameter (typically 0.8) | $D_{Pitch}$ | : Magnetic Pitch [m] |

**Example:**
An application requires running a motor at 500 RPM with a continuous torque of 30 N.M. The motor specs are as follow:

$L_p = 10\text{mH},\ R_p = 2\text{Ohm},\ N_p = 16,\ K_t = 2.187\text{Nm/Amps}$

Using the equation above, a minimum bus of 233 VDC (~165VAC) is necessary to achieve the speed and torque requirements.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

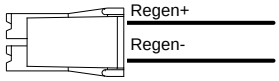
## J5: External Shunt Resistor

J5 is used to wire an external shunt resistor to expel the excess power during demanding deceleration profiles. These shunt resistors are designed to drain excess bus energy very quickly.

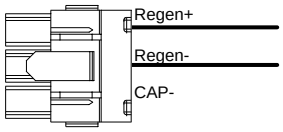


*Caution*

All applications using Geo direct PWM Drives (all configurations) are strongly advised to install an external shunt resistor.

| **J5: Molex 2-Pin Female**<br>**Mating: Molex 2-Pin Male** | |  |  |
|---|---|---|---|
| **Pin #** | **Symbol** | **Function** | |
| 1 | REGEN- | Output | |
| 2 | REGEN+ | Output | |
| Molex Mating Connector p/n: 0444412002<br>Molex Crimper tool p/n: 63811-0400<br>Molex Pins p/n: 0433751001<br>Delta Tau Mating Connector p/n: 014-000F02-HSG<br>Delta Tau Pins p/n: 014-043375-001 | | | |

**Gxx201, Gxx301**

| **J5: Molex 3-Pin Female**<br>**Mating: Molex 3-Pin Male** | |  |  |
|---|---|---|---|
| 1 | CAP- | Bus – (do NOT wire) | |
| 2 | REGEN- | Output | |
| 3 | REGEN+ | Output | |
| Molex Mating Connector p/n: 0428160312<br>Molex Crimper tool p/n: 63811-1500<br>Molex Pins p/n: 0433751001<br>Delta Tau Mating Connector p/n: 014-H00F03-049<br>Delta Tau Pins p/n: 014-042815-001 | | | |



*Caution*

The external shunt resistors can reach temperatures of up to 200°C. They must be mounted away from other devices and ideally near the top of the cabinet, also ensure they are enclosed and cannot be touched during operation or anytime they are hot. Sufficient warning labels should be placed prominently nearby.

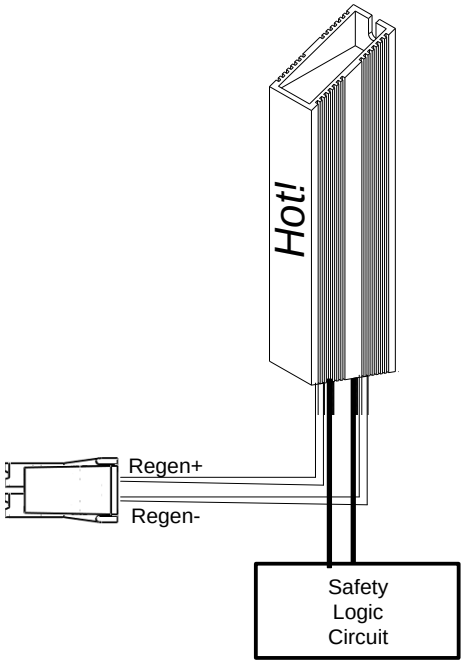


Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

The black wires are for the thermostat and the white wires are for the shunt resistor.

The shunt resistor incorporates a normally closed (N.C) thermal overload protection thermostat that opens up when the core temperature of the resistor exceeds 225°C (450° F). This thermostat is accessible through the two black leads. It is important that these two leads be wired in a safety circuit to halt operation should the resistor temperature exceed the specified threshold.

The external shunt resistor Ohm rating range is found so that the minimum value limits the current to the permissible amperage, and that the maximum value limits the bus (during deceleration) to the permissible voltage.






***Note***

For GPL models, the shunt circuitry turn-on threshold is 392 VDC (~278 VAC). The turn-off threshold is 372 VDC (~263VAC).



***Note***

For GPH models, the shunt circuitry turn-on threshold is 784 VDC (~555 VAC). The turn-off threshold is 744 VDC (~526VAC).

## Recommended Shunt Resistors

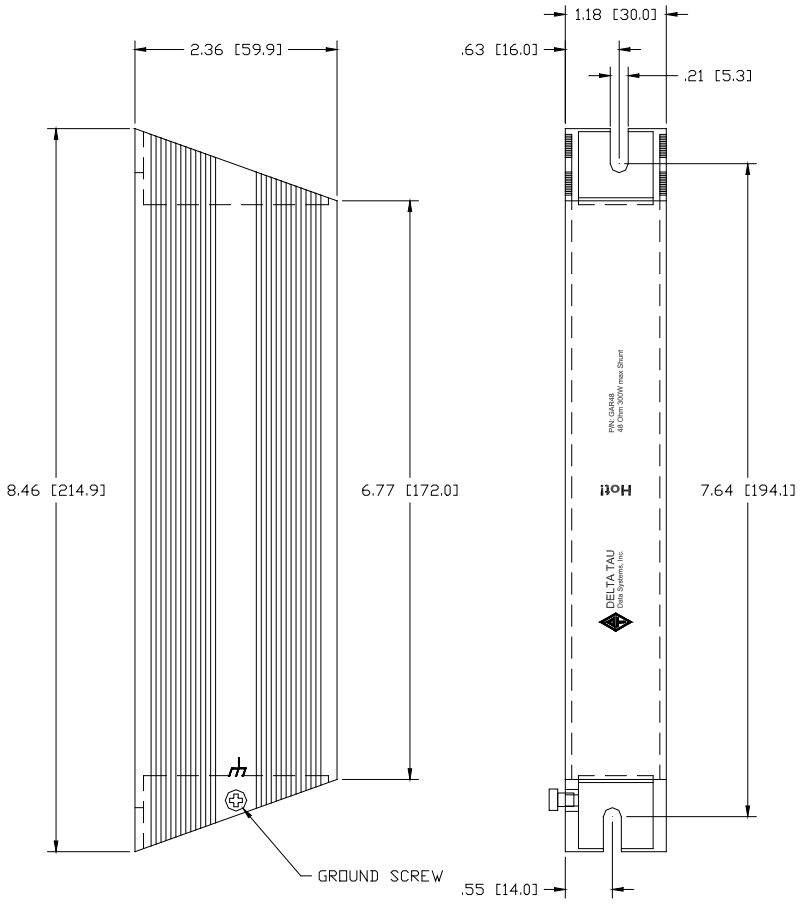
| Model | Ω | W | Peak Power(W) | Pins | Shunt Resistor |
|---|---|---|---|---|---|
| GPL011 | 48 | 150 | 3,134 | 2 | GAR48 |
| GPL031 | 48 | 150 | 3,134 | 2 | GAR48 |
| GPL051 | 22 | 300 | 6,839 | 2 | GAR22 |
| GPL101 | 22 | 300 | 6,839 | 2 | GAR22 |
| GPL151 | 10 | 300 | 15,045 | 2 | GAR10-2 |
| GPL201 | 10 | 300 | 15,045 | 3 | GAR10-3 |
| GPL301 | 10 | 300 | 15,045 | 3 | GAR10-3 |
| GPL012 | 48 | 150 | 3,134 | 2 | GAR48 |
| GPL032 | 48 | 150 | 3,134 | 2 | GAR48 |
| GPL052 | 22 | 300 | 6,839 | 2 | GAR22 |
| GPL102 | 22 | 300 | 6,839 | 2 | GAR22 |
| GPL152 | 10 | 300 | 15,045 | 2 | GAR10-2 |

| Model | Ω | W | Peak Power(W) | Pins | Shunt Resistor |
|---|---|---|---|---|---|
| GPH011 | 78 | 150 | 7,971 | 2 | GAR78 |
| GPH031 | 78 | 150 | 7,971 | 2 | GAR78 |
| GPH051 | 78 | 150 | 7,971 | 2 | GAR78 |
| GPH101 | 48 | 300 | 12,455 | 2 | GAR48 |
| GPH151 | 22 | 300 | 27,175 | 2 | GAR22 |
| GPH201 | 15 | 300 | 39,856 | 3 | GAR15-3 |
| GPH301 | 15 | 300 | 39,856 | 3 | GAR15-3 |
| GPH012 | 78 | 150 | 7,971 | 2 | GAR78 |
| GPH032 | 78 | 150 | 7,971 | 2 | GAR78 |
| GPH052 | 48 | 150 | 12,455 | 2 | GAR48 |
| GPH102 | 48 | 150 | 12,455 | 2 | GAR48 |
| GPH152 | 22 | 300 | 27,175 | 2 | GAR22 |



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Shunt Resistor Layout

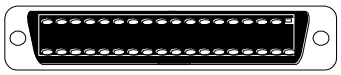





Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## X1 – X2: PWM Connectors

This mini D36 connector provides the interface to the PWM output channel from the controller (PMAC).

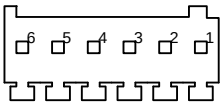
| X1 – X2: 36-Pin Mini-D Connector | | |  | |
|---|---|---|---|---|
| **Pin#** | **Symbol** | **Function** | **Description** | **Notes** |
| 1 | Reserved | | | |
| 2 | Reserved | | | |
| 3 | ADC_CLK1+ | Command | A/D converter clock | |
| 4 | ADC_STB1+ | Command | A/D converter strobe | |
| 5 | CURRENT1A+ | Feedback | Phase A actual current data | Serial digital |
| 6 | CURRENT1B+ | Feedback | Phase B actual current data | Serial digital |
| 7 | AENA1+ | Command | Amplifier enable | High is enable |
| 8 | FAULT1+ | Feedback | Amplifier fault | High is fault |
| 9 | PWMATOP1+ | Command | Phase A top cmd | High is on command |
| 10 | PWMABOT1+ | Command | Phase A bottom cmd | High is on command |
| 11 | PWMBTOP1+ | Command | Phase B top cmd | High is on command |
| 12 | PWMBBOT1+ | Command | Phase B bottom cmd | High is on command |
| 13 | PWMCTOP1+ | Command | Phase C top cmd | High is on command |
| 14 | PWMCBOT1+ | Command | Phase C bottom cmd | High is on command |
| 15 | GND | Common | Reference voltage | |
| 16 | +5V | Power | +5V Power | From controller |
| 17 | Reserved | | | |
| 18 | Reserved | | | |
| 19 | Reserved | | | |
| 20 | Reserved | | | |
| 21 | ADC_CLK1- | Command | A/D converter clock | |
| 22 | ADC_STB1- | Command | A/D converter strobe | |
| 23 | CURRENT1A- | Feedback | Phase A actual current DATA | Serial digital |
| 24 | CURRENT1B- | Feedback | Phase B actual current DATA | Serial digital |
| 25 | AENA1- | Command | Amplifier enable | Low is enable |
| 26 | FAULT1- | Feedback | Amplifier fault | Low is fault |
| 27 | PWMATOP1- | Command | Phase A top cmd | Low is on command |
| 28 | PWMABOT1- | Command | Phase A bottom cmd | Low is on command |
| 29 | PWMBTOP1- | Command | Phase B top cmd | Low is on command |
| 30 | PWMBBOT1- | Command | Phase B bottom cmd | Low is on command |
| 31 | PWMCTOP1- | Command | Phase C top cmd | Low is on command |
| 32 | PWMCBOT1- | Command | Phase C bottom cmd | Low is on command |
| 33 | GND | Common | Reference Voltage | |
| 34 | +5V | Power | +5V Power | From controller |
| 35 | Reserved | | | |
| 36 | Reserved | | | |



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## X3: Discrete I/O for Motor Thermals

This 6-pin Phoenix Contact terminal block provides connectivity to low impedance 12 – 24 VDC motor thermostat overload detection. This is a normally closed contact, in normal mode operation the Geo direct PWM Drive expects to see 12 – 24 VDC coming into Pins #1 and #3 respectively for motors 1 and 2.

| **X3: Phoenix 6-Pin TB Female**<br>**Mating: Phoenix 6-pin TB Male** | | |  |
|---|---|---|---|
| **Pin #** | **Symbol** | **Function** | **Description** |
| 1 | MTR1 PTC | Input | Motor 1 thermal |
| 2 | MTR 1 PTC RTN | Return | |
| 3 | MTR2 PTC | Input | Motor 2 thermal |
| 4 | MTR2 PTC RTN | Return | |
| 5 | 24V RET | Common | |
| 6 | N.C. | Not Connected | |
| Part Type: FKMC 0,5/6-ST-2,5<br>Phoenix Contact p/n: 1881367 | | | |



***Note***

If nothing is wired fault codes **5** and **A** are triggered respectively for motors 1 and 2. Tie MTR PTC and MTR PTC RET to disable this function.



***Note***

These contacts can be used for other general purpose safety functions to kill motor power when desired.



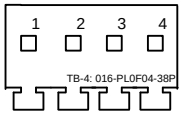
Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## X4: Safety Relay

This 4-pin Phoenix Contact Terminal Block provides connectivity to a safety relay input, and

If the Safety Relay option is installed, there is a dedicated Safety Input @24VDC (user supplied). When the Safety Input is asserted, then the hardware will cut the 20V power to the gate driver which will prevent all output from the power stage (the Gate Enable LED will turn off).

If the user doesn't need to use the Safety Input and the drive has it installed, the user has to bypass it by wiring a 24VDC input to WA (pin 1) and the return (24VDC) to WB (pin 2).

| **X4: Phoenix Contact 4-Pin TB Female<br>Mating: Phoenix Contact 4-Pin TB Male** | | |  |
|---|---|---|---|
| **Pin #** | **Symbol** | **Function** | **Description** |
| 1 | RELAY WA | Input | Safety Input 24V |
| 2 | RELAY WB | Input | Safety Input Return |
| 3 | RELAY COM | Common | |
| 4 | RELAY N/O | Relay | Normally Open |



***Note***

There are no software configurable parameters to enable/disable or otherwise manipulate the Safety Input functionality.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# POWER ON/OFF PROCEDURES



***Caution***

Changing the ADC clock on the controller (PMAC) side requires recycling power on the Geo Direct PWM Drive.



***Caution***

Main bus power should NEVER be applied if the 24V logic power is NOT applied.



***Caution***

Make sure that no motor commands (e.g. phasing, jogging, or open loop) are being executed by or sent by the controller (PMAC) at the time of applying main bus power.

- **Powering up** the Geo Direct PWM Drive must obey the following procedure:

1. Make sure that PMAC is powered up, and that the PWM cable is connected
2. Apply 24V logic power to the Geo Direct PWM Drive
3. Wait a minimum of ~3 seconds
4. Apply main bus power
5. Wait ~ 3seconds before enabling the drive (motor)

- **Powering down** the Geo Direct PWM Drive must obey the following procedure:

1. Disconnect main bus power
2. Wait a minimum of ~5 seconds
3. Disconnect 24V logic power

## Cycling Main Bus Power



***Caution***

Main bus power should NEVER be applied or cycled if the 24V logic power is NOT applied.

Cycling main bus power must obey the following warning restrictions. A delay should be inserted in either software, hardware or both to ensure that these restrictions are conformed.



***Caution***

Do NOT to cycle main bus power frequently and rapidly within a few seconds.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

If the main bus power is removed (i.e. E-Stop condition), it is necessary to keep it off until the Bus LED is turned off or dimmed completely. About 5-6 minutes. This ensures that the capacitors' voltage has dropped below 97 VAC and that the soft start circuitry has been armed.



***Caution***

Main bus power should Not be recycled within a time range of about ~ **5 minutes.**



***Note***

With the GPx201 and GPx301 models, it is possible to use the external shunt resistor as a bleeding resistor to avoid the downtime delay. Contact Delta Tau for details.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# PWM FREQUENCY

The minimum PWM frequency of a system is based on the time constant of the motor. In general, the lower the time constant, the higher the PWM frequency should be. The motor time constant is calculated dividing the motor inductance by the resistance (phase-phase). The minimum PWM Frequency is then determined using the following relationship:

$$\tau_{sec} = \frac{L_H}{R_\Omega} \quad ; \quad \tau_{sec} > \frac{20}{2 \times \Pi \times f_{PWM}}$$

$$\Rightarrow \boxed{f_{PWM}(Hz) > \frac{20 \times R_\Omega}{2 \times \Pi \times L_H}}$$

**Example:** A motor with an inductance of 6.1 millihenries (mH), and a resistance of 11.50 Ohms (Ω phase-phase) yields a time constant of 0.53 milliseconds. Therefore, the minimum PWM Frequency is about ~6000Hz (6.0 KHz).



***Note***

Systems with very low time constants (needing higher PWM frequencies) may require the addition of chokes or in-line inductive loads to obtain a good current loop bandwidth.



***Note***

The maximum PWM frequency for each model of the Geo Direct PWM Drives is listed in the electrical specifications.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# POWER PMAC3 DRIVE SETUP



*Caution*

The ADC Strobe Word, **Gate3[i].AdcAmpStrobe**, must be set to **$FFFFFC** for proper operation in default mode. Failure to do so could result in damage to the amplifier.

## Key Gate Parameters

The following Gate-specific parameters are essential for the proper software setup of the Geo Direct PWM Drive:

| Structure Element | Description | Typical/Default | Notes |
|---|---|---|---|
| Sys.WpKey | PMAC3 Write Protection | 0 | $AAAAAAAA to allow writing |
| Gate3[i].PhaseFreq | Phase Frequency | 9000 | 9.00 KHz Phase |
| Gate3[i].ServoClockDiv | Servo clock divider | 3 | 2.25 KHz Servo |
| Gate3[i].HardwareClockCtrl | Hardware Clocks | $55555403 | 2.50 MHz ADC Clock |
| Sys.ServoPeriod | =1000*(Gate3[i].ServoClockDiv+1)/Gate3[i].PhaseFreq | | |
| Sys.PhaseOverServoPeriod | = 1 /(Gate3[i].ServoClockDiv + 1) | | |
| Gate3[i].AdcAmpStrobe | ADC Strobe Word | **$FFFFFC** | Default Mode |
| Gate3[i].Chan[j].OutputMode | Output mode | **0** | PWM output |



*Note*

Sys.ServoPeriod and Sys.PhaseOverServoPeriod must be re-computed if the main clocks (Phase, and Servo) are changed.



*Note*

The above settings require a **Save** and a Reset (**$$$**) on the PMAC side in order to take effect.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Key Channel Parameters

The following channel-specific parameters are essential for the proper software setup of the Geo Direct PWM Drive:

| Structure Element | Description | Typical/Default | Notes |
|---|---|---|---|
| Gate3[i].Chan[j].PwmFreqMult | PWM Frequency | 0 | 4.5 KHz PWM |
| Motor[x].ServoCtrl | Activate channel | 1 | |
| Motor[x].PhaseCtrl | Commutation enable | 1 | With PackInData = 0 |
| Motor[x].PhaseOffset | Commutation Phase angle | **-683** | **-512** for Brush Motor |
| Motor[x].pAdc | Current Feedback Address | Pointer | Initiated by the firmware |
| Motor[x].AdcMask | ADC Mask | **$FFF00000** | |
| Motor[x].PwmSf | PWM Scale Factor | = 0.9 * 16384 | Voltage limiter |
| Motor[x].I2TSet | Continuous current limit | To be Computed | Motor $I^2T$ protection |
| Motor[x].I2TTrip | Integrated current limit | | Motor $I^2T$ protection |
| Motor[x].MaxDac | Maximum command output | | Current limiter |
| Motor[x].IiGain | Integral | Current Loop Tuning | |
| Motor[x].IpfGain | Forward path proportional | | |
| Motor[x].IpbGain | Back-path proportional | | |



***Note***

A **Save** and a Reset (**$$$**) is necessary for these parameters to take effect.

- Motor[x].PwmSf is calculated based on the motor and bus voltages

  If the Motor Rated Voltage is greater than > Bus Voltage:
  Motor[x].PwmSf = 0.9 * 16384

  If the Motor Rated Voltage is less than < Bus Voltage:
  Motor[x].PwmSf = 0.9 * 16384 * $V_{Motor}/V_{Bus}$

- I2T Settings **Example:**

```
GLOBAL  ContCurrent = 3;       // RMS Continuous Current Limit [Amps] -User Input
GLOBAL  PeakCurrent = 9;       // RMS Instantaneous Current Limit [Amps] -User Input
GLOBAL  MaxADC = 16.26;        // =16.26 for 5/10A  -User Input, see electrical specs
GLOBAL  I2TOnTime = 2;         // Time allowed at peak Current [sec] -User Input

Motor[1].MaxDac = (PeakCurrent / MaxADC) * 32767 * COSD(30)
Motor[1].I2tSet = (ContCurrent / MaxADC) * 32767 * COSD(30)
Motor[1].I2tTrip = (POW(Motor[1].MaxDac,2) - POW(Motor[1].I2tSet,2)) * I2TOnTime
```



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com



***Caution***

Trying to enable the Geo Direct PAM Drive with misreported current data could result in damaging the electronics of the Drive.

At this point of the drive-motor setup, and before tuning the current loop, a couple of sanity checks can be performed, making sure that:

- Enabling the drive with a #nOut0 command does not produce any faults in neither the drive nor the PMAC.
- The current sensors are operating properly by monitoring the current measurements (i.e. Motor[x].IaMeas, and Motor[x].IbMeas). These should be reporting values fluctuating around 0. Frozen values, or values greater than 1000 indicate that the current sensors are not functioning properly, or a software parameter is incorrect (i.e. Gate3[i].AdcAmpStrobe, Motor[x].PhaseOffset, Motor[x].AdcMask)

Subsequently, the current loop (Motor[x].IiGain, Motor[x].IpfGain, and Motor[x].IpbGain) can be tuned using the tuning utility in the IDE software. Commutation, encoder feedback, phasing, and position loop tuning can then be configured for closed loop control.



***Note***

Complete closed loop setup procedure can be found in the pertaining hardware axis-interface, and Power PMAC User/Software Reference manuals.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# POWER PMAC2 DRIVE SETUP



*Caution*

The ADC Strobe Word, **Gate1[i].AdcStrobe**, must be set to $3FFFFF for proper operation in default mode. Failure to do so could result in damage to the amplifier.

## Key Gate Parameters

The following Gate-specific parameters are essential for the proper software setup of the Geo Direct PWM Drive:

| Structure Element | Description | Typical/Default | Notes |
|---|---|---|---|
| Gate1[i].PwmPeriod | PWM Frequency | 6527 | 4.50 KHz PWM |
| Gate1[i].PhaseClockDiv | Phase clock divider | 0 | 9.00 KHz Phase |
| Gate1[i].ServoClockDiv | Servo clock divider | 3 | 2.25 KHz Servo |
| Gate1[i].HardwareClockCtrl | Hardware Clocks | 2258 | 2.50 MHz ADC Clock |
| Sys.ServoPeriod | = 1000 * (Gate1[4].ServoClockDiv + 1) / 18000 | | |
| Sys.PhaseOverServoPeriod | = 1 / (Gate1[4].ServoClockDiv + 1) | | |
| Gate1[i].AdcStrobe | ADC Strobe Word | **$3FFFFF** | Default Mode |
| Gate1[i].Chan[j].OutputMode | Output mode | **0** | PWM output |



*Note*

Sys.ServoPeriod and Sys.PhaseOverServoPeriod must be re-computed if the main clocks (Phase, PWM, and Servo) are changed.



*Note*

The above settings require a **Save** and a Reset (**$$$**) on the PMAC side in order to take effect.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Key Channel Parameters

The following channel-specific parameters are essential for the proper software setup of the Geo Direct PWM Drive:

| Structure Element | Description | Typical/Default | Notes |
|---|---|---|---|
| Motor[x].ServoCtrl | Activate channel | 1 | |
| Motor[x].PhaseCtrl | Commutation enable | 1 | |
| Motor[x].PhaseOffset | Commutation Phase angle | **683** | **512** for Brush Motor |
| Motor[x].pAdc | Current Feedback Address | Pointer | Initiated by the firmware |
| Motor[x].AdcMask | ADC Mask | **$FFF000** | |
| Motor[x].PwmSf | PWM Scale Factor | = 0.9 * Gate1[i].PwmPeriod | Voltage limiter |
| Motor[x].I2TSet | Continuous current limit | To be computed | Motor $I^2T$ protection |
| Motor[x].I2TTrip | Integrated current limit | | Motor $I^2T$ protection |
| Motor[x].MaxDac | Maximum command output | | Current limiter |
| Motor[x].IiGain | Integral gain | Current Loop Tuning | |
| Motor[x].IpfGain | Forward path proportional gain | | |
| Motor[x].IpbGain | Back-path proportional gain | | |



***Note***

A **Save** and a Reset (**$$$**) is necessary for these parameters to take effect.

- Motor[x].PwmSf is calculated based on the motor and bus voltages

  If the Motor Rated Voltage is greater than > Bus Voltage:
  Motor[x].PwmSf = 0.9 * Gate1[i].PwmPeriod

  If the Motor Rated Voltage is less than < Bus Voltage:
  Motor[x].PwmSf = 0.9 * Gate1[i].PwmPeriod * $V_{Motor}/V_{Bus}$

- I2T Settings **Example:**

```
GLOBAL  ContCurrent = 3;        // RMS Continuous Current Limit [Amps] -User Input
GLOBAL  PeakCurrent = 9;        // RMS Instantaneous Current Limit [Amps] -User Input
GLOBAL  MaxADC = 16.26;         // = 16.26 for 5/10A  -User Input, see electrical specs
GLOBAL  I2TOnTime = 2;          // Time allowed at peak Current [sec] -User Input

Motor[1].MaxDac = (PeakCurrent / MaxADC) * 32767 * COSD(30)
Motor[1].I2tSet = (ContCurrent / MaxADC) * 32767 * COSD(30)
Motor[1].I2tTrip = (POW(Motor[1].MaxDac,2) - POW(Motor[1].I2tSet,2)) * I2TOnTime
```



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com



***Caution***

Trying to enable the Geo Direct PAM Drive with misreported current data could result in damaging the electronics of the Drive.

At this point of the drive-motor setup, and before tuning the current loop, a couple of sanity checks can be performed, making sure that:

- Enabling the drive with a #nOut0 command does not produce any faults in neither the drive nor the PMAC.
- The current sensors are operating properly by monitoring the current measurements (i.e. Motor[x].IaMeas, and Motor[x].IbMeas). These should be reporting values fluctuating around 0. Frozen values, or values greater than 1000 indicate that the current sensors are not functioning properly, or a software parameter is incorrect (i.e. Gate1[i].AdcStrobe, Motor[x].PhaseOffset, Motor[x].AdcMask)

Subsequently, the current loop (Motor[x].IiGain, Motor[x].IpfGain, and Motor[x].IpbGain) can be tuned using the tuning utility in the IDE software. Commutation, encoder feedback, phasing, and position loop tuning can then be setup for closed loop control.



***Note***

Complete closed loop setup procedure can be found in the pertaining hardware axis-interface, and Power PMAC User/Software Reference manuals.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# TURBO PMAC2 DRIVE SETUP



***Caution***

The ADC Strobe Word, I7m06 ($C014 in Non-Turbo PMAC), must be set to $3FFFFF for proper operation in default mode. Failure to set I7m06 equal to $3FFFFF could result in damage to the amplifier.

## Key Gate Parameters

The following Gate-specific parameters are essential for the proper software setup of the Geo Direct PWM Drive:

| Turbo | Non-Turbo | Description | Typical/Default | Notes |
|---|---|---|---|---|
| I7m00 | I900 | Max phase clock | 6527 | 4.50 KHz PWM |
| I7m01 | I901 | Phase clock divider | 0 | 9.00 KHz Phase |
| I7m02 | I902 | Servo clock divider | 3 | 2.25 KHz Servo |
| I7m03 | I903 | Hardware Clocks | 2258 | 2.50 MHz ADC Clock |
| I10 | I10 | Servo interrupt time | 3713991 | |
| I7m06 | X:$C014 | ADC Strobe Word | **$3FFFFF** | Default Mode |
| I7mn6 | I9n6 | Output mode | **0** | PWM output |



***Note***

Non-Turbo ADC Strobe words are at addresses X:$C0**1**4 for axis 1-4 (1st PMAC2 Gate), and X:$C0**2**4 for axis 5-8 (2nd PMAC2 Gate).



***Note***

The servo interrupt time I10 must be re-computed if the main clocks (Phase, PWM, and Servo) are changed.



***Note***

The above settings require a **Save** and a Reset (**$$$**) on the PMAC side in order to take effect.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Key Channel Parameters

The following channel-specific parameters are essential for the proper software setup of the Geo Direct PWM Drive:

| Variable | Description | Typical/Default | Notes |
|---|---|---|---|
| Ixx00 | Activate channel | 1 | |
| Ixx01 | Commutation enable | 1 | |
| Ixx72 | Commutation Phase angle | **683** | **512** for Brush Motor |
| Ixx82 | Current Feedback Address | Address Location | Found in the SRM Manual |
| Ixx84 | ADC Mask | **$FFF000** | |
| Ixx66 | PWM Scale Factor | = 0.9 * I7m00 | Voltage limiter |
| Ixx57 | Continuous current limit | To be computed | Motor $I^2T$ protection |
| Ixx58 | Integrated current limit | | Motor $I^2T$ protection |
| Ixx69 | Maximum command output | | Current limiter |
| Ixx61 | Integral gain | Current Loop Tuning | |
| Ixx62 | Forward path proportional gain | | |
| Ixx76 | Back-path proportional gain | | |



*Note*

A **Save** and a Reset (**$$$**) is necessary for these parameters to take effect.

- Ixx82 Turbo PMAC2 UMAC addresses (first 8 channels)

| | | | |
|---|---|---|---|
| Channel 1 | $078206 | Channel 5 | $078306 |
| Channel 2 | $07820E | Channel 6 | $07830E |
| Channel 3 | $078216 | Channel 7 | $078316 |
| Channel 4 | $07821E | Channel 8 | $07831E |

- Ixx66 is calculated based on the motor and bus voltages
  If the Motor Rated Voltage is greater than > Bus Voltage: Ixx66 = 0.9 * I7000
  If the Motor Rated Voltage is less than < Bus Voltage: Ixx66 = 0.9 * I7000 * $V_{Motor}/V_{Bus}$



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

- I2T Settings, Ixx57, Ixx58, and Ixx69 **Example:**

```
#define ServoClk        2.258   ; Servo Clock [KHz]—computed in Dominant Clock Settings Section
#define ContCurrent     3       ; Continuous Current Limit [Amps] -User Input
#define PeakCurrent     9       ; Instantaneous Current Limit [Amps] -User Input
#define MaxADC          16.26   ; =16.26 for 5/10A  -User Input, see electrical specs
#define I2TOnTime       2       ; Time allowed at peak Current [sec] -User Input

I157 = INT(32767*(ContCurrent*1.414/MaxADC)*cos(30))
I169 = INT(32767*(PeakCurrent*1.414/MaxADC)*cos(30))
I158 = INT((I169*I169- I157*I157)*ServoClk*1000*I2TOnTime/(32767*32767))
```



***Caution***

Trying to enable the Geo Direct PAM Drive with misreported current data could result in damaging the electronics of the Drive.

At this point of the drive-motor setup, and before tuning the current loop, a couple of sanity checks can be performed, making sure that:

- Enabling the drive with a #nO0 command does not produce any faults in neither the drive nor PMAC.
- The current sensors are operating properly by monitoring the current measurements (i.e. Mxx05, and Mxx06). These should be reporting value fluctuating around 0. Frozen values, or values greater than 1000 indicate that the current sensors are not functioning properly, or a software parameter is incorrect (i.e. I7m06, Ixx72, Ixx84)

Subsequently, the current loop (Ixx61, Ixx62, and Ixx76) can be tuned using the tuning utility in the Pewin32Pro2 software. Commutation, encoder feedback, phasing, and position loop tuning can then be setup for closed loop control.



***Note***

Complete closed loop setup procedure can be found in the pertaining hardware axis-interface, and Turbo User/Software reference manuals.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# DRIVE COMMAND STRUCTURE

## Default Mode

In default mode, the Geo Direct PWM Drive returns phases A and B current measurements as well as global and axis faults.



***Caution***

Failure to set the ADC strobe word correctly could result in damaging the drive's electronics.

The global and axes faults are in the lower 12 bits of ADC A, whereas the current measurements are in the upper 12bits of ADC A:

| **ADC A Data Register** | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| **Phase A Current Measurement** | | | | | | | | | | | | **Global and Axis Faults** | | | | | | | | | | | |

The ADC Strobe word must be set up properly for the data to come back correctly (and proper operation):

| PMAC Type | ADC Strobe Word | Value | ADC A data register |
|---|---|---|---|
| Non-Turbo | WX:$C0***1***4 | $3FFFFF | Y:$C005 |
| Turbo | I7***m***06 | $3FFFFF | Mxx05 |
| Power PMAC2 | Gate1[***i***].AdcStrobe | $3FFFFF | Gate1[*i*].Chan[*j*].Adc[**0**] |
| Power PMAC3 | Gate3[***i***].AdcAmpCtrl | $FFFFFC02 | Gate3[*i*].Chan[*j*].AdcAmp[**0**] |



***Note***

In normal mode operation, the ADC Strobe word has to be set for each Servo IC which has a PWM Drive attached to it.



***Note***

The ADC Strobe word can be saved with the SAVE command. It will be set automatically on the next power-up or normal reset.



***Note***

In default mode, ADC B does not contain any significant data.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Enhanced Mode

Enhanced mode enables access to and control of additional functions:

- Bus voltage reading
- IGBT temperature(s) reading
- Set PWM control for brush motor
- Turn Line Monitor off



***Caution***

The drive must be put in enhanced mode before accessing the additional functions.



***Caution***

Once the drive is set up for enhanced mode, do not set it back to default mode until the next logic power cycle.

| PMAC Type | ADC Strobe Word | Enhanced mode | Additional Functions | | | |
|---|---|---|---|---|---|---|
| | | | IGBT Temp | Bus Voltage | PWM For Brush | Line Monitor Off |
| Non-Turbo | WX:$C0*1*4 | $C00003 | $800003 | $880003 | $A00013 | $A00023 |
| Turbo | I7***m***06 | | | | | |
| Power PMAC2 | Gate1[***i***].AdcStrobe | | | | | |
| Power PMAC3 | Gate3[***i***].AdcAmpCtrl | $C0000204 | $80000204 | $88000204 | $A0001204 | $A0002204 |

With Power PMAC3, setting the drive to enhanced mode requires the following motor setting changes:

- Motor[x].PhaseCtrl = 4
- Gate3[i].Chan[j].PackInData = 0
- Gate3[i].Chan[j].PackOutData = 0



***Note***

Once in enhanced mode, the drive's communication will remain in enhanced mode until the next logic power cycle.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

And the data is found in the lower 12 bits of ADC B for each axis:

| PMAC Type | ADC B data register |
|---|---|
| Non-Turbo | Y:$C006 |
| Turbo | Mxx06 |
| Power PMAC2 | Gate1[*i*].Chan[*j*].Adc[**1**] |
| Power PMAC3 | Gate3[*i*].Chan[*j*].AdcAmp[**1**] |

| **ADC B Data Register** | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Phase B Current Measurement | | | | | | | | | | | | Enhanced Mode Data | | | | | | | | | | | |

This is a read-modify-write register, once the drive is set up for enhanced mode, the following procedure can be followed to access additional information:

- Read the ADC B data register (i.e. query it in the terminal window)
- Set the strobe word to the desired command code of a function (i.e. Reading Bus Voltage)
- Read the lower 12 bits of ADC B to access the reported bus voltage value



***Note***

Subsequent additional information command code must follow the same procedure with the drive always in enhanced mode until the next logic power cycle.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

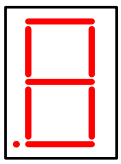
# TROUBLESHOOTING

## LED Status

| LED | Description |
|---|---|
| ENABLE 1 | ➢ **Green** when axis 1 is enabled<br>➢ **Red** when axis 1 is not enabled<br>➢ **Unlit** does not necessarily mean a faulty condition |
| ENABLE 2 | ➢ **Green** when axis 2 is enabled<br>➢ **Red** when axis 2 is not enabled<br>➢ **Unlit** does not necessarily mean a faulty condition |
| BUS | ➢ **Red** when bus is connected (capacitors are charged)<br>➢ **Unlit** when bus is not connected (capacitors fully discharged) |
| SHUNT | ➢ **Yellow** when the drive is dissipating power<br>➢ **Unlit** when the drive is not dissipating (most cases) |
| +5V | ➢ **Green** when 5 VDC power is present<br>➢ **Unlit** indicates that the 5VDC is not present (failure condition) |
| GATE ENABLE | ➢ **Green** when the gate is enabled<br>➢ **Unlit** when the gate is disabled |

## 7-Segment Display

The Global and Axis faults are interpreted by the Amplifier processor(s) and sent to the 7-segment 3-character scrolling display (D1 amp status).



The blinking dot is the heartbeat of the drive processor(s) and is always active in normal mode operation. It is turned off or not blinking when the drive is in reset mode (reloading firmware) or has no logic power.

The display is blank if there are no axes enabled, and no faults. It shows a 0 if any of the axes are enabled, this is the normal mode operation. Not all errors reflect a message back to the PMAC. In these cases, the error is only sent to the Status Display.



***Note***

The Geo Drive disables (kills the output to the motors) automatically at the occurrence of a fault.

The response of the Geo Drive to an error depends on the error's severity. There are two levels of severity:

- Warnings, simply called errors and not considered faults. They do not disable operation.
- Fatal errors which disable the drive's output to the motors, occasionally communication to PMAC



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Error Codes

| Display Code | | Error / Fault Description | Description |
|---|---|---|---|
| AXIS 1 | AXIS 2 | | |
|  |  | Over Current RMS | Indicates that the I2T model, hard-coded in the amplifier processor projecting current output over time, has been violated within the operating current specification range of the amplifier. |
|  |  | Over Current Peak | Indicates that an excessive amount of current (exceeding the specs of the amplifier) has been detected through the motor leads. This could be due to a shorted motor lead or a current/voltage surge. |
|  |  | PWM Over Frequency | Indicates that the PWM frequency has exceeded the permissible limit. This can occur if the clock settings are incorrect, or the presence of a bad PWM cable. |
|  |  | IGBT Over Temperature | Indicates excessive IGBT temperature (close to 75 ºC) has been detected. Power off the drive and let it cool down.<br>Check cabinet ventilation, and fan functionality. Check for blocked airflow. |
|  |  | Motor Thermal Relay | Indicates that the normally closed Motor Thermal contact (connector X3) is in open circuit. |



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

| Display Code | Error / Fault Description | Troubleshooting Notes |
|---|---|---|
| | | **GLOBAL** |
|  | Normal Mode Operation | ➢ No faults reported |
|  | Over Voltage | ➢ The bus voltage has exceeded the permissible threshold:<br>420 VAC for GPL Drives<br>820 VAC for GPH Drives<br>➢ Make sure that the external shunt is connected properly.<br>➢ Make sure that the AC input is not excessively over spec. |
|  | Under Voltage | ➢ No bus voltage input.<br>➢ Bus voltage has dropped below the permissible threshold (97 VAC). |
|  | Shunt Regulator | ➢ Shunt resistor leads or pins shorted.<br>➢ Internal shunt regulator resistor failure. |
|  | Ground Short | ➢ Motor leads shorted.<br>➢ Shunt resistor leads or pins shorted. |
|  | Gate Driver | ➢ Motor leads shorted<br>➢ Shunt leads or pins shorted<br>➢ Gate driver (internal) failure. |
|  | Line Monitor | ➢ AC line voltage is low or not present. |



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

# APPENDIX A: CABLE/CONNECTOR KITS

## PWM Cables

| Option | Cable Length | Part Number |
|---|---|---|
| CABPWM-1 | 24” (600 mm) | 200-602739-024X |
| CABPWM-2 | 36” (900 mm) | 200-602739-036x |
| CABPWM-3 | 60” (1.5 m) | 200-602739-060x |
| CABPWM-4 | 72” (1.8 m) | 200-602739-072x |
| CABPWM-5 | 84” (2.1 m) | 200-602739-084x |
| CABPWM-6 | 144” (3.6 m) | 200-602739-144x |



***Note***

PWM cables are compatible with all models of the Geo Direct PWM Drives.

## Connector Kits

| Part Number | Model | Description |
|---|---|---|
| CONKIT1A | Gxx012xx<br>Gxx032xx<br>Gxx052xx<br>GxL102xx | Molex Connectors for **2** axes, AC input, and 24 VDC input. |
| CONKIT1C | Gxx051xx | Molex Connectors for **1** axis, AC input, and 24 VDC input. |
| CONKIT2A | GxH102xx<br>Gxx152xx | Molex Connectors for **2** axes, AC input, and 24 VDC input. |
| CONKIT2C | Gxx101xx<br>Gxx151xx | Molex Connectors for **1** axis, AC input, and 24 VDC input. |
| CONKIT4A | Gxx201xx<br>Gxx301xx | Molex Connectors for **1** axis (4 pins), AC input (4 pins), and 24 VDC input. |



***Note***

The connector kits require Molex Crimping tools for proper installation.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

## Cable Kits

| Part Number | Model | Description |
|---|---|---|
| CABKIT1B | Gxx012xx<br>Gxx032xx<br>Gxx052xx<br>GxL102xx | Molex mating connectors pre-crimped for **2** axes:<br>➢ 3 ft. AC Input Cable<br>➢ 3 ft. 24 VDC Power Cable<br>➢ 10 ft. shielded Motor Cables |
| CABKIT1C | Gxx051xx | Molex mating connectors pre-crimped for **1** axis:<br>➢ 3 ft. AC Input Cable<br>➢ 3 ft. 24 VDC Power Cable<br>➢ 10 ft. shielded Motor Cables |
| CABKIT2B | GxH102xx<br>Gxx152xx | Molex mating connectors pre-crimped for **2** axes:<br>➢ 3 ft. AC Input Cable<br>➢ 3 ft. 24 VDC Power Cable<br>➢ 10 ft. shielded Motor Cables |
| CABKIT2D | Gxx101xx<br>Gxx151xx | Molex mating connectors pre-crimped for **1** axis:<br>➢ 3 ft. AC Input Cable<br>➢ 3 ft. 24 VDC Power Cable<br>➢ 10 ft. shielded Motor Cables |
| CABKIT4B | Gxx201xx<br>Gxx301xx | Molex mating connectors pre-crimped for **1** axis:<br>➢ 3 ft. AC Input Cable (4 pins)<br>➢ 3 ft. 24 VDC Power Cable<br>➢ 10 ft. shielded Motor Cables (4 pins) |
| G14AWG | Gxx051xx<br>Gxx101xx<br>Gxx151xx<br>Gxx012xx<br>Gxx032xx<br>Gxx052xx<br>Gxx102xx<br>Gxx152xx | Extended cable length. Per foot per cable for the CABKITs.<br>Customer must specify length. |



***Note***

Cable kits have terminated cables on the drive end and flying leads on the other.



Artisan Technology Group - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisantg.com

**Artisan Technology Group** is an independent supplier of quality pre-owned equipment

## Gold-standard solutions

Extend the life of your critical industrial, commercial, and military systems with our superior service and support.

## We buy equipment

Planning to upgrade your current equipment? Have surplus equipment taking up shelf space? We'll give it a new home.

## Learn more!

Visit us at **artisantg.com** for more info on price quotes, drivers, technical specifications, manuals, and documentation.

Artisan Scientific Corporation dba Artisan Technology Group is not an affiliate, representative, or authorized distributor for any manufacturer listed herein.

We're here to make your life easier. How can we help you today?

(217) 352-9330 | sales@artisantg.com | artisantg.com

ARTISAN® TECHNOLOGY GROUP