Modicon
Cyberline 1000A System
Design and Installation Manual

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Modicon, Inc., Industrial Automation Systems
One High Street
North Andover, MA 01845

Preface

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Modicon, Inc. assumes no responsibility for any errors that may appear in this document. If you have any suggestions for improvements or amendments or have found errors in this publication, please notify by using the form on the last page of this publication.

Caution All pertinent state, regional, and local safety regulations must be observed when installing and using this product.

Caution For reasons of safety and to ensure compliance with documented system data, repairs to components should be performed only by the manufacturer.

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Chapter 1
Introduction

- Who should read this manual
- How this manual is organized
- Related documents
- Warnings and hazards

Who Should Use this Manual

This manual is written for anyone at your site who is responsible for installing - mounting, wiring, powering up, testing, and maintaining -- your Cyberline 1000A (CL1000A) drive, and the servo system equipment with which it interfaces. You are expected to have some overall understanding of what your CL1000A drive does and how it will function in a motion control system. You are also expected to have some experience installing electronic equipment.

☞ **Note** This manual also documents the Modicon Cyberline PLS4 power supply, which powers Cyberline drives and Modicon controllers.

Be sure you read and understand the procedures and general information presented in this manual before installing your CL1000A. If you have questions, please consult your Modicon customer service representative.

How This Manual is Organized

This manual is organized as follows:

Chapter / Appendix	Description
Chapter 1 *Introduction*	Presents an introduction to this manual.
Chapter 2 *System Overview*	Presents descriptions of components that are supplied by Modicon and by the customer in a typical CL1000A system. Also presents some considerations for integrating system components.
Chapter 3 *Specifications*	Presents specifications for CL1000A drives and power supplies.
Chapter 4 *How To Install CL1000A Equipment*	Presents mounting information, including dimensions and installation hardware.
Chapter 5 *Wiring the System*	Presents wiring instructions showing how to connect system components.
Chapter 6 *Initial Power Up and Component Check*	Presents procedures for applying power to the system for the first time.
Chapter 7 *CL1000A and PLS4 Indicator Lights*	Presents descriptions of drive and power supply light emitting diode (LED) indicators.
Chapter 8 *Troubleshooting*	Presents decision tree flowcharts and test procedures.
Appendix A *Grounding and Noise Reduction*	Presents system grounding, shielding, and noise reduction information.
Appendix B *Sizing an Isolation Transformer*	Presents two methods for sizing an isolation transformer.
Appendix C *Parts List*	Presents descriptions and part numbers for system equipment related to the CL1000A drive.
Appendix D *System Wiring Diagrams*	Presents detailed system power wiring diagrams for typical CL1000A system configurations.

Related Documents

This manual contains all the information you will need to install, power up, and test your CL1000A system. It includes general descriptions of system components and their interfaces, step-by-step installation procedures, and many illustrations of system and component wiring.

The CL1000A drive is designed to be configured with single-axis motion controllers, such as MOT 20X motion modules and B885-1XX motion modules, and the 3220 and 3240 multi-axis controllers. Related documentation includes the following manuals:

- *Modicon MOT 201, 202 Motion Modules User Guide*, GI-BMOT-20X. This manual provides system wiring and installation information that is unique to these two compact motion controllers.

- Modicon B885-1XX system design and installation guides that cover system wiring and installation information that is unique to the B885-100, B885-01, B885-10, and B885-111 motion modules. These documents are:

  - *Modicon B885-100 Motion Module System Design and Installation Guide*, GI-B885-101

  - *Modicon B885-110 Motion Module System Design and Installation Guide*, GI-B885-110

  - *Modicon B885-101 and B885–-11 Motion Module Read-Me-First*, GI-B885-RMF

- *Modicon 3220 System Design and Installation Guide*, 2000–038

- *Modicon 3240 System Design and Installation Guide*, 2000–069

Warnings and Hazards

Read the following shock hazard information very carefully to ensure the safety of personnel at your site.

Warning SHOCK HAZARD! Lethal voltages exist at the connection points of Cyberline equipment. To avoid severe personal injury or death, the procedures in this manual should only be performed by skilled technical personnel. Such personnel should be familiar with safe industrial wiring practices.

Disconnect all power to the complete system before installing or removing parts.

All wiring must be in accordance with the National Electrical Code (NEC) or its national equivalent (CSA, CENELEC, etc.), as well as in accordance with all prevailing local codes.

Always make certain that the wire sizes used are adequate for the current they will carry.

Use only high-temperature rated copper wire, 75° C or greater.

Never operate Cyberline equipment with metal screens or covers removed. Lethal voltages exist within the equipment.

Exercise extreme caution when using instruments such as oscilloscopes, chart recorders or volt-ohm meters with equipment connected to line power. Special precautions must be exercised when one of the instrument leads is connected to the case or other metal parts of the instrument. If the case of the instrument is grounded, this lead may only be connected to grounded parts of the system. The instrument must be isolated and its metal parts treated as live equipment. Use of the instruments with both leads isolated from the chassis permits grounding of the chassis even when measurements are made between two live parts.

Ground the drive system common circuit at only one point: one central cabinet star connection. This, all motor bases, and other equipment enclosures should be connected to the factory or facility earth grounding system.

Read, understand, and heed all WARNINGs, Cautions, and other labels posted on the equipment.

Always read and understand the complete instructions before applying power to or troubleshooting the system. Follow the start-up procedure step-by-step.

These units have been short-circuit tested and found to be in compliance with applicable provisions of UL/CSA specifications for AC mains capable of delivering up to 5000 A RMS maximum.

Modicon recommends the installation of a safety interlock with separate contactors for each motor. Such a system should be hard wired with over travel limit switches and a self-sealing E-type button. Any interruption of this circuit or fault indication should:

- **Open the motor contactors**
- **Shunt dynamic braking resistors across each motor, if they are present**

Warning SEPARATE MOTOR OVERCURRENT, OVERLOAD AND OVERHEATING PROTECTION IS REQUIRED TO BE PROVIDED IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE, PART 1 and the National Electrical Code.

Avertissement LE MOTEUR DOIT ETRE MUNI D UNE PROTECTION DISTINCTE CONTRE LES SURINTENSITES, LA SURCHARGE ET LA SURCHAUFFE CONFIRMEMENT AU CODE CANADIAN DE L ELECTRICITE, PREMIERE PARTIE.

Chapter 2
System Overview

- Introduction
- CL1000A system overview
- System integration considerations

Introduction

This chapter presents an overview of the Modicon Cyberline 1000A (CL1000A) series drive and other components that make up a typical CL1000A system configuration.

Specifically, this chapter describes:

- CL1000A series drive
- Ready-made connection cables
- Circuit breakers and fuses
- PLS4 power supply
- Isolation transformers
- Mounting plate system
- Motor contactors
- Servo motors

Some important considerations for integrating system components are presented at the end of this chapter.

CL1000A System Overview

Cyberline 1000A (CL1000A) series drives are three-phase, pulse width modulated (PWM) current amplifiers designed specifically for Modicon brushless servo motors. Some CL1000A drive advantages include:

- CL1000A drives ensure reliability through design. An absolute minimum number of components reduces the chances of failure.
- Internal monitoring circuits can detect:
  - Motor faults
  - Short circuits
  - Summing errors in the current commands
  - High enclosure temperature
  - Internal circuitry faults
  - Loss of motor cable continuity
- The drive can disable the servo motor and alert the controller if any of the errors listed above is detected.
- A rugged metal enclosure provides excellent heat dissipation and protection against magnetic and radio interference.
- Through digital motor control, there are no potentiometers to adjust.
- Through modular series design, most CL1000A drives have the same dimensions for easy mounting.

During operation, a CL1000A drive receives current command vector signals from the controller. These commands are processed to provide the three-phase power for the servo motor.

Note The drive will attempt to provide whatever current levels the controller demands, so your controller and its limits (particularly IAVG) must be set correctly to motor specifications to prevent motor damage. Proper setting of the current limit parameters (IAVG, IPEAK) must be assured. Refer to your controller manual for the proper setting of IAVG.

CL1000A drives are available in five models, which control various sizes of Modicon servo motors. Each model must be configured with a PLS4 power supply, except the CL1060 drives, which have their own internal power supplies. The following table lists CL1000A model numbers, the PLS4 power supply, and their part numbers.

Cyberline CL1000A Drive Models, PLS4 Power Supply, and Part Numbers

Model	Part Number
CL1005 drive	DR-1005-000
CL1010 drive	DR-1010-000
CL1020 drive	DR-1020-000
CL1030 drive	DR-1030-000
CL1060 drive/power supply mounted on CPM mounting plate with 110 VAC fans	DR-1060-100
CL1060 drive/power supply mounted on CPM mounting plate with 220 VAC fans	DR-1060-200
CL1060W drive/power supply mounted on CWM mounting plate	DR-1060-300
PLS4 power supply	DR-PLS4-000

☞ **Note** For reliable operation, drives must be capable of providing adequate continuous and peak output currents for their particular servo motors and loads. See Chapter 3 *Specifications* for continuous and peak output current specifications for each drive model. Proper setting of the current limiting parameters must be assured. See your controller manual for the proper settings.

Figure 1 shows the CL1000A drive.

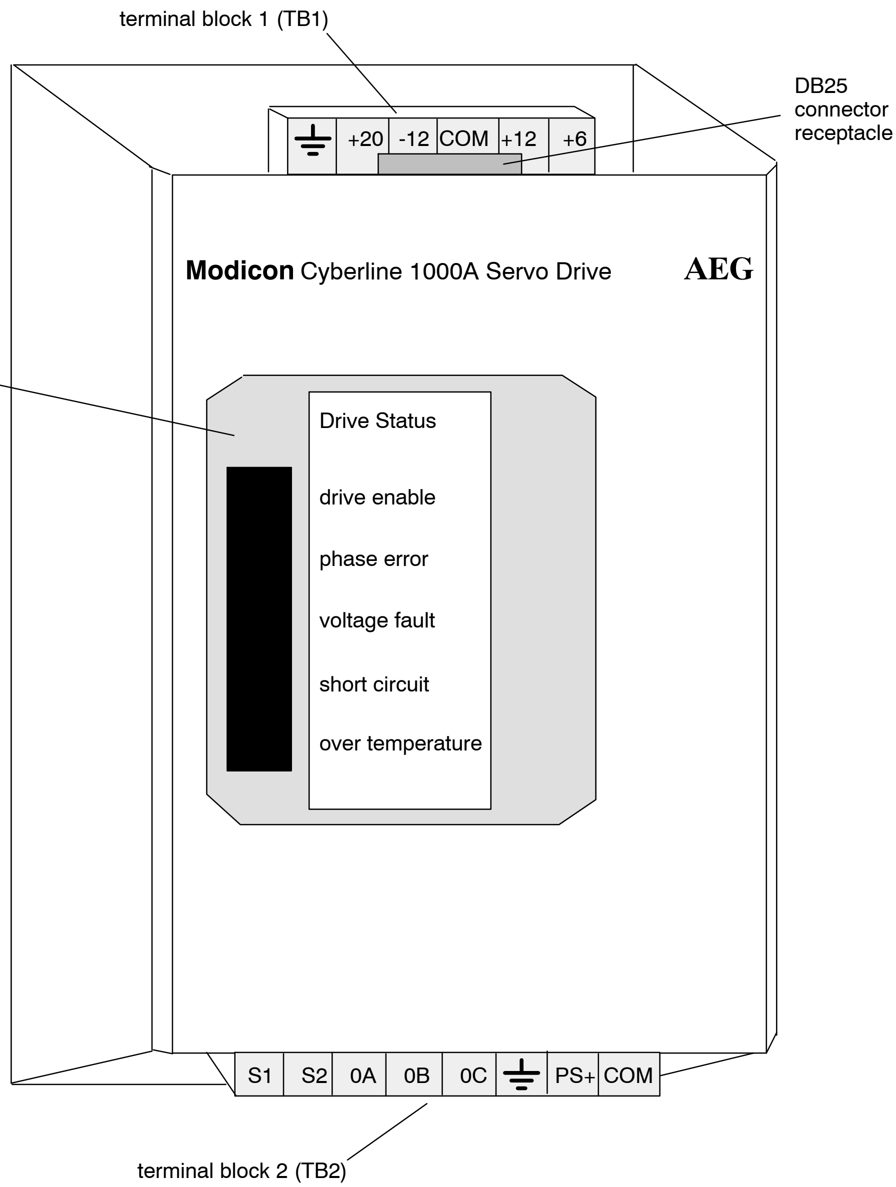


Figure 1 Modicon Cyberline CL1000A Series Drive

Overview of Ready-Made Connection Cables

Modicon offers cables designed to connect the CL1000A drives to the controller and to servo motors. Modicon signal cables are designed for maximum noise suppression, using shielded twisted pair design. All cables are equipped with the required connectors and are tested to Modicon s quality standards.

Overview of Circuit Breakers and Fuses

Power feeds and other power inputs to equipment housed in the mounting cabinet should always be wired to the isolation transformer through an adequate circuit breaker, or through fuses.

Overview of PLS4 Power Supply

The Cyberline model PLS4 power supply provides all of the required power for drive models CL1005, CL1010, CL1020, or CL1030. The CL1060 drive/power supply assembly has a built-in power supply, which resembles the PLS4, and does not require a PLS4. Each PLS4 has a shunt regulator equipped with an externally mounted shunt resistor, and is protected by the Regen fuse. This circuit is activated when the servo motor is generating energy on the DC bus.

The PLS4 monitors:

- Baseplate temperature
- DC bus activity and voltage levels
- Shunt regulator activity

Status indicator lights, mounted on the top panel of the PLS4, inform the operator of power-supply activities and faults. If any fault is detected, the power supply will automatically disable all associated drives. The drives will indicate a fault if this happens.

Figure 2 shows the PLS4 power supply.

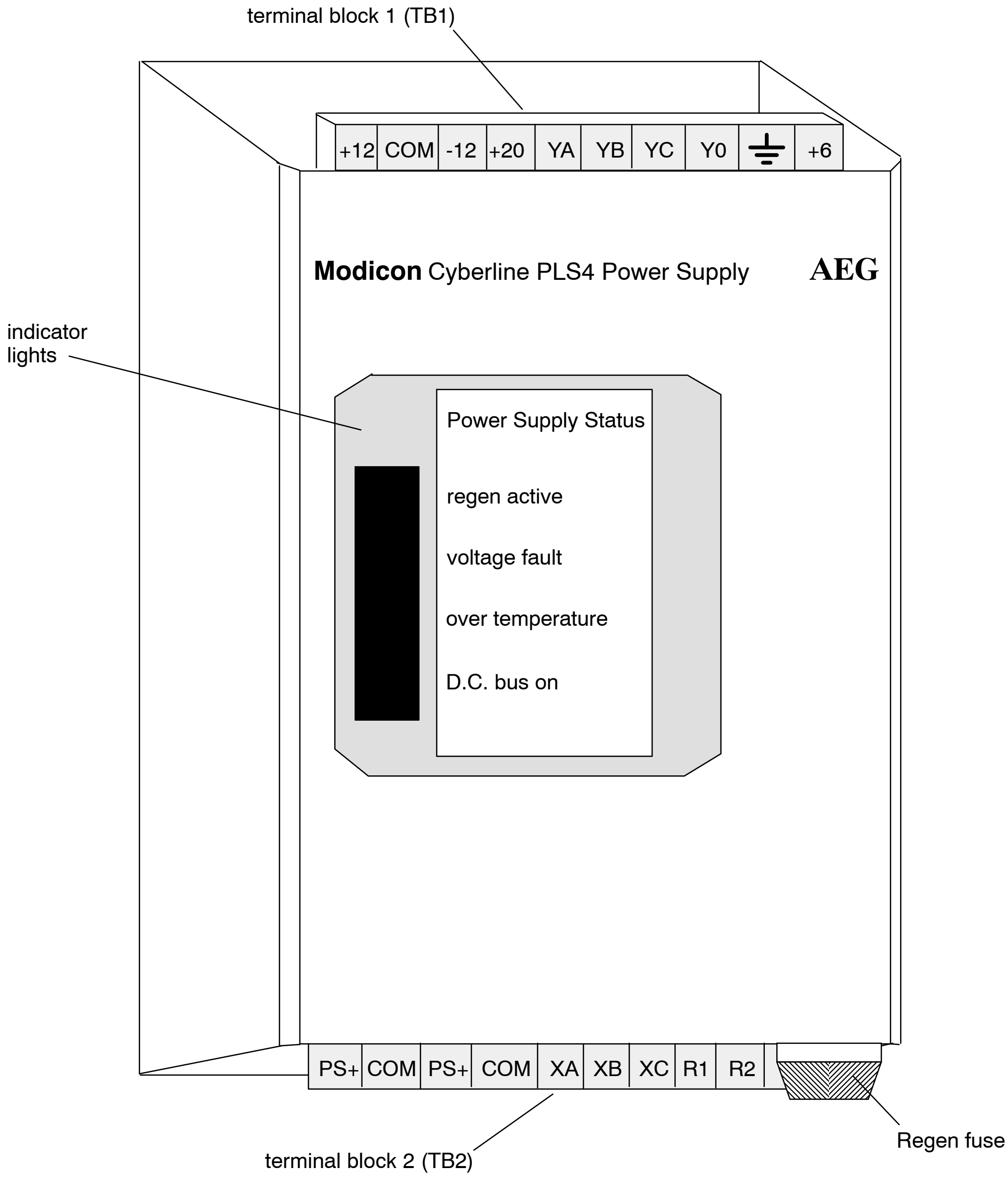


Figure 2 Modicon Cyberline PLS4 Power Supply

Overview of Isolation Transformers

All CL1000A systems require an isolation transformer. Modicon s three-phase and single-phase transformers provide the unique high and low-voltage secondary outputs needed by the power supplies. These transformers are available in NEMA 12 enclosures or as open-frame designs for cabinet mounting. The transformer kVA rating must be matched to the continuous power requirements of the system. Standard high voltage taps are:

- 135 VAC line-to-line (190 VDC bus nominal, open design only)
- 199 VAC line-to-line (280 VDC bus nominal)
- 220 VAC line-to-line (325 VDC bus nominal)

In general, it is best to use the lowest voltage that meets your system performance requirements.

The standard low-voltage taps provide 19 VAC line--o-neutral. There are also 21 VAC taps for abnormally low line voltage conditions. For details, call Modicon s Application Support at 1-800-468-5342.

You are responsible for installing adequate fusing for both the high and low-voltage outputs from the isolation transformer.

Three KTK-10 fuses are required for the 19 VAC supply, and three KTK-30 fuses are required for the high voltage. Modicon offers a fuse kit for this purpose. Fuse wiring is covered in Chapter 5.

For applications requiring a different high-voltage bus or more than a 13 kVA rated transformer, you are responsible for supplying the transformer. Modicon offers a 0.5 kVA three-phase transformer for the low voltage supply.

☞ **Note** If you supply your own transformer, consult Modicon.

Modicon offers five sizes of three-phase isolation transformers and two sizes of single-phase transformers. The two single-phase transformers are 115 VAC primary open-frame design transformers that power one or two small motors.

For more information on transformers, see Chapter 5. See also Appendix B *Sizing an Isolation Transformer*.

Figure 3 shows an open-frame design, three-phase isolation transformer.

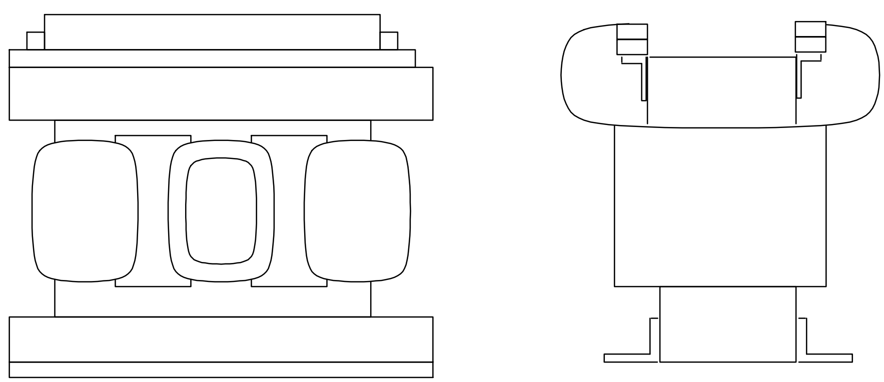


Figure 3 Isolation Transformer

Overview of the Mounting Plate System

CL1000A equipment must be mounted on mounting plates to manage heat dissipation. Two styles are available in sizes that mount two or three components. The CL1060 drive/power supply assembly has its own mounting plate.

These two styles are:

- Coldplate panel mount (CPM) mounting plate
- Coldplate wall mount (CWM) mounting plate

CPM Mounting Plate

The CPM has a heat sink mounted on the reverse side of the mounting surface, and fans that continuously circulate air over the heat sink. It is designed for back panel mounting in NEMA enclosures, and all heat is dissipated within the enclosure. Available fan voltages are 110 VAC and 220 VAC.

Figure 4 shows the CPM mounting plate.

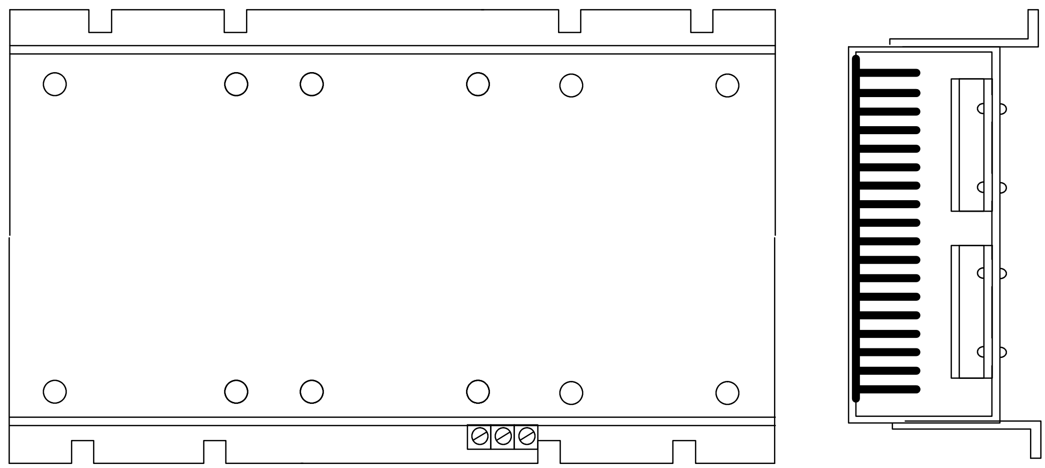


Figure 4 CPM Three-Position Mounting Plate Mounting System

CWM Mounting Plate

The CWM mounting plate has large heat-sinking fins and is designed to be mounted through the cabinet wall. The CWM allows you to reduce your cabinet size because it dissipates most of the heat outside the cabinet.

Note There are restrictions on the number and type of components that should be mounted on any one mounting plate. See the section *System Integration Considerations* at the end of this chapter.

Note The mounting holes for CL1000A equipment are predrilled and threaded on both mounting platforms.

Overview of Motor Contactors

Contactors can be used with a servo control system when the system design demands that power be disconnected under certain conditions. A servo motor is best controlled by its drive. The drive can stop the motor faster than almost any other braking method.

When contactors are used, Modicon recommends wiring the three-phase output of the CL1000A drive through a DC contactor rated for the full load current of the motor. This contactor can also switch in dynamic braking resistors, if required.

Motor contactors and braking resistors are customer-supplied. Please consult your Modicon representative with questions on your system design.

Figure 5 shows wiring for a motor contactor and dynamic braking resistors.

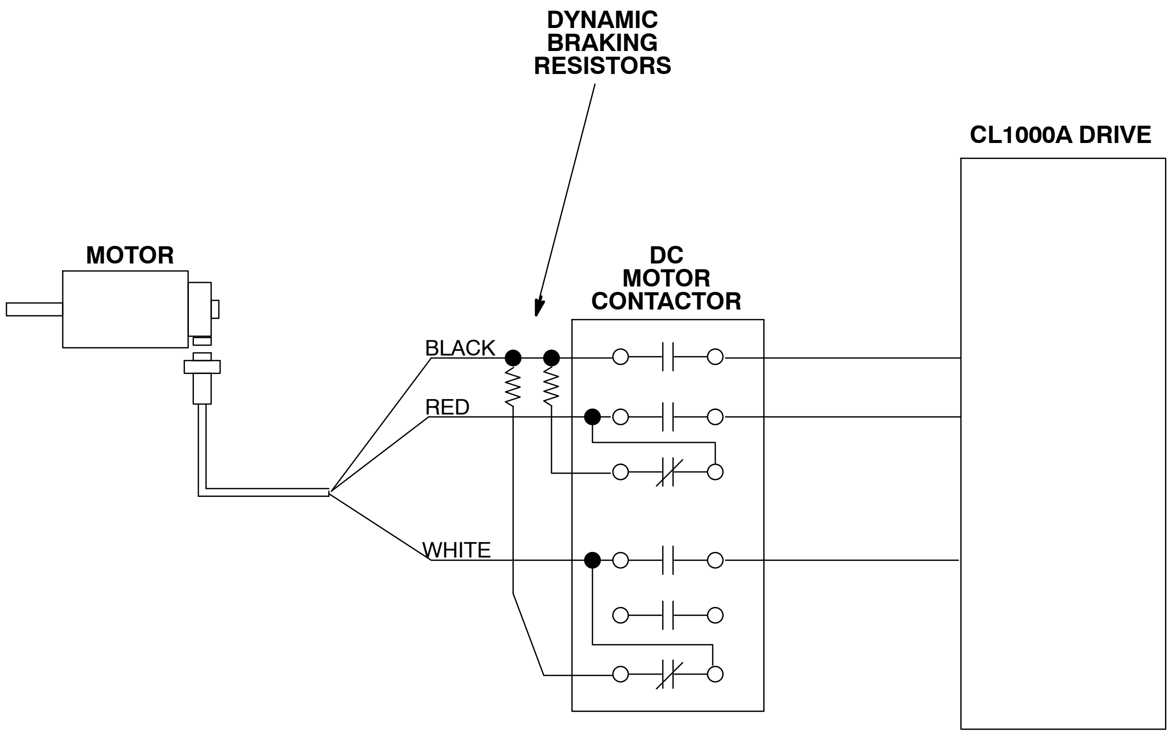


Figure 5 Motor Contactor and Dynamic Braking Resistor Wiring

Overview of Servo Motors

Modicon s rugged brushless servo motors are totally enclosed servo motors designed for high reliability. They require no internal electronics for speed and position sensing. Instead, they are equipped with brushless resolvers. For maximum stability and commutation control, the resolver is mounted at the rear of the servo-motor shaft. The resolver provides position information to the controller. Velocity is derived in the controller via the position information.

Contact your Modicon representative and sales/marketing data sheets for specific information concerning motors.

System Integration Considerations

This sections provides some integration considerations that can help you design a safe, efficient CL1000A system configuration.

Every CL1000A drive requires at least one of each of the following components:

- CL1000A drive
- Transformer
- Fusing
- Power supply
- Mounting panel
- Control signal interconnecting cable

Note Sample configurations are presented in the *Modicon 984 Catalog and Specifier s Guide*, MC-CAT-001.

As a brushless servo drive, the CL1000A is not compatible with control signals from any controller other than the Modicon Direct Numerical Processing (DNP) controllers, which supply the three-phase, commutated current command. Modicon DNP controller specifications are based on system performance testing.

Interaction between the drive and power supply is important, since it minimizes the number of components and maximizes performance. **The PLS4 power supply has specific ratings for its high-voltage current, and, as long as this rating is not exceeded, the PLS4 can support its maximum number of drives.** The PLS4 sees a load, which at any given time is derived from the application s sequence-of-operation or timing load profile. Generating a load profile for each axis, then summing them for all axes, is the best way to determine drive sizes and the minimum number and distribution of power supplies. Once the major components are identified, they must be arranged in a cabinet environment. Here, two factors are important:

- The mounting plates
- Heat dissipation

Mounting plates come in two sizes -- a two-position mounting plate and a three-position mounting plate. Any combination of two or more components can be configured using these two sizes. The CL1060 60-amp drive/power supply comes on its own three-position mounting plate. Typically, a two-position mounting plate is designed for one drive and one PLS4 power supply, and a three-position mounting plate is designed for two drives and a power supply.

Three CL1020 20-amp drives or three CL1030 30-amp drives should never be on the same mounting plate. Rather, mount two CL1020s or CL1030s and a PLS4 power supply on a three-position mounting plate. For best thermal performance, do not mount the power supply in the middle position on the three-position mounting plate. On a three-position mounting plate (two drives and a power supply) mount the higher heat dissipating drive in the middle with the other drive on one side and the power supply on the other side.

☞ **Note** Use a good thermal compound, such as Wakefield Thermal Compound (supplied with your Modicon drive system) between the power supply base plate and the drive mounting plate. This provides adequate thermal transfer. Apply compound in a thin, even layer on both surfaces for most effective heat transfer.

This mounting scenario assumes your ambient temperature does not exceed 45° C. For ambient temperatures from 46° C to 60° C, there are some additional considerations. If two CL1030 drives and a power supply are on one mounting plate, the drives must be derated to 21.5 amps. Similarly, CL1060 drives cannot deliver full power continuously at ambient temperatures from 46° C to 60° C, but only in extreme cases will this affect CL1060 system performance. Consult Modicon if you have questions concerning applications that exceed 45° C.

The CPM mounting plate dissipates all heat within the cabinet, which must be sized to accommodate this heat. (See Chapter 4.) When a CWM mounting plate is used, however, most of the heat is distributed outside the cabinet. Consult Modicon for an application evaluation.

To size a transformer, use the total load profile for your application. (See Appendix B *Sizing an Isolation Transformer*.) One transformer can feed several power supplies, but each power supply must be fused separately.

Signal interconnect cables should be routed between the controller and drive to avoid power wiring. Appendix A gives details for grounding and noise reduction.

Chapter 3
Specifications

- Drive specifications
- Power supply specifications

Drive Specifications

The following tables list electrical, environmental, and physical specifications for the CL1000A models.

High Power Electronics	CL1005	CL1010	CL1020	CL1030	CL1060
AC mode (for brushless servo motors)					
Continuous output current (rms)	5A	10A	20A	30A	60A
Peak output current (rms)	7A	14A	28A	42A	84A
DC mode (for DC servo motors)					
Continuous output current	5A	10A	20A	30A	60A
Peak output current	10A	20A	40A	60A	120A
Nominal bus voltage	180 VDC to 325 VDC				

☞ **Note** Continuous current ratings are theoretical values. Continuous motor shaft power can only be specified with a particular drive/motor combination. Modicon provides detailed torque/speed curves with all Modicon servo motors. This data has been collected using the appropriate drive and PLS4 power supply coupled to a CPM mounting plate. (See Modicon s sales/marketing motor data sheets.) Installations using the CWM coldplate typically have to be derated at elevated ambient temperatures. Consult Modicon for further assistance on CWM installations.

Other Electrical Features	CL1005	CL1010	CL1020	CL1030	CL1060
Input voltage	± 10V	± 10V	± 10V	± 10V	± 10V
Input impedance	10k Ω	10k Ω	10k Ω	10k Ω	10k Ω
Current scaling (amps / volt)	1 A/V	2 A/V	4 A/V	6 A/V	12 A/V
Gain linearity	± 10%	± 10%	± 10%	± 10%	± 10%
Gain drift	0.3%/°C (0.54%/°F)	0.3%/°C (0.54%/°F)	0.3%/°C (0.54%/°F)	0.3%/°C (0.54%/°F)	0.3%/°C (0.54%/°F)
Offset drift	0.03%/°C (0.05%/°F)	0.03%/°C (0.05%/°F)	0.03%/°C (0.05%/°F)	0.03%/°C (0.05%/°F)	0.03%/°C (0.05%/°F)
Efficiency: Maximum	98.5%	98.5%	98.5%	98.5%	96.0%
Typical	96.0%	96.0%	96.0%	96.0%	92.0%
Minimum	90.0%	90.0%	90.0%	90.0%	85.0%
Minimum required line-to-line inductance	2mH	2mH	2mH	2mH	2mH

Environmental Factor	Specification
Ambient temperature *(See note below.)*	
Operating	0 to 60° C (32 to 140° F)
Storage	-20 to 80° C (-4 to 176° F)
Humidity	10 to 90% non-condensing

☞ **Note** If the three-position mounting plate configuration consists of two CL1030 drives and a power supply, THEY MUST BE OPERATED IN A 45° C MAXIMUM AMBIENT TO ACHIEVE MAXIMUM RATED POWER FROM BOTH DRIVES. If the ambient temperature exceeds 45° C, then the output current of the CL1030 mounted on the end of the mounting plate must be limited to 21.5 amps RMS.

Please consult Modicon for CL1060 configurations that operate above 45° C ambient temperature. See the Note in the High Power Electronics table on the previous page. See also *System Integration Considerations* in Chapter 2.

Physical Dimension	Specification
Dimensions (H x W x D)	
CL1005 through CL1030	11.0 x 6.0 x 4.5 in (27.9 x 15.2 x 11.4 cm)
CL1060	12.3 x 18 x 8 in (31.2 x 45.7 x 20.3 cm)
CL1060W	15 x 21 x 10 in (38.1 x 53.3 x 25.4 cm)
Weight	
CL1005 through CL1030	10 lbs (4.5 kg)
CL1060	55 lbs (24.9 kg)
CL1060W	60 lbs (27.1 kg)

Power Supply Specifications

The following tables list electrical, environmental, and physical specifications for the PLS4 power supply and the CL1060 drive/power supply.

Electrical Feature	PLS4	CL1060 / CL1060W
Maximum input voltage	230 VAC	230 VAC
Bus voltage at maximum input voltage	325 VDC	325 VDC
Shunt regulator trip point (typical)	370 VDC	370 VDC
Over-voltage trip point (typical)	390 VDC	390 VDC
Maximum shunt regulator current	4.5 A (rms) 37 A (peak)	10 A (rms) 74 A (peak)
Maximum number of CL1000A drives supported	Four (See note below.)	Three (external)

☞ **Note** The PLS4 power supply has specific ratings for its high-voltage current, and, as long as this rating is not exceeded, the PLS4 can support its maximum number of drives.

Environmental Factor	Specification
Ambient temperature	
Operating	0 to 60° C (32 to 122° F)
Storage	-20 to 80° C (-4 to 176° F)
Humidity	10 to 90% non-condensing

Physical Dimension	Specification
Dimensions (H x W x D)	
PLS4	11.0 x 6.0 x 4.5 in (27.9 x 15.2 x 11.4 cm)
Weight	
PLS4	11 lbs (5 kg)

☞ **Note** F30/10 fuse kit is required with each PLS4 or CL1060 and CL1060W.

Chapter 4
How to Install CL1000A Equipment

- Installation overview
- Selecting the mounting cabinet
- Mounting the open frame isolation transformer
- Mounting the enclosed isolation transformer
- Mounting the CPM mounting plate
- Mounting the CWM mounting plate
- Mounting the PLS4 power supply
- Mounting drives CL1005 - CL1030
- Mounting the CL1060 and CL1060W drives

Installation Overview

Installing CL1000A system components involves the following major steps:

- Select a mounting cabinet that meets the installation requirements.
- Mount the isolation transformer.
- If installing PLS4 power supplies and/or CL1005 through CL1030 drives, mount the mounting plates.
- Mount the drives and power supplies. (The CL1060 is a combined power supply, drive, and mounting plate package.)
- Mount the brushless servo motors.
- Refer to the next chapter for wiring information.

Caution   After drilling, tapping, or performing any other cutting procedure on the cabinet panels, remove all metal filings from the enclosure. These filings can severely damage equipment if they come in contact with and short connections. If you are drilling or cutting *after* the drives are mounted, cover the drives with cloth to keep out metal particles.

Figure 6 shows a typical two-drive system installation.

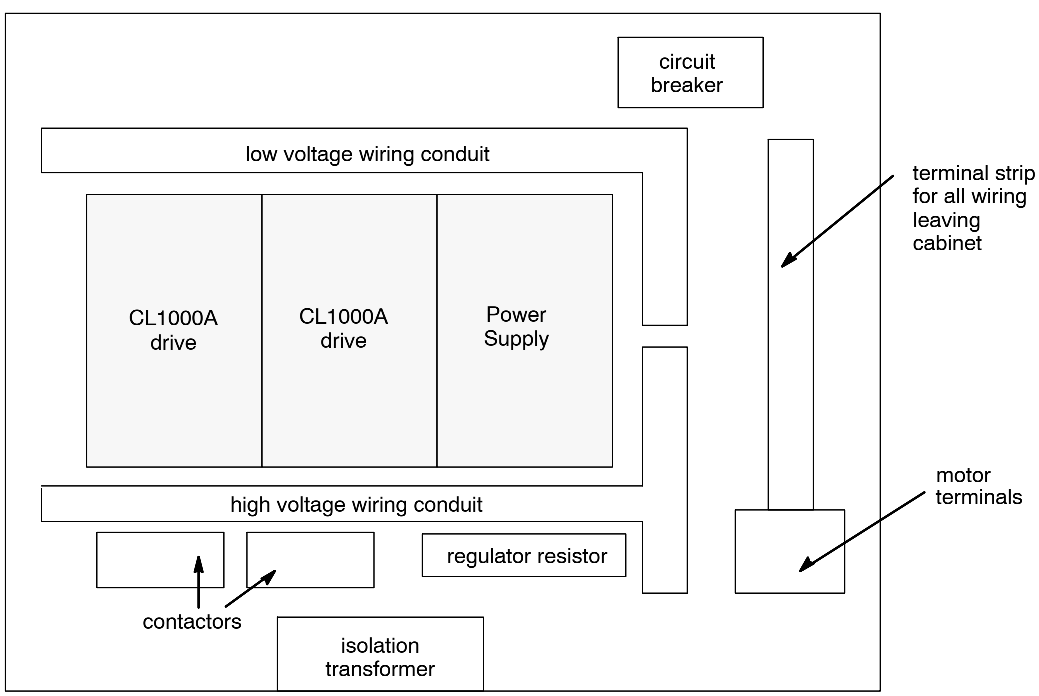


Figure 6   Typical Two-Drive System Installation

Important Considerations

The following subsections present some important considerations to know about before you install system components.

Use Approved Items

All items in the Cyberline installation should either be supplied by Modicon or conform to Modicon s design requirements.

Install for Accessibility

Plan your system for comfortable installation and service.

Allow Adequate Ventilation

Select a cabinet that is properly sized for the heat that your system components dissipate. (See the next section, *Selecting the Mounting Cabinet*.)

The CPM mounting plate comes equipped with fans. These must be used for air circulation through the heatsink on the mounting plate. Do not try to operate the Cyberline without these fans.

Install the components with space around them for air movement. Do not pack the cabinet to use all available space. With the proper size cabinet, there should be sufficient heat dissipation through the cabinet. You should not need slots or holes in the cabinet for ventilation.

Proper airflow through and around the assemblies is required to provide optimal thermal transfer. The requirements for clearance distances are:

- **CPM model** There must be a clearance of 4 inches around all sides of the plate. This allows air to circulate away from the heat sink.
- **CWM model** There must be a clearance of 6 inches around all sides of the external heat sink, and a clearance of 4 inches above and below the drives. This allows air to circulate away from the heat sink.

Protect against Physical Damage

The Cyberline system should be housed to protect against dirt, spray, and flying debris, and to contain the damage in the event of an accident. A suitable choice is a NEMA 12 cabinet, although your choice and requirements should dictate choice of cabinet.

If your location is hazardous, you have special requirements. Be sure the system is installed and wired to conform with to NEC, local regulations, and any regional and special codes that apply to your hazardous location.

Selecting the Mounting Cabinet

The NEMA mounting cabinet that you select must:

- Hold all of the system components and provide adequate working space
- Dissipate the heat generated by the system components

The acceptable ambient air temperature range for CL1000A drives is 0 to 60°C (32° to 140° F). The recommended temperature range is 15° to 45° C (59° to 113° F). If the drive baseplate reaches 90° C (194° F) the thermal switches within the power supply and the drives will cause them to shut down.

The cabinet you select should be able to maintain the air around the mounting plate at a temperature of no more than 60°C (140°F), and preferably at 45°C (113°F) or less. The following sections provide formulas for calculating heat dissipation for each Cyberline component.

The information calculated in this section, combined with cabinet specification provided by your cabinet vendor, should allow you to size the panel economically.

Drive Heat Dissipation

Use the following formula to calculate heat dissipation for each drive.

CL1005 $P_d = 11 \times I_{rms}$
CL1010 $P_d = 11 \times I_{rms}$
CL1020 $P_d = 9.3 \times I_{rms}$
CL1030 $P_d = 8.4 \times I_{rms}$
CL1060 $P_d = 8.0 \times I_{rms}$

Where:

P_d is the Power Dissipation (Watts).

Irms is the current output of the drive for your application (Amps).

Heat Dissipation from Power Supplies

PLS4 and the CL1060 integral power supplies are about 96 percent efficient. About four percent of the total power consumption is dissipated as heat. Use this formula to calculate the heat dissipation from the PLS4 power supply:

$$Ke \times \frac{rpm}{1000} \times I_{rms} \times 0.04 = P_d$$

Where:

Ke is the motor voltage constant (V / Krpm).

rpm is the motor revolutions per minute for your application.

Irms out is the continuous current output of the drive for your application.
Use Irms of the motor if rms current is not known (Amps).

Pd is power dissipation (Watts).

☞ **Note** The Irms values are actual for (applied to) your applications. Do not confuse these values with the power supply specifications.

To calculate heat dissipation from the CL1060 integral power supply, add both of the previous equations:

$$P_d = \left[8 \times I_{rms}\right] + \left[K_e \times \frac{rpm}{1000} \times I_{rms} \times 0.04\right]$$

Mounting the Open Frame Transformer

Because of their size, weight, and high voltages/operating temperatures, Modicon recommends mounting the open-frame style isolation transformers externally to the drive s cabinet, protected by a ventilated cover that you supply. If the transformers are mounted in the cabinet, they should be mounted in the base or bottom in an area that provides free air flow and adequate protection from accidental contact. Transformers can reach a temperature of 100° C (212° F) or more under full load conditions. Always allow sufficient wiring space around the transformer barrier strips, depending on the wire gauge being used.

Use the following equipment to mount an isolation transformer:

- Eye protector
- Four sets of mounting hardware, including screws or bolts, nuts and lockwashers. All isolation transformers are equipped with four 5/16 inch by 1/2 inch (8 mm by 13 mm) slots for mounting hardware.
- Electric drill with appropriately sized bit
- Screwdrivers and wrenches to attach the hardware to the transformer and cabinet

To mount the isolation transformer:

1. Refer to the following tables, Figure 7, and Figure 8 for the mounting dimensions and weight of your particular transformer. Dimensions D and E provide the distances between the mounting slots.
2. Spot and drill the four mounting holes in the base of the cabinet.
3. Securely mount the transformer.

Open Frame Isolation Transformer: Mounting Dimensions (inches)

Part Number	kVA	A	B	C	D	E	F	G	Weight (lbs)
800-110	1.5	10.0	5.25	8.0	3.50	5.00	2.50	7.0	35 lbs
800-111	3.2	12.0	5.25	10.0	3.50	6.00	3.00	7.0	50 lbs
800-112	6.4	16.5	7.25	12.5	4.31	8.00	4.25	10	80 lbs
800-113	9.6	16.5	7.25	12.5	5.25	8.00	4.25	11	110 lbs
800-125	13.0	16.5	8.25	12.5	5.75	8.00	4.25	12	150 lbs
800-026	2.0	6.75	5.63	10.0	6.50	6.13	4.13		37 lbs
800-027	0.75	6.00	5.00	8.5	6.00	5.00	3.25		23 lbs
800-033	0.5	8.00	3.50	6.0	2.25	5.50	1.25	5.0	15 lbs

Open Frame Isolation Transformer: Mounting Dimensions (centimeters)

Part Number	kVA	A	B	C	D	E	F	G	Weight (Kg)
800-110	1.5	25.4	13.3	20.3	8.9	12.7	6.4	17.8	15.8 Kg
800-111	3.2	30.5	13.3	25.4	8.9	15.2	7.6	17.8	22.5 Kg
800-112	6.4	41.9	18.4	31.8	11.0	20.3	10.8	25.4	36.0 Kg
800-113	9.6	41.9	18.4	31.8	13.3	20.3	10.8	27.9	49.5 Kg
800-125	13.0	41.9	21.0	31.8	14.6	20.3	10.8	30.5	67.5 Kg
800-026	2.0	17.2	14.3	25.4	16.5	15.6	10.5		16.7 Kg
800-027	0.75	15.2	12.7	21.6	15.2	12.7	8.3		10.4 Kg
800-033	0.5	20.3	8.9	15.2	17.2	14.0	3.2	12.7	6.8 Kg

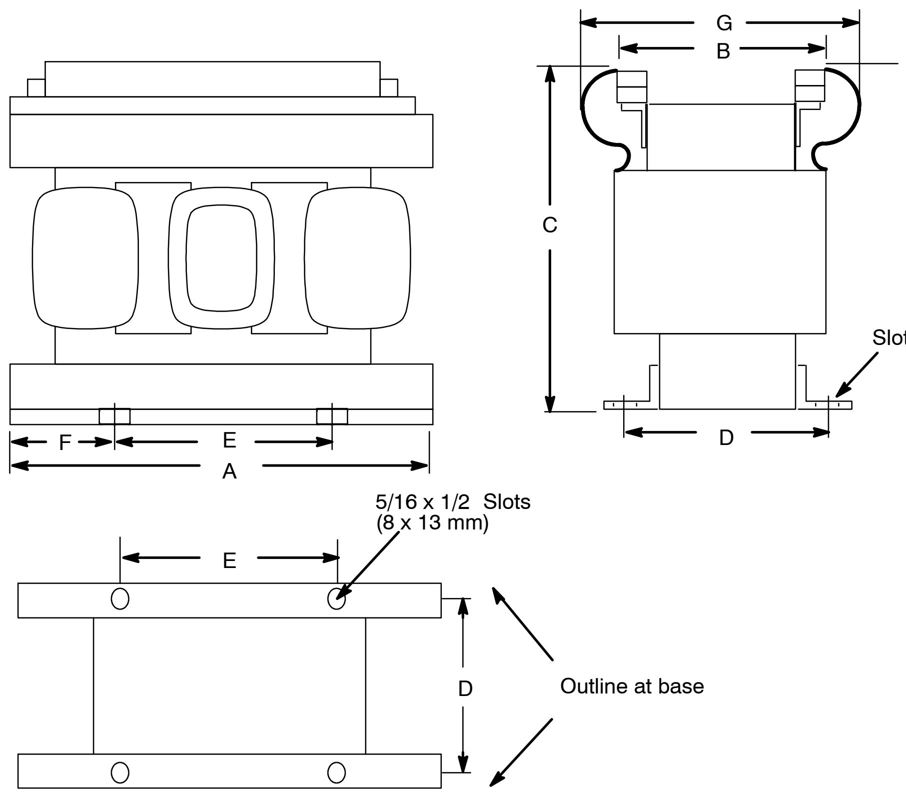


Figure 7 Open Frame Three-Phase Transformers

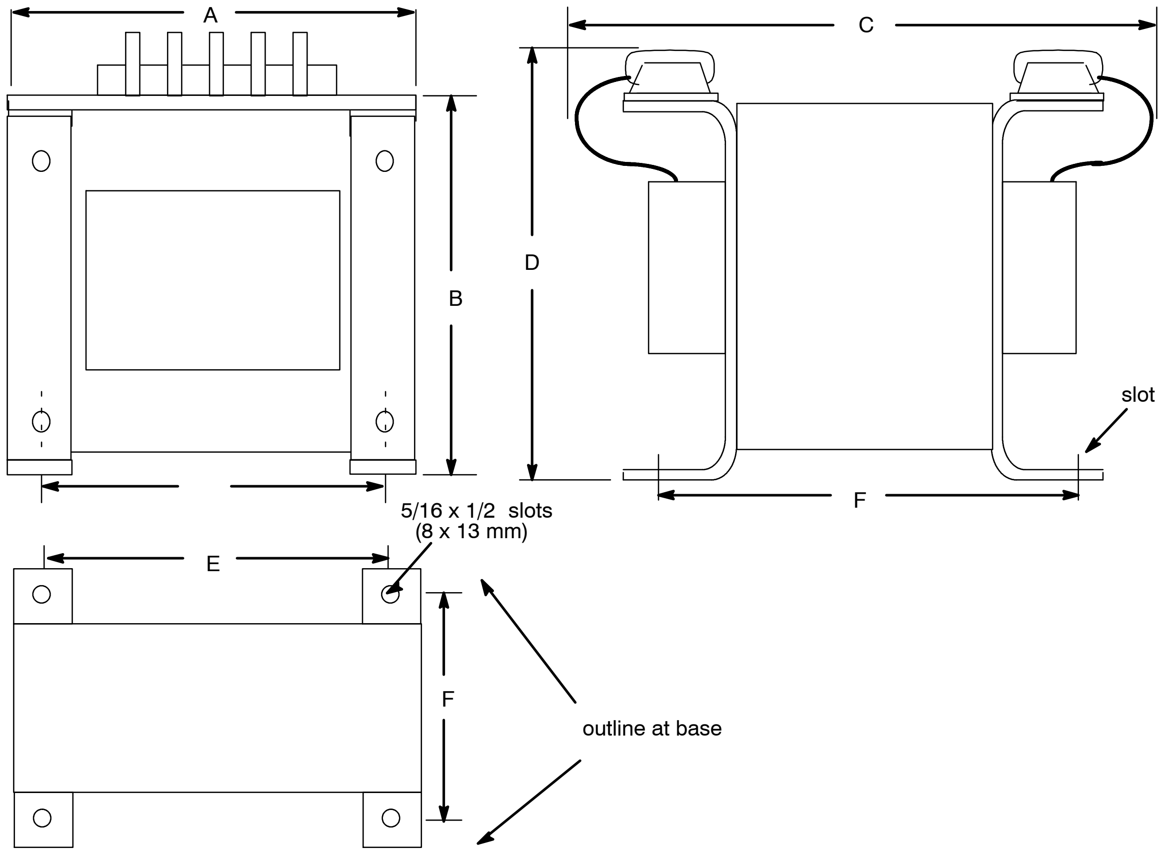


Figure 8 Open Frame Single-Phase Transformers

Mounting the Enclosed Transformer

Modicon enclosed transformers are rated to NEMA 12 and are suitable for many applications without further modifications. They can be mounted externally to control cabinets, on walls, or in any other convenient horizontal or vertical surface. Terminal access is through the removable top. Be sure to use wire and conduit fittings that maintain at least NEMA 12 integrity. The following table and Figure 9 show dimensions.

NEMA 12 Enclosed Three-Phase Transformers: Mounting Dimensions

		DIMENSIONS IN INCHES										
Part Number	**KVA**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**Weight**
800-061	3.2	14.75	6.0	13.17	4.5	13.38	12.0	13/32	7.00	6.48	2.75	94 lbs
800-062	6.4	19.00	8.0	16.17	6.0	17.38	16.0	17/32	8.50	8.48	3.00	190 lbs
800-063	9.6	19.00	8.0	16.17	6.0	17.38	16.0	17/32	8.50	8.48	3.00	209 lbs
800-064	13.0	21.50	8.0	19.20	6.0	19.88	18.5	17/32	11.50	8.51	3.03	320 lbs

		DIMENSIONS IN CENTIMETERS										
Part Number	**KVA**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**Weight**
800-061	3.2	37.47	15.2	33.45	11.4	33.99	30.5	1.03	17.78	16.46	6.99	42.7 Kg
800-062	6.4	48.26	20.3	41.07	15.2	44.15	40.6	1.35	21.59	21.54	7.62	86.3 Kg
800-063	9.6	48.26	20.3	41.07	15.2	44.15	40.6	1.35	21.59	21.54	7.62	94.9 Kg
800-064	13.0	54.61	20.3	48.77	15.2	50.50	46.99	1.35	29.21	21.62	7.70	145.3 Kg

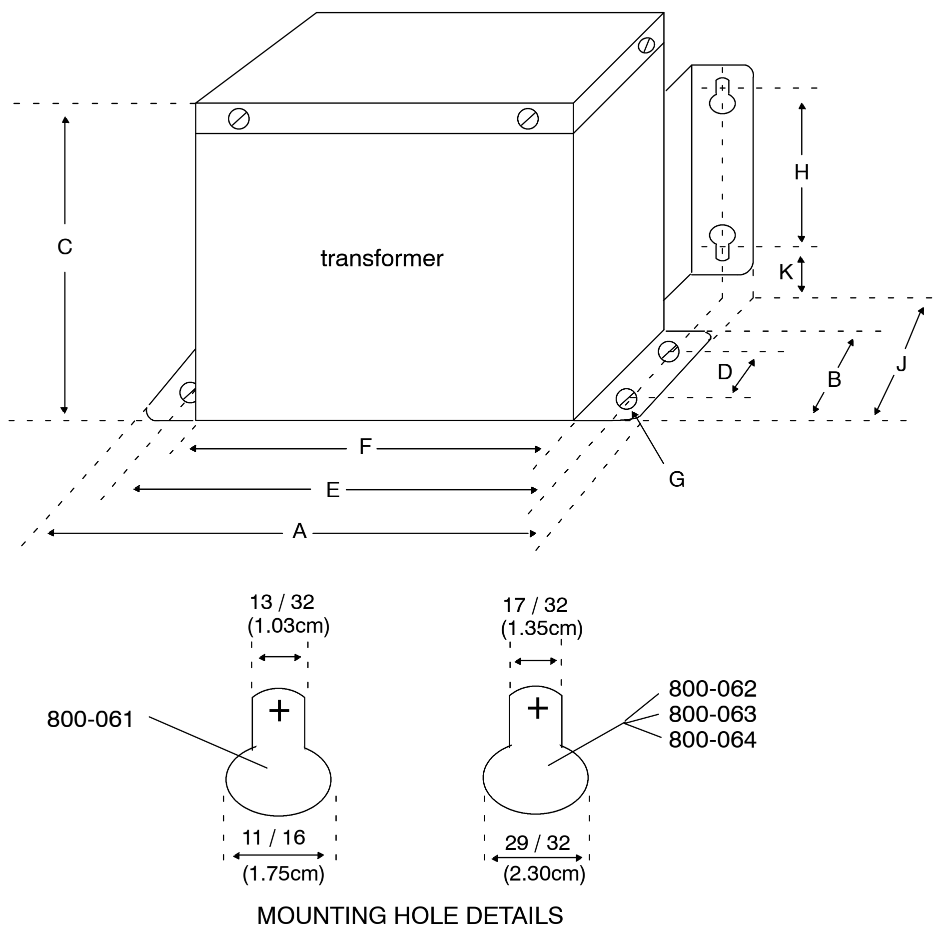


Figure 9 NEMA 12 Enclosed Three-Phase Transformer

Mounting the CPM Mounting Plate

Caution   Allow a minimum clearance of 4 inches around all sides of the plate. This permits air to circulate away from the heat sink. Any mounting scheme that blocks air circulation reduces the plate s ability to dissipate heat and will reduce the system s longterm performance.

If two CPM mounting plates are mounted above or beside each other, then a clearance of 8 inches is required.

When selecting a mounting site for the CPM mounting plate:

- Select a site that allows the panel to be mounted with the terminal block down. This makes wiring easier.
- If the inside cabinet temperature is above 40° C (104° F) cut a four-inch diameter hole in the mounting subpanel under both mounting plate bottom fans. This allows a free flow of cool air and improves heat dissipation.
- If your mounting plate is equipped with the three-fan side bracket, remove the bracket before attempting to wire the mounting plate.

Use the following equipment to mount the mounting plate:

- Eye protector
- Electric drill with bits for #10 or 1/4-20 mounting hardware. For #10 hardware use 7/32, number 9 or 6 mm drill bit. For 1/4-20 hardware use 9/32 or 7 mm drill bit.
- A four-inch hole punch, if you are cutting heat dissipation holes
- Eight sets of #10 or 1/4-20 mounting hardware, including bolts, nuts and lockwashers.
- Screwdrivers and wrenches to attach the mounting hardware to the mounting plate and cabinet.

To mount the CPM mounting plate:

1. Spot and drill eight mounting holes for the #10 or 1/4-20 mounting hardware on the subpanel of the cabinet. Figure 10 provides mounting dimensions for the three-position mounting plate. Figure 11 provides mounting dimensions for the two-position mounting plate.

2. If the inside cabinet temperature is above 40° C (104° F), punch the two four-inch diameter holes beneath the mounting positions for the cooling fans. Figure 12 provides dimensions to locate the hole positions on the three-position mounting plate. Figure 13 provides dimensions to locate the hole positions on the two-position mounting plate.

3. Securely mount the mounting plate to the cabinet.

4. To make wiring easier, remove the fan bracket if installed. (See fan installation figure in Chapter 5.)

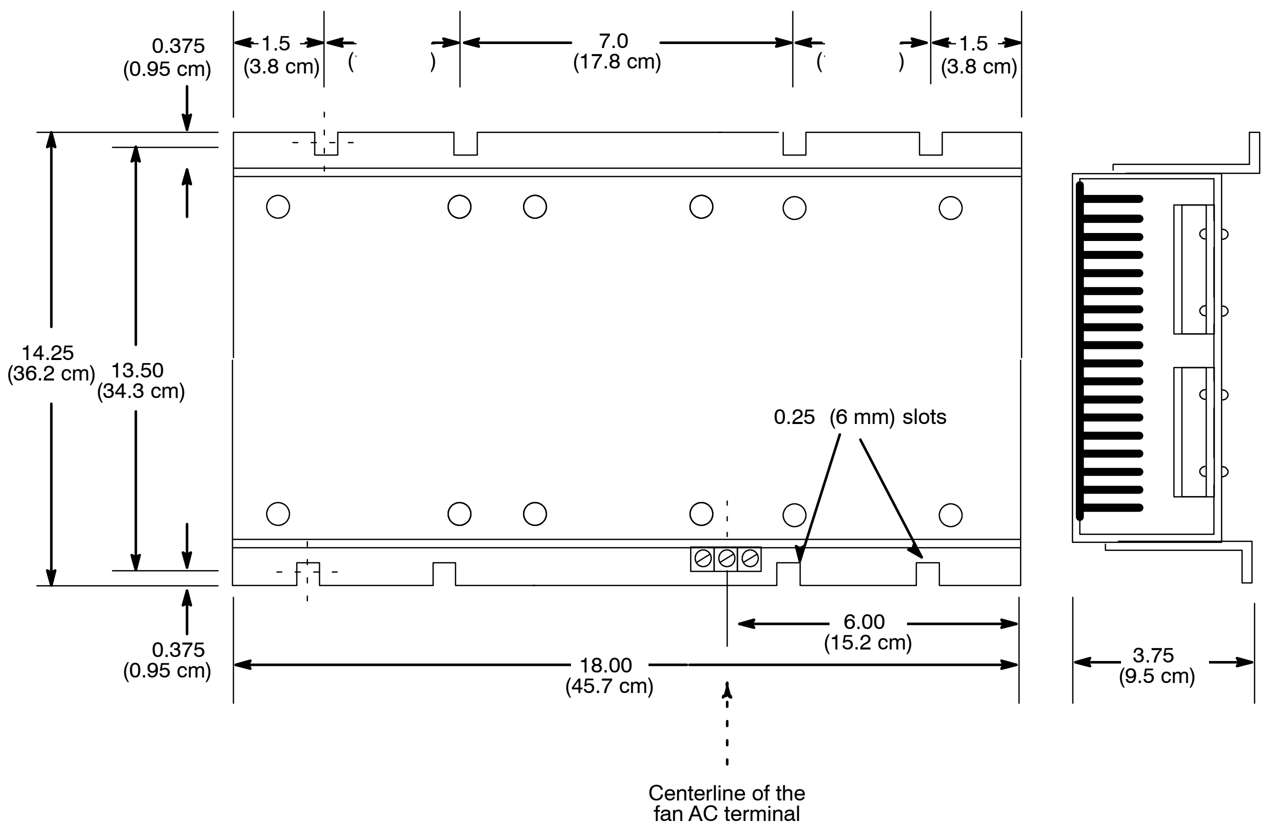


Figure 10 CPM Three-Position Mounting Plate Mounting Dimensions

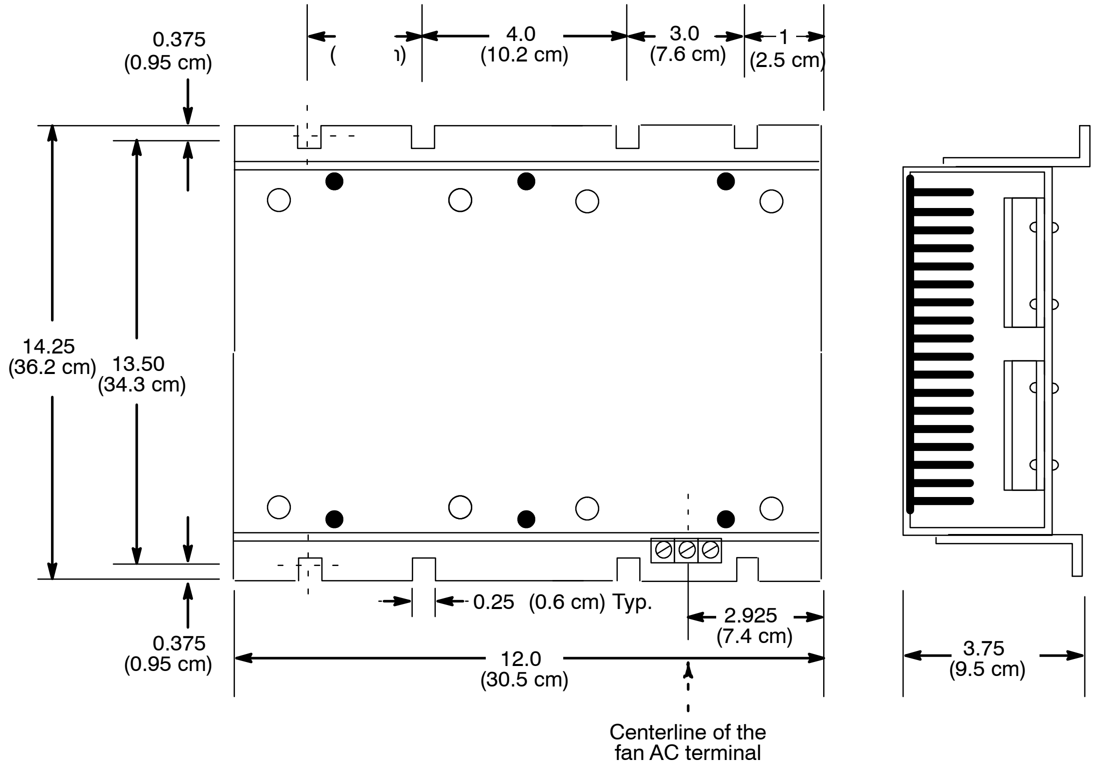


Figure 11 CPM Two-Position Mounting Plate Mounting Dimensions

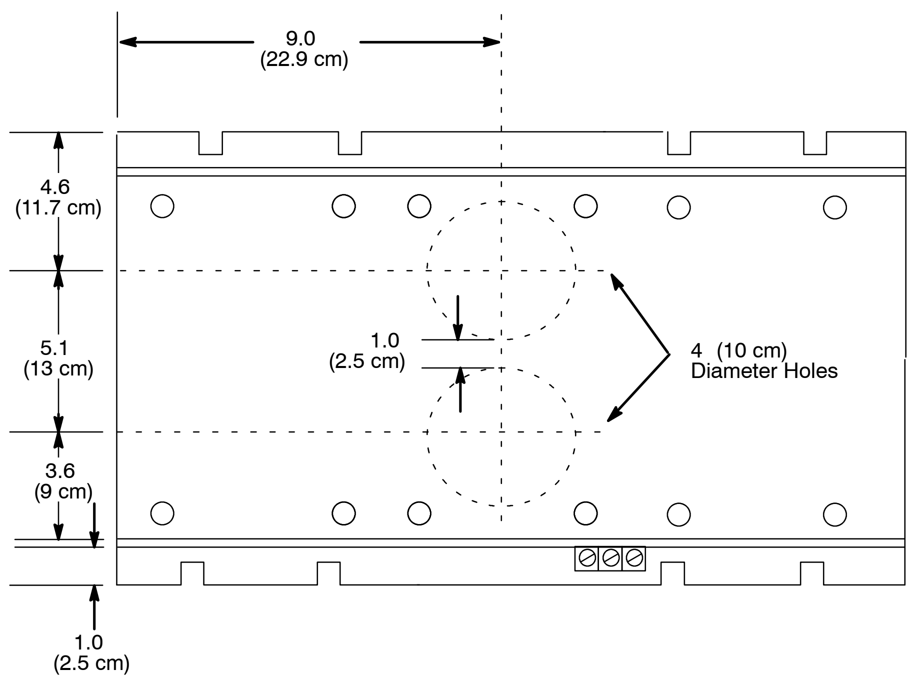


Figure 12 Dimensions to Locate Optional Fan Holes on CPM Three-Position Mounting Plate

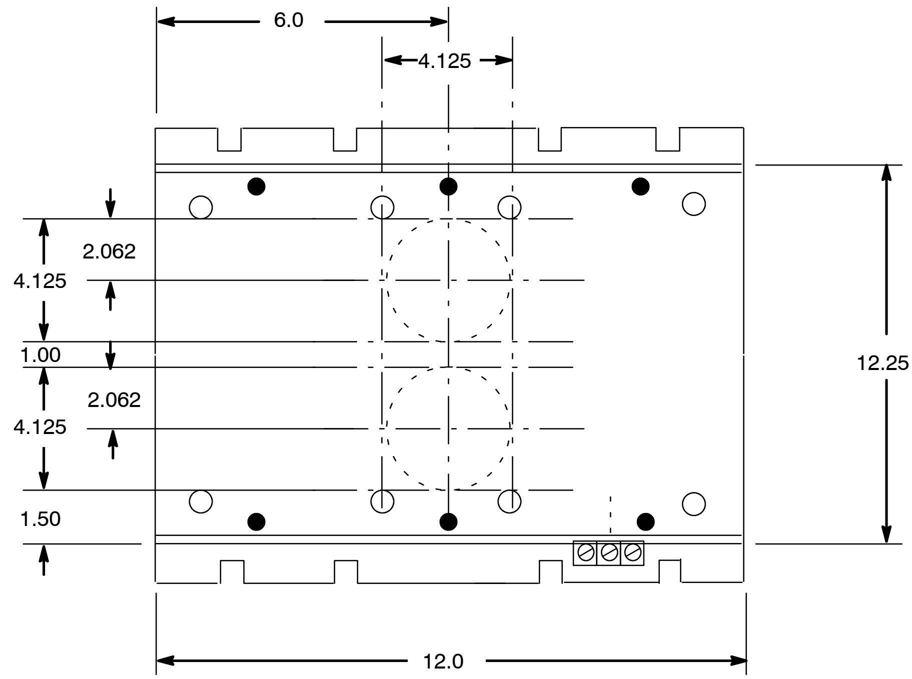


Figure 13 Dimensions to Locate Optional Fan Holes on CPM Two-Position Mounting Plate

Mounting the CWM Mounting Plate

When selecting a mounting site for the CWM mounting plate:

Select a site on the panel side wall that allows the panel to be mounted with the terminal block down. This makes wiring easier.

Caution Leave a clearance of at least 6 inches (15.25 cm) around all sides of the external heat sink, and a clearance of 4 inches (10.16 cm) above and below the drives. This allows air to circulate away from the heat sink. Any mounting scheme that blocks air circulation reduces the plate s ability to dissipate heat, and will reduce the system s longterm performance.

Use the following equipment to mount the mounting plate:

- Eye protector
- Electric drill with 1/4 inch (6 mm) bit
- Ten sets of 1/4-20 x 5/8 mounting hardware, including pan head phillips screws, nuts, and lockwashers.
- The mounting gasket (shipped with the mounting plate assembly)
- Screwdrivers and wrenches to attach the mounting hardware to the mounting plate and cabinet

To mount the CWM mounting plate:

1. Cut a hole in the cabinet wall using the dimensions of the dotted rectangle in Figures 14 and Figure 15.
2. Spot and drill ten mounting holes for the #10 or 1/4-20 mounting hardware on the cabinet wall. Refer to Figure 14 and 15 for mounting dimensions.
3. If mounting the mounting plate outside the cabinet, place the gasket against the outside cabinet wall before mounting. If mounting the mounting plate inside the cabinet, place the gasket against the inside cabinet wall before mounting.
4. Securely mount the mounting plate to the outside of the cabinet.

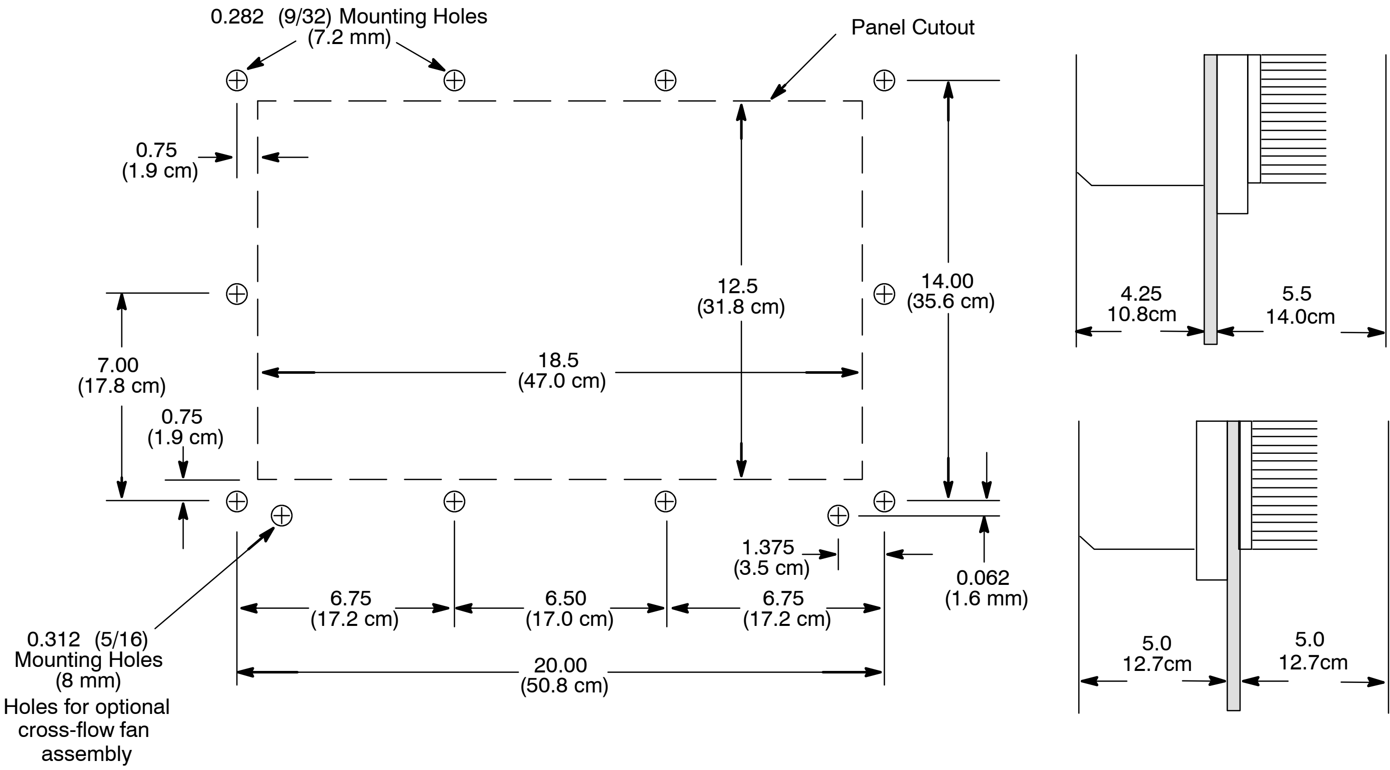


Figure 14 CWM Three-Position Mounting Plate Mounting Dimensions

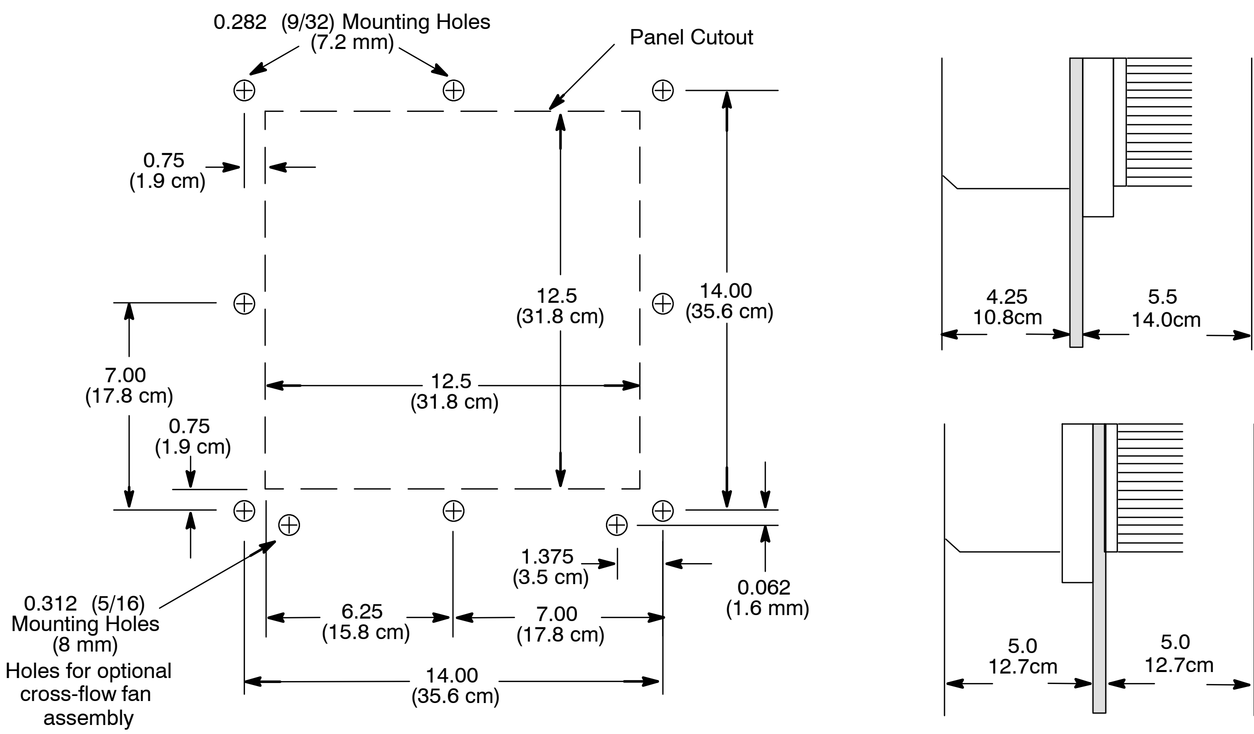


Figure 15 CWM Two-Position Mounting Plate Mounting Dimensions

Mounting the PLS4 Power Supply

PLS4 power supplies have the same mounting dimensions as CL1000A drives and are designed to mount on the mounting plate. The usual configuration is one PLS4 to a single mounting plate, allowing two open mounting areas for Cyberline CL1005 through CL1030 drives. The mounting plate has been drilled and tapped for 10-24 NC mounting hardware.

Use the following equipment to mount the PLS4 power supply:

- Four 10-24 NC screws (included with power supply)
- Thermal grease (included with power supply)
- Screwdriver, #2 Phillips

Caution Mount the higher heat dissipating drive in the middle with the other drive on one side and the power supply on the other side. See Figure 16. When two CL1030s are used, be sure you follow good ventilation and heat dissipation procedures. Apply thermal compound between the power supply base plate and the drive mounting plate is necessary to provide adequate thermal transfer. Apply the compound in an even layer on both surfaces for most effective heat transfer.

To mount the power supply:

1. Apply thermal compound in a thin, even layer to the bottom of the PLS4.
2. Position the power supply on the mounting plate in one of the two side positions, as shown in Figure 16. The two rows of holes along the edges of the mounting plate will line up with the power supply mounting holes.
3. Securely fasten the power supply to the mounting plate with the 10-24 NC screws. Tighten to 30-35 inches * lbs.

Note You can reduce electrical noise by using toothed lock washers under the screws that attach both the PLS4 power supply and the CL1000A drive to the mounting plate.

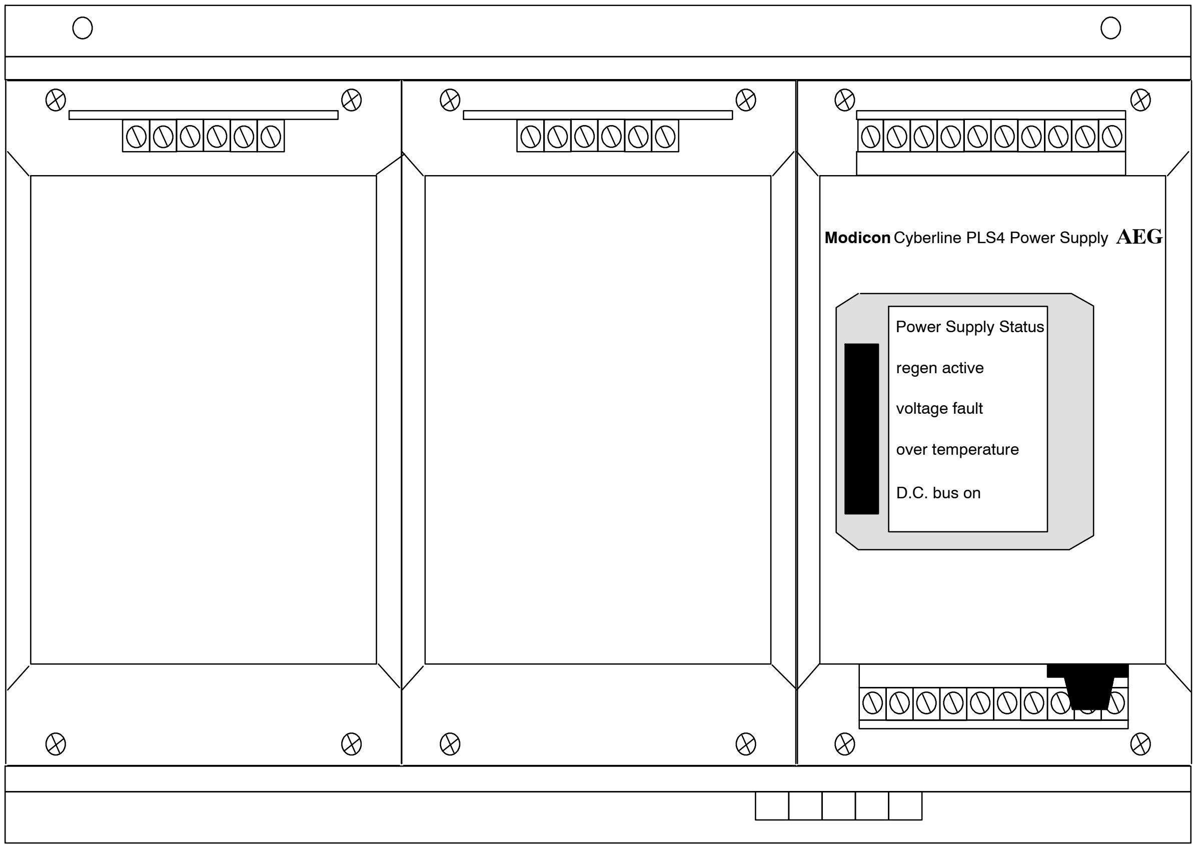


Figure 16 PLS4 Power Supply Mounted on Mounting Plate

Mounting Drives CL1005-CL1030

CL1000A drive models CL1005 through CL1030 all have the same dimensions. The two-position mounting plate can be used to mount any two drives or any drive with a power supply. A three-position mounting plate can be used with the following drive/power supply combination:

1. Three CL1005 or CL1010 drives
2. Two CL1005, CL1010, or CL1020 drives and a power supply
3. Two CL1030 drives and a power supply OPERATED IN A 45° C MAXIMUM AMBIENT. If the ambient temperature exceeds 45° C , then the output current of the CL1030 mounted on the end of the mounting plate must be limited to 21.5 amps RMS.

The mounting plate has been drilled and tapped for 10-24 mounting hardware to simplify drive mounting.

Use the following equipment to mount a CL1000A drive:

- Four 10-24 NC screws (included with drive)
- Screwdriver, #2 Phillips
- Thermal grease (or compound)

⚠ **Caution When using a three-position CPM, the drive with the higher dissipation should be mounted in the middle with the power supply on one side and the other drive on the other side. (When two CL1030s are used, be sure you follow good ventilation and heat dissipation procedures.)**

⚠ **Caution Apply thermal compound between the power supply base plate and the drive mounting plate to provide adequate thermal transfer. Apply the compound in an even layer on both surfaces for most effective heat transfer.**

To mount the drive:

1. Apply thermal compound in a thin, even layer to the bottom of the drive.

2. Position the drive in one of the two mounting positions on a two-position mounting plate (or in one of the three positions on a three-position mounting plate). The two rows of holes along the edges of the mounting plate will line up with the drive mounting holes.

   Figure 17 shows two drives mounted onto a three-position mounting plate.

3. Fasten the drive to the plate with the 10-24 NC screws. Tighten to 30-35 in. * lbs.

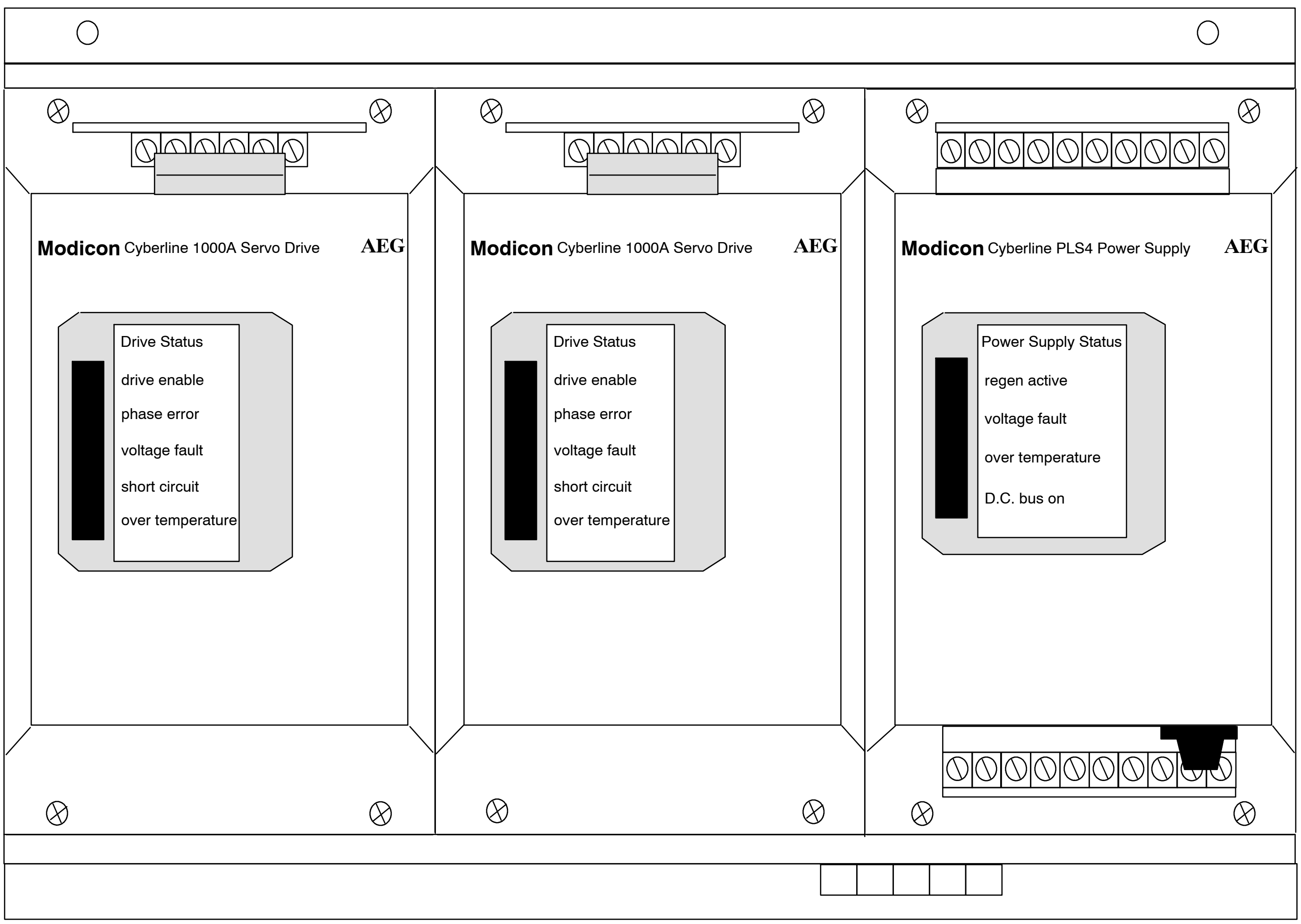


Figure 17 Drives Mounted on the Mounting Plate

Mounting the CL1060 and CL1060W Drive

The CL1060 drive is a combination drive, power supply, and mounting plate in a single assembly. Part number DR-1060□-00 identifies the CL1060 mounted on a CPM mounting plate with 110 VAC fans. Part number DR-1060-200 identifies the CL1060 mounted on a CPM mounting plate with 220 VAC fans. Part number DR-1060-300 identifies the CL1060W (with the CWM mounting plate, intended for through-the-wall mounting). The following sections provide details for each type of CL1060 drive.

Mounting the CL1060

⚠ **Caution Allow a minimum clearance of 4 inches around all sides of the plate. This permits air to circulate away from the heat sink. Any mounting scheme that blocks air circulation reduces the plate's ability to dissipate heat, and will reduce the system's longterm performance.**

When selecting a mounting site for the CL1060:

- If the inside cabinet temperature is above 40° (104° F), cut four-inch diameter holes in the mounting subpanel under the two mounting plate bottom fans. This allows a free flow of cool air and improves heat dissipation.

Use the following equipment to mount the CL1060 drive:

- Eye protector
- Electric drill with bits for #10 or 1/4-20 mounting hardware. (For #10 hardware use 7/32, number 9 or 6 mm drill bit. For 1/4-20 hardware use 9/32 or 7 mm drill bit.)
- A four-inch hole punch, if you are cutting heat dissipation holes
- Eight sets of #10 or 1/4-20 mounting hardware, including bolts, nuts, and lockwashers
- Screwdrivers and wrenches to attach the mounting hardware to the drive mounting plate and cabinet subpanel

To mount the CL1060 drive:

1. Using a 9/32-inch bit, spot and drill eight mounting holes for the #10 or 1/4-20 mounting hardware on the subpanel of the cabinet.
2. Refer to Figure 18 for mounting dimensions.
3. (Optional) Punch the two four-inch diameter holes beneath the mounting positions for the cooling fans. Refer to Figure 19 for dimensions to locate hole positions.
4. Securely mount the CL1060 drive to the cabinet.

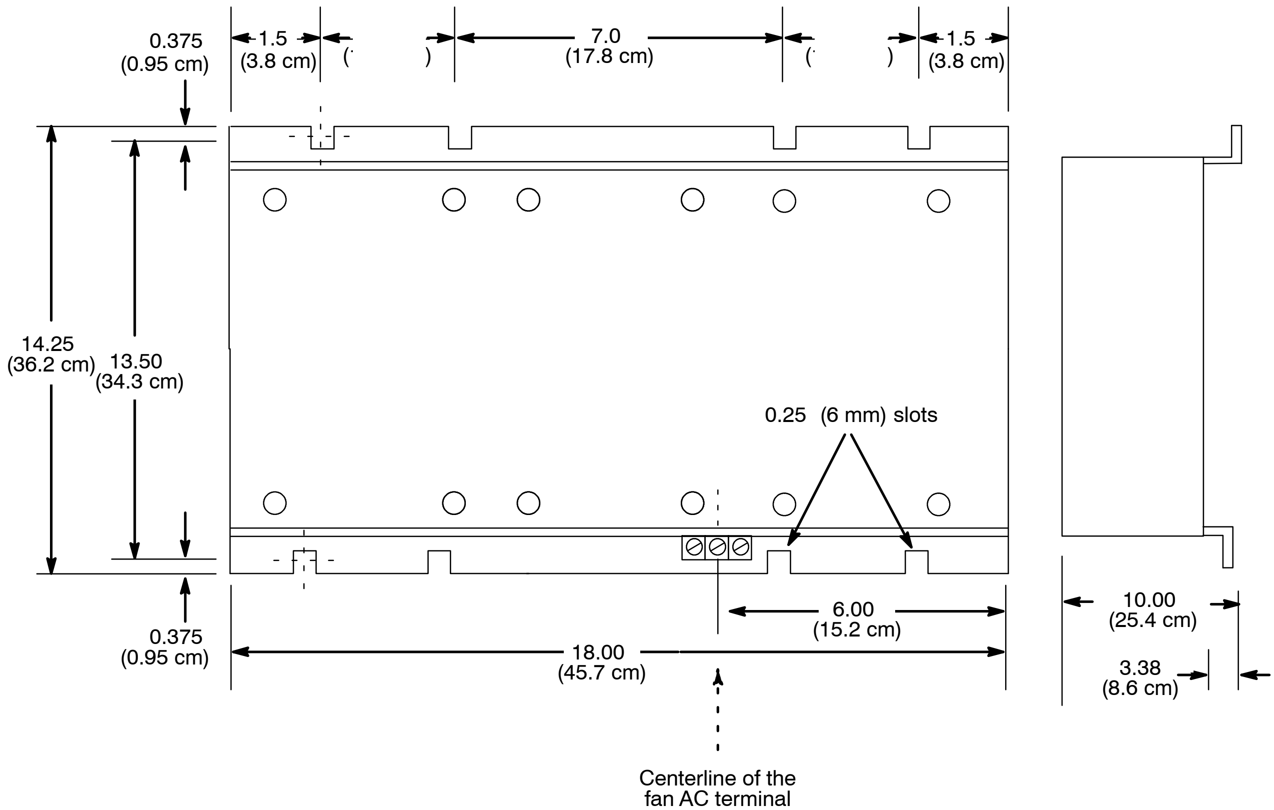


Figure 18 Mounting Dimensions for the CL1060 Drive

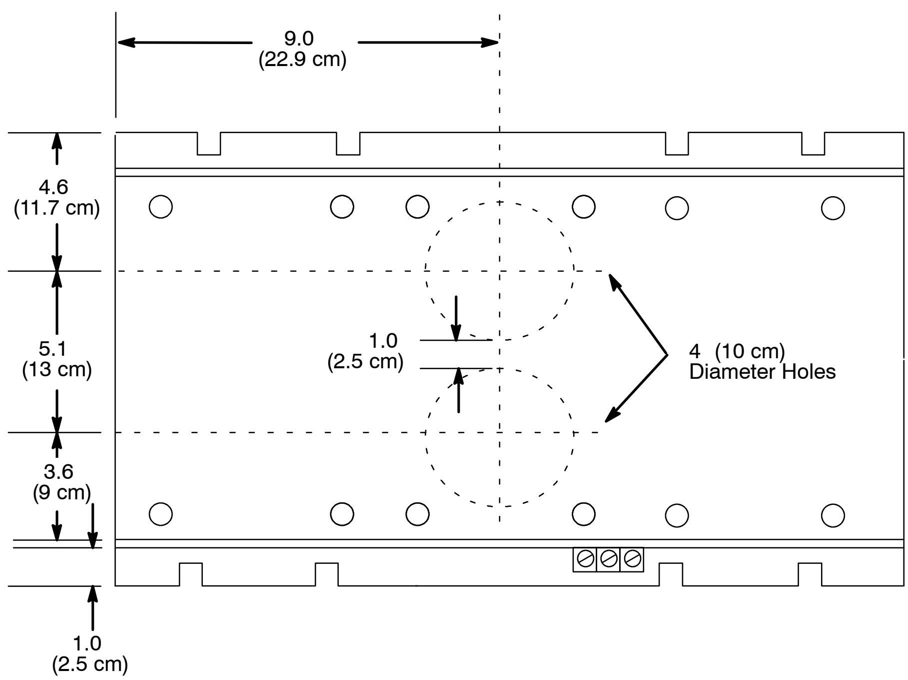


Figure 19 Dimensions to locate Optional Fan Holes on CL1060 Drive Mounting Plate

Mounting the CL1060W

When selecting a mounting site for the CL1060W, select a site on the panel wall that allows sufficient space for mounting and wiring the drive components and allows free air circulation.

Caution   Leave at least 6 inches (15.25 cm) of clearance around all sides of the external heat sink, and a clearance of 4 inches above and below the drives. This allows air to circulate away from the heat sink. Any mounting scheme that blocks air circulation reduces the plate s ability to dissipate heat and will reduce the system s longterm performance.

Use the following equipment to mount the CL1060W drive:

- Eye protector
- Electric drill with 9/32-inch (7.2 mm) and 5/16-inch (8mm) bits
- Ten sets of 1/4-20 x 5/8 mounting hardware, including pan head phillips screws, nuts, and lockwashers
- The mounting gasket (shipped with the mounting plate assembly)
- Screwdrivers and wrenches to attach the mounting hardware to the drive and cabinet

To install the CL1060W:

1. Refer to Figure 20 for the mounting dimensions. Locate and mark the mounting holes in the cabinet.
2. Using a 9/32-inch bit, drill the ten mounting plate mounting holes. Using a 5/16-inch bit, drill the two fan bracket mounting holes.
3. Securely install the mounting plate with 1/4-20 or #10 hardware.
4. Mount the shunt regulator resistor in a convenient location. Allow a minimum of 1 inch of free space surrounding the resistor for heat dissipation.

Caution   After drilling, tapping, or performing any other cutting procedure on the cabinet panels, remove all metal filings from the enclosure. These filings can severely damage equipment if they come in contact with and short connections.

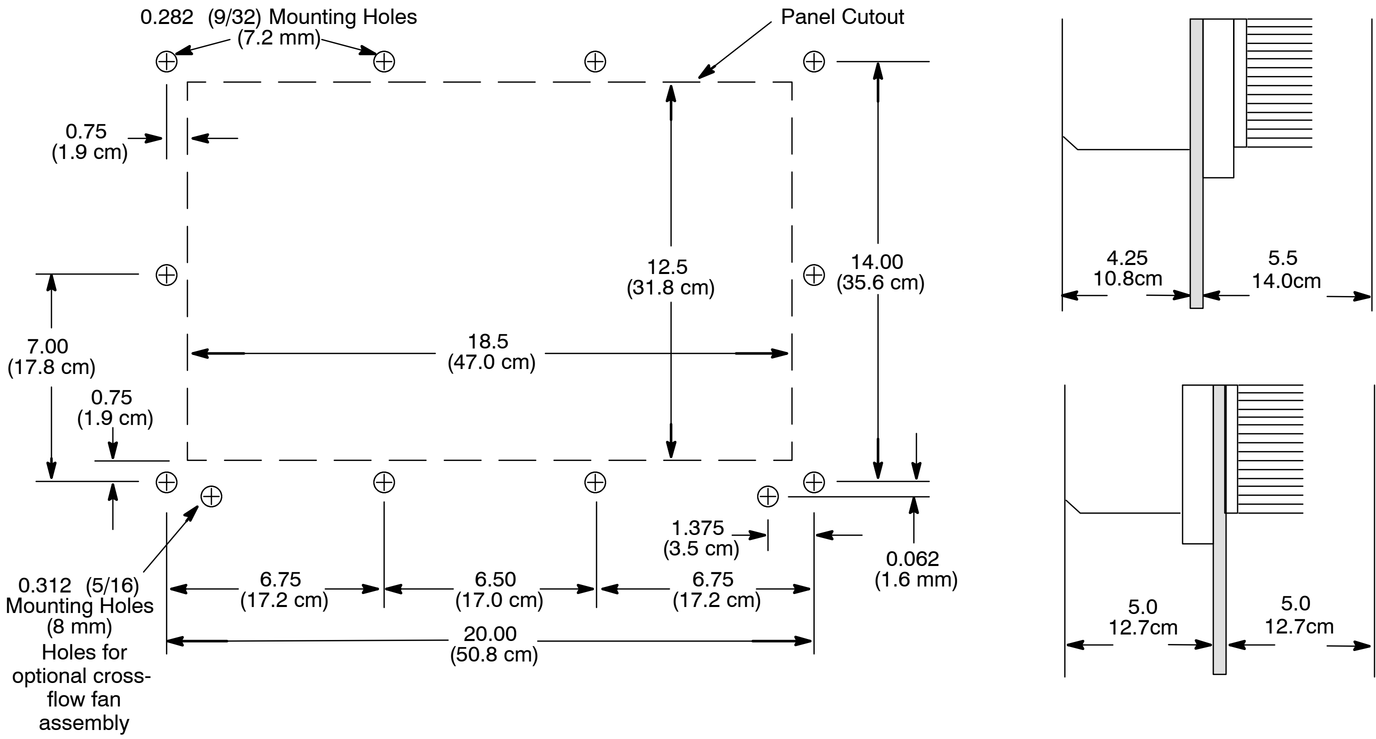


Figure 20 CL1060W Mounting Dimensions

Chapter 5
Wiring the System

- Introduction
- Power wiring

Introduction

This chapter provides instructions for wiring power to your CL1000A system. It covers the following topics:

- Power wiring terminal-block connectors
- Wiring the isolation transformers
- Wiring the drives to a PLS4 power supply
- Wiring the CL1060 drives
- Wiring drives to controller
- Connecting the drive to motor cables
- Connecting line power to the fans
- Connecting components to chassis ground

Power Wiring

This section provides several procedures for wiring system power. Each wiring procedure has a connection drawing, a list of all of the materials and tools required for the procedure, and step-by-step wiring instructions. See Appendix D for a detailed diagram of a typical CL1000A system configuration.

To wire the system, you need to perform these major steps:

1. Connect the transformer primary jumpers for your voltage option.

2. Wire the transformer secondary outputs through proper fusing to the power supply.

3. Wire the drive to the power supply. The CL1060 drive has its own internal power supply; however, it can also provide power for up to three CL1005-CL1030 drives.

4. Connect the drive to the controller.

5. Connect the drive to the servo motor. These connections can be through emergency stop contactors, equipped with dynamic braking resistors

6. Connect the servo motor resolver to the drive.

Caution Do not bundle power wiring to signal wiring, as this will increase signal noise. Be sure to route signal and power cables in separate conduits or raceways. Where signal cables cross power cables, they should do so at right angles. Improper cable routing is one of the most common application problems that can occur.

Tag the wires as you connect them. After completing wire runs, use cable ties to neatly bundle your various connections (by type) within the mounting cabinet.

Terminal Block Connectors

CL1000A system power is wired via two terminal-block connectors:

- TB1

- TB2

TB1 and TB2 are located on drive models CL1005-CL1030, the PLS4 power supply, and the CL1060 drive/power supply.

Figure 21 shows TB1 and TB2 and their terminal functions for the CL1000A drive (models CL1005 to CL1030), the PLS4 power supply, and the CL1060 drive/power supply.

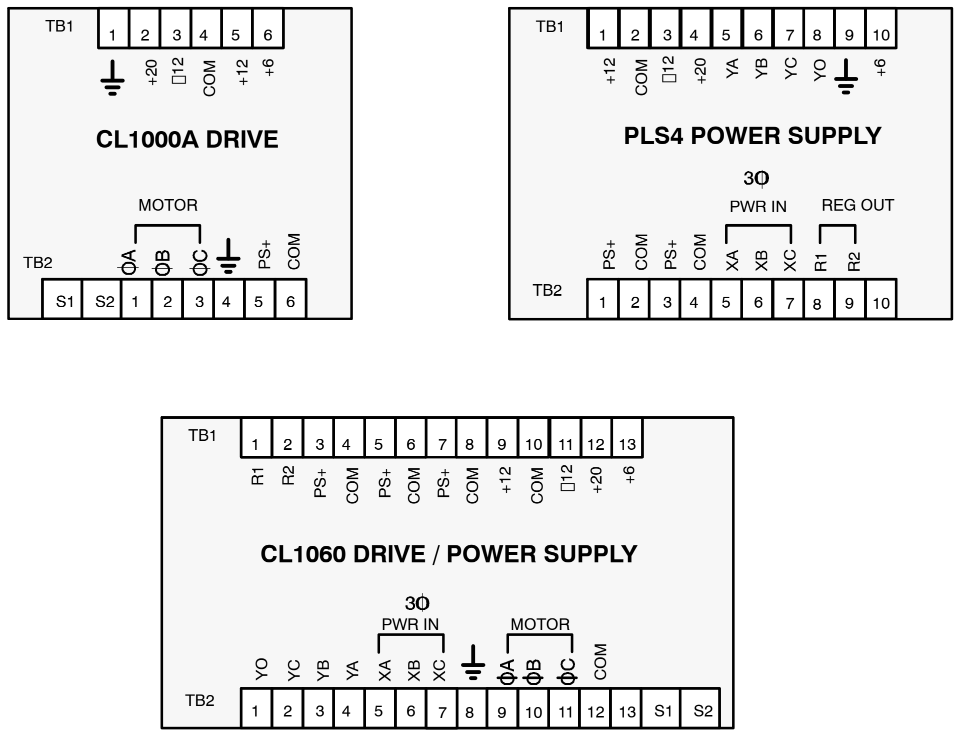


Figure 21 TB1 and TB2 on the CL1000A Drive, PLS4 Power Supply, and CL1060 Drive/Power Supply

Wiring the Isolation Transformers

Isolation transformers come in two styles --open frame and NEMA 12 enclosed. These two styles come with the following primary voltages:

- Open frame:
  - Three-phase (208, 240, 416, and 480 VAC)
  - Single-phase (105,115, and 120 VAC)
- NEMA 12 enclosed:
  - Three-phase (460 and 480 VAC)

Open Frame Three-Phase Transformers

Modicon offers five open-frame isolation transformers that can be wired for three-phase power at line voltages of 208, 240, 416, or 480 VAC at 60 Hz:

Modicon Part Number	kVA Rating	Minimum Wire Size for Primary Connections [1]	Minimum Wire Size for XA, XB, XC Connections [2]
800-110	1.5	12 AWG	12 AWG
800-111	3.2	12 AWG	12 AWG
800-112	6.4	10 AWG	10 AWG
800-113	9.6	8 AWG	8 AWG
800-125	13.0	6 AWG	6 AWG

[1] Assumes 208 or 240 VAC mains. For 416 or 480 VAC mains, add 2 to the AWG number.

[2] Assumes one power supply per transformer. If multiple power supplies are used with balance loading, add 2 to the AWG number. Remember that the maximum KVA of the transformer cannot be exceeded.

To wire the three-phase transformer:

1. Wire the transformer primary to match the input voltage.

   See the three-phase primary wiring table on the next page, and see Figure 22.

2. Wire the transformer secondaries through the fuses to the PLS4 power supply or to the supply connections on the CL1060.

   See the low-voltage and high voltage secondary wiring tables on the next page, and see Figure 23 and 24.

3. If this transformer is powering another PLS4 or CL1060, run separate fused wires from the transformer to the power supply. Do not connect the power supplies in a daisy chain.

STOP **Warning SHOCK HAZARD! Lethal voltages exist at transformer connections. Always make certain that the line power has been disconnected before wiring.**

Note Wire circuit breakers (or fuses) in series with the the transformer primary connections.

Use only high-temperature rated copper wire, 75° C or greater.

Open Frame Three-Phase Transformer Primary Wiring

Three-phase Line Voltage	Jumpers	Line Connections
208 VAC	H1 to H4 H2 to H5 to H7 H7 to H10 H8 to H11 to H13 H13 to H16 H14 to H17 to H1	H1, H7, H13
240 VAC	H1 to H4 H3 to H6 to H7 H7 to H10 H9 to H12 to H13 H13 to H16 H15 to H18 to H1	H1, H7, H13
416 VAC	H2 to H4 H5 to H7 H8 to H10 H11 to H13 H14 to H16 H17 to H1	H1, H7, H13
480 VAC	H3 to H4 H6 to H7 H9 to H10 H12 to H13 H15 to H16 H18 to H1	H1, H7, H13

Open Frame Three-Phase Transformer Secondary Wiring --Low Voltage

From this Transformer Terminal	To this PLS4 Power Supply Terminal
Y0	Y0
Y1 (19 VAC) or Y4 (21 VAC) [1]	YA
Y2 (19 VAC) or Y5 (21 VAC) [1]	YB
Y3 (19 VAC) or Y6 (21 VAC) [1]	YC

[1] Lead must be fed through fuse type KTK10.

Open Frame Three-Phase Transformer Secondary Wiring -- High Voltage

From this Transformer Terminal	To this PLS4 Power Supply Terminal
X1 (135 VAC) or X2 (199 VAC) or X7 (220 VAC) [2]	XA
X3 (135 VAC) or X4 (199 VAC) or X8 (220 VAC) [2]	XB
X5 (135 VAC) or X6 (199 VAC) or X9 (220 VAC) [2]	XC

[2] Lead must be fed through fuse type KTK30.

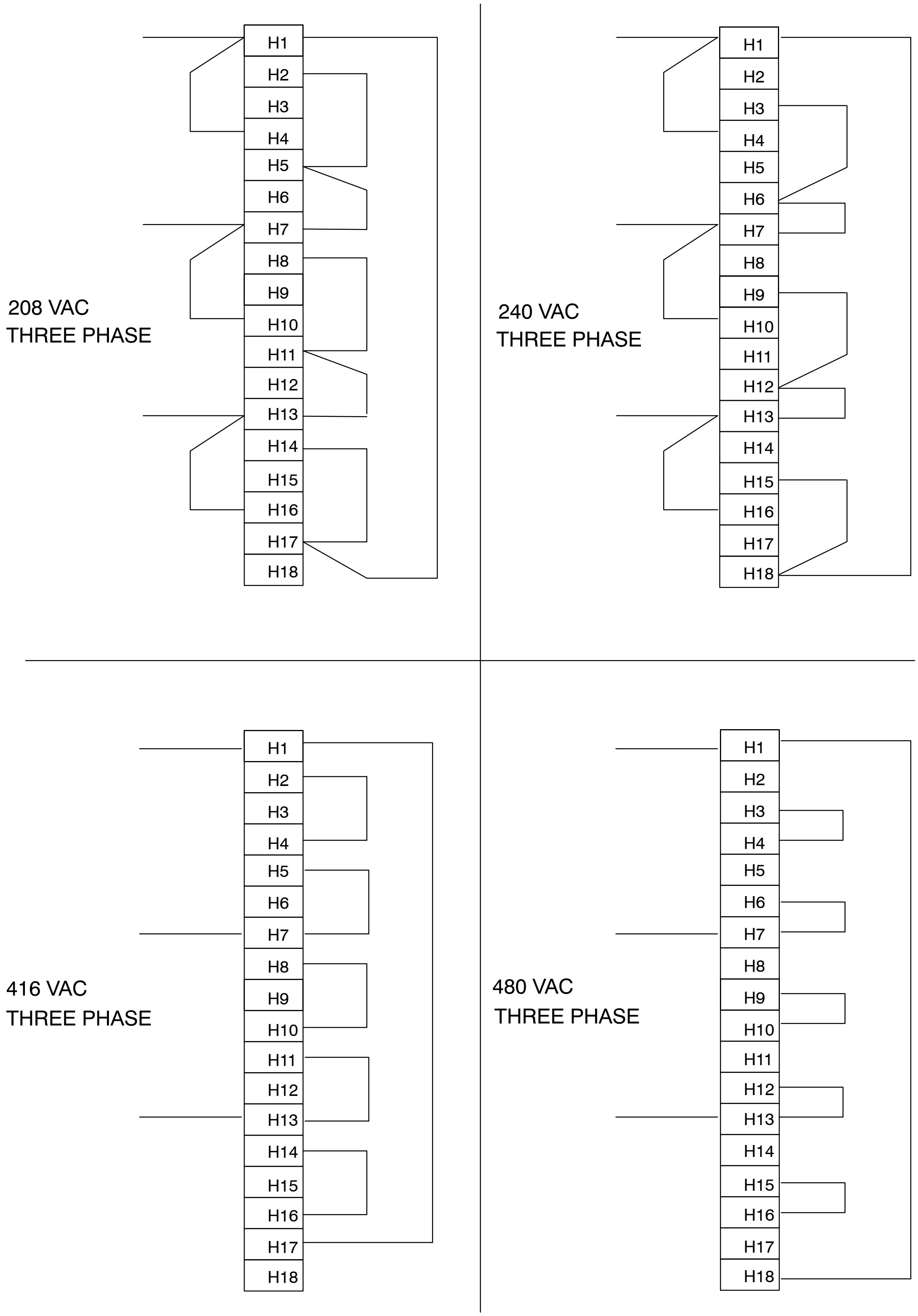
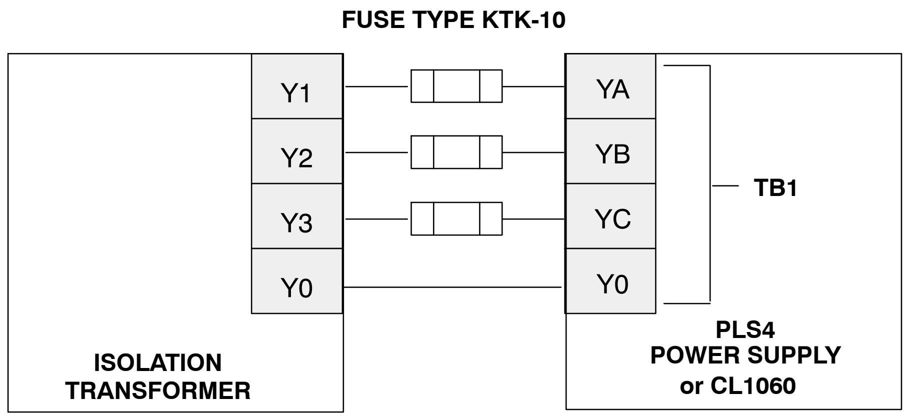


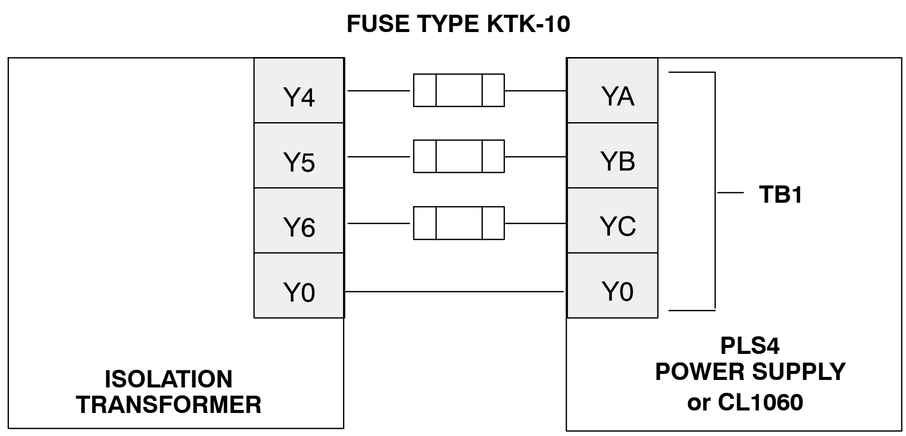
Figure 22 Open Frame Three-Phase Transformer Primary Wiring

GI-CYBL-002

1) STANDARD WIRING (19 VAC)



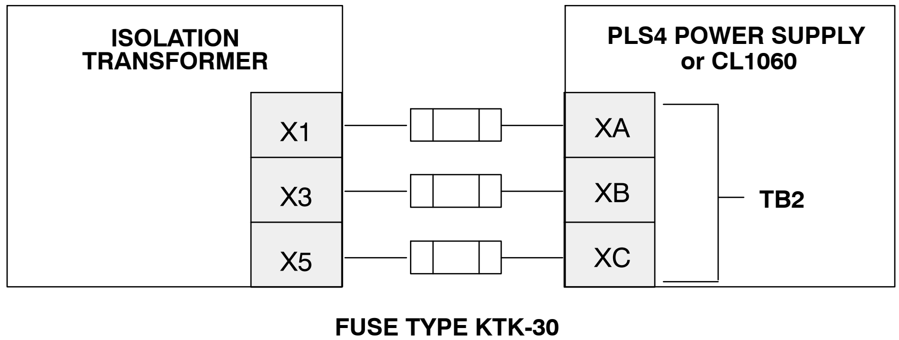
2) OPTIONAL WIRING (21 VAC) *



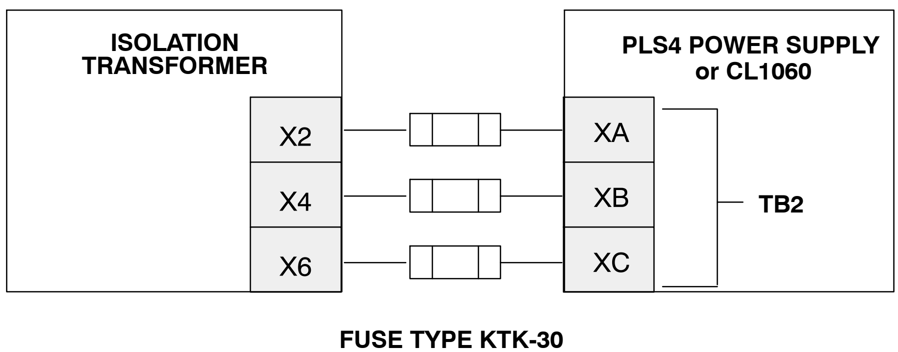
* **NOTE:** Higher voltage configuration should only be used in cases where line voltage from the main power source is known to be consistently low. Do not use this configuration unless conditions require it.

Figure 23 Open Frame Three-Phase Low Voltage Secondary Wiring

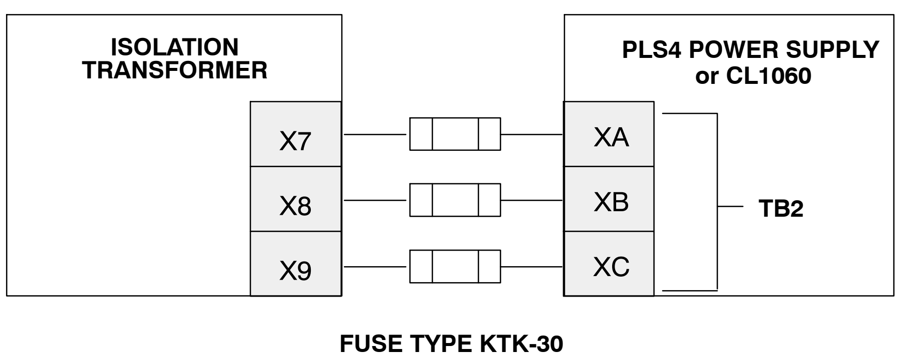
1) 135 VAC WIRING



2) 199 VAC WIRING



3) 220 VAC WIRING



NOTE: For best motor performance, always use the lowest voltage possible that will meet the needs of your application.

Figure 24 Open Frame Three-Phase High Voltage Secondary Wiring

Note Wire fuses in series with the secondary connections. On the low voltage secondary lines, use Bussman type KTK-10 fuses or equivalent. On the high-voltage secondary lines, use Bussman type KTK-30 fuses or equivalent. The neutral line (Y0) should not be fused. These fuses and their holders are included in the Modicon F30/10 fuse kit.

Open Frame Single-Phase Transformers

The single-phase isolation transformer provides all AC power required by the PLS4 power supply. The transformer has two secondaries: 19 VAC and 199 VAC (or 135 VAC).

Modicon offers two isolation transformers that can be wired for single-phase power at line voltages of 105, 115, and 120 VAC at 60 Hz:

Part Number	kVA Rating	Low-Voltage Winding Capacity (number of drives)
800-026	2.0	two drives
800-027	0.75	one drive

Warning SHOCK HAZARD! Lethal voltages exist at transformer connections. Always make certain that the line power has been disconnected before wiring.

Note Use 12 AWG wire for isolation transformer connections.

Note Wire circuit breakers (or fuses) in series with the transformer primary connections.

To wire the single-phase transformer:

1. Wire the transformer primary to match the input voltage.

   See the single-phase primary wiring table that follows. Figure 25 shows both primary and secondary single-phase wiring.

2. Wire the transformer secondaries through the fuses to the PLS4 power supply. See the single-phase secondary wiring table that follows. Figure 25 shows both primary and secondary single-phase wiring.

Note Modicon does not recommend using a single-phase transformer with a CL1030 drive or a CL1060 drive.

Open Frame Single-Phase Transformer Primary Wiring

Single-phase Line Voltage	Transformer Connections
105 VAC	Hot to H2 Neutral to H1
115 VAC	Hot to H3 Neutral to H1
120 VAC	Hot to H4 Neutral to H1

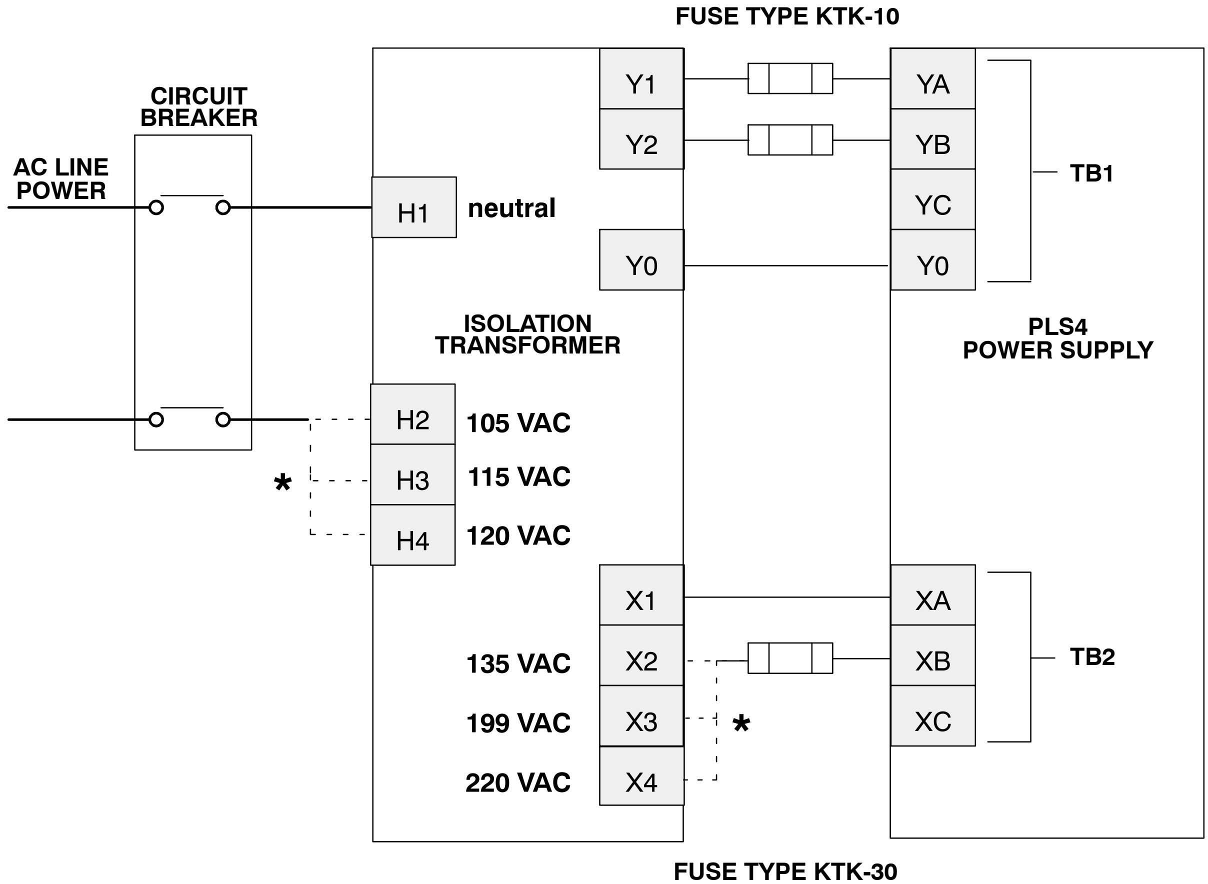
Open Frame Single-Phase Transformer Secondary Wiring

From this Transformer Terminal	To this PLS4 Power Supply Terminal
Y0	Y0
Y1 [1]	YA
Y2 [1]	YB
X1	XA
X2 (135 VAC) or X3 (199 VAC) or X4 (220 VAC) [2]	XB

[1] Lead must be fed through fuse type KTK10.

[2] Lead must be fed through fuse type KTK30.

Only one transformer terminal can be used.



*** NOTE: For best motor performance, always use the lowest voltage possible that will meet the needs of your application.**

Figure 25 Single-Phase Transformer Wiring

NEMA 12 Enclosed Three-Phase Transformers

Modicon offers five NEMA 12 enclosed isolation transformers that can be wired for three-phase power at line voltages of 460 or 480 VAC at 60 Hz. The following table lists minimum wire sizes (75 °C copper wire).

Modicon Part Number	kVA Rating	Minimum Wire Size Primary Connections	Minimum Wire Size for XA, XB, XC Connections [1]
800-060	1.5	14 AWG	14 AWG
800-061	3.2	12 AWG	14 AWG
800-062	6.4	10 AWG	12 AWG
800-063	9.6	8 AWG	10 AWG
800-064	13.0	6 AWG	8 AWG

[1] Assumes one power supply per transformer. If multiple power supplies are used with balance loading, add 2 to the AWG number. Remember that the maximum kVA of the transformer cannot be exceeded.

To wire the three-phase transformer:

1. Wire the transformer primary to match the input voltage.

   See the three-phase primary wiring table on the next page, and see Figure 26.

2. Wire the transformer secondaries through the fuses to the PLS4 power supply or to the supply connections on the CL1060.

   See the three-phase secondary wiring table on the next page, and see Figure 27 and Figure 28.

3. If this transformer is powering another PLS4 or CL1060, run separate fused wires from the transformer to the power supply. Do not connect the power supplies in a daisy chain.

Warning SHOCK HAZARD! Lethal voltages exist at transformer connections. Always make certain that the line power has been disconnected before wiring.

Note Wire circuit breakers (or fuses) in series with the the transformer primary connections.

Use only high-temperature rated copper wire, 75° C or greater.

NEMA 12 Enclosed Three-Phase Transformer Primary Wiring

Three-phase Line Voltage	Jumpers	Line Connections
460 VAC	H1 to E H2 to A H3 to C	H1, H2, H3
480 VAC	H1 to F H2 to B H3 to D	H1, H2, H3

NEMA 12 Enclosed Three-Phase Transformer Secondary Wiring

From this Transformer Terminal	To this PLS4 Power Supply Terminal
Y0	Y0
7 (19 VAC) or 8 (21 VAC) [1]	YA
9 (19 VAC) or 10 (21 VAC) [1]	YB
11 (19 VAC) or 12 (21 VAC) [1]	YC

[1] Lead must be fed through fuse type KTK10.

1 (199 VAC) or 2 (220 VAC) [2]	XA
3 (199 VAC) or 4 (220 VAC) [2]	XB
5 (199 VAC) or 6 (220 VAC) [2]	XC

[2] Lead must be fed through fuse type KTK30

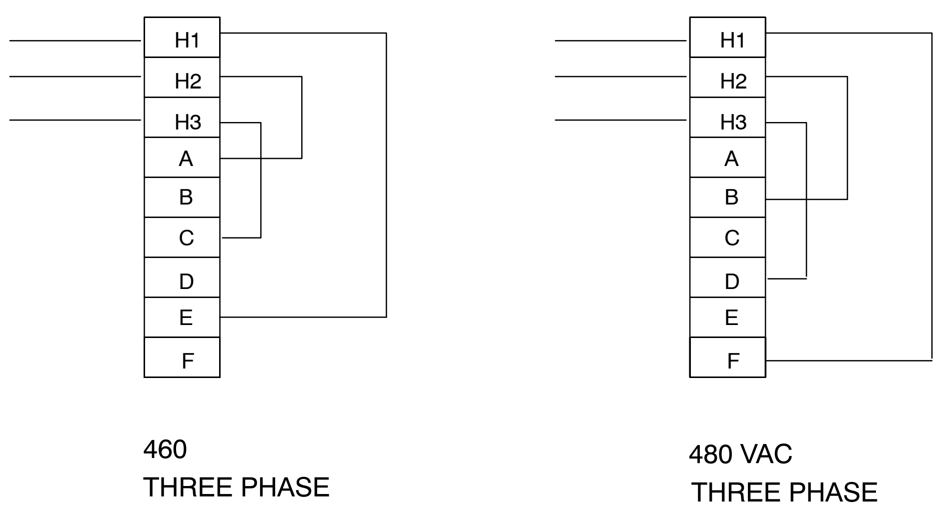
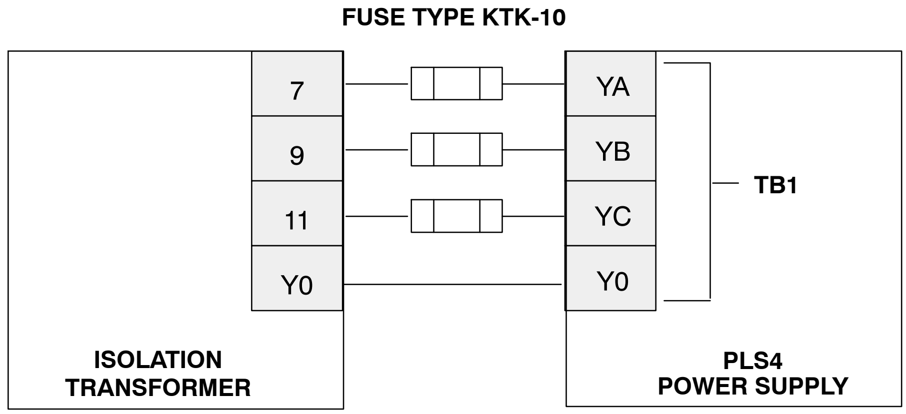
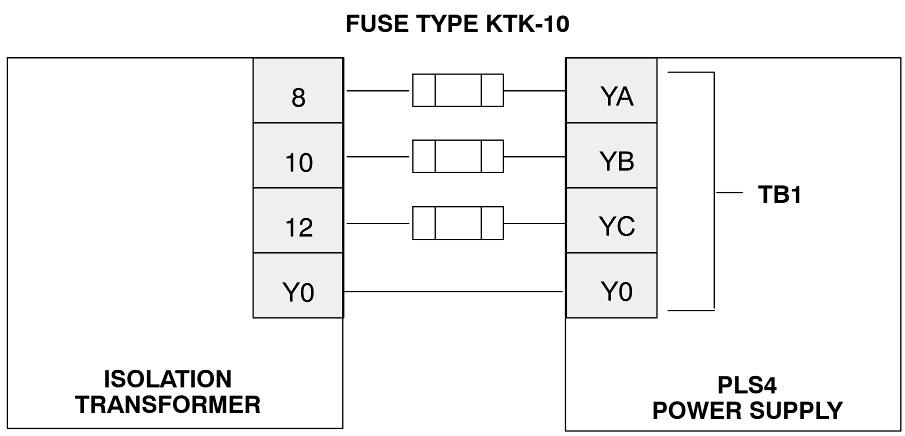


Figure 26 NEMA 12 Enclosed Three-Phase Transformer Primary Wiring

1) STANDARD WIRING (19 VAC)



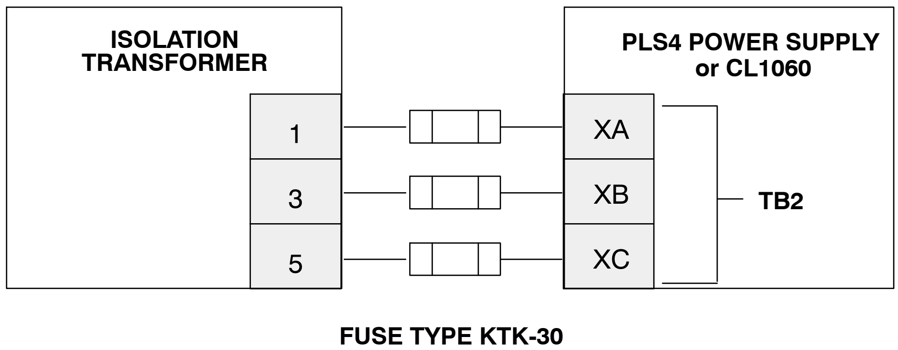
2) OPTIONAL WIRING (21 VAC) *



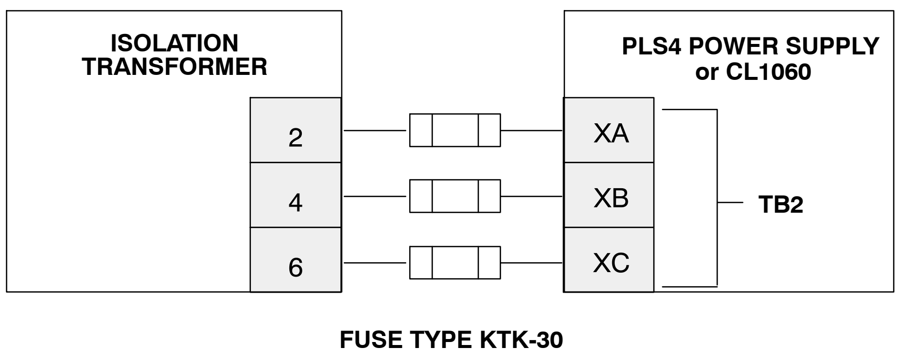
* **NOTE:** Higher voltage configuration should only be used in cases where line voltage from the main power source is known to be consistently low. Do not use this configuration unless conditions require it.

Figure 27 NEMA 12 Enclosed Three-Phase Low Voltage Secondary Wiring

1) 199 VAC WIRING



2) 220 VAC WIRING



NOTE: For best motor performance, always use the lowest voltage possible that will meet the needs of your application.

Figure 28 NEMA 12 Enclosed Three-Phase High Voltage Secondary Wiring

☞ **Note** Wire fuses in series with the secondary connections. On the low voltage secondary lines, use Bussman type KTK-10 fuses or equivalent. On the high-voltage secondary lines, use Bussman type KTK-30 fuses or equivalent. The neutral line (Y0) should not be fused. These fuses and their holders are included in the Modicon F30/10 fuse kit.

Wiring Drives to a PLS4 Power Supply

The following subsections provide instructions for wiring CL1005 through CL1030 drives to a PLS4 power supply. If your system has a CL1060 drive/power supply, refer to the next section, Wiring the CL1060 Drive.

Connecting Shunt Regulator Resistor to the PLS4

A 10 ohm, 225 watt shunt regulator resistor (supplied with the power supply) must be wired to the R1 and R2 on the PLS4 power supply. The regulator limits the DC bus voltage during motor regeneration.

Use the following equipment to wire the shunt resistor:

- 10 ohm, 225 watt resistor (shipped with the power supply)
- Mounting kit (shipped with the power supply)
- Two lengths of 12-gauge, high temperature rated wire (155° C or greater)

To wire the shunt regulator resistor:

1. Mount the shunt resistor. There are two mounting kit designs shipped with the resistor. One kit contains end brackets. The second kit contains a long clamping bolt that can be attached to the cabinet. The resistor should be mounted with at least 1 inch clearance on all sides for adequate air flow.
2. Connect the resistor leads to R1 and R2 on the power supply. See Figure 29.

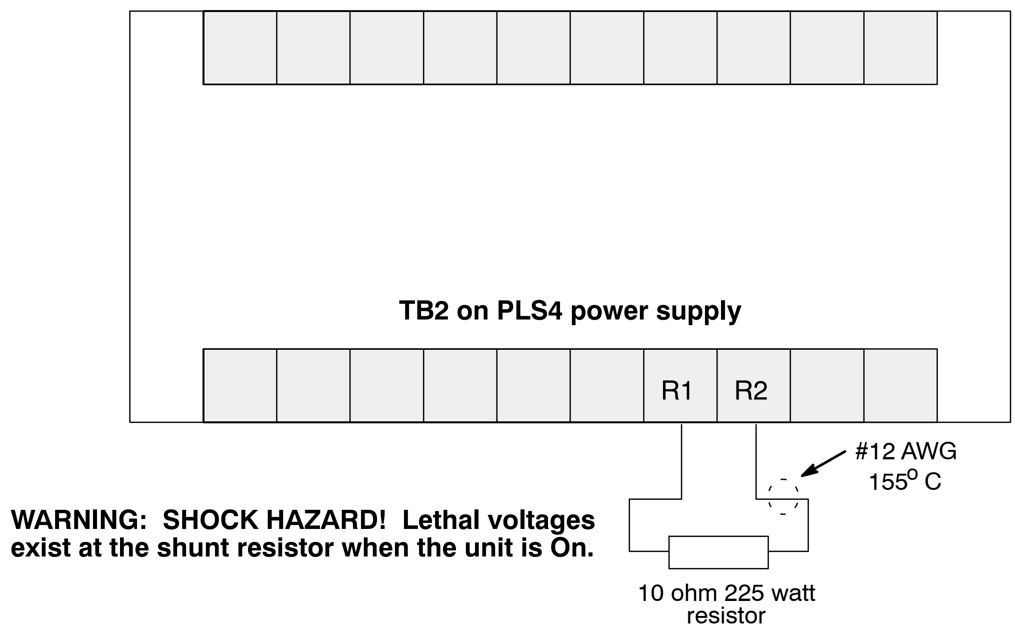


Figure 29 Wiring the Shunt Regulator Resistor to Power Supply

Note In applications involving rapidly accelerating and decelerating heavy inertial loads, the regen resistor can become quite warm. If possible, put the regen resistor outside the equipment cabinet in free air flow, away from the drive electronics. The regen wire should be rated for high-temperature operation (155° C copper wire, not aluminum).

Connecting PLS4 to CL1005-CL1030 Drives

Two separate sets of outputs are provided by the PLS4 power supply:

- Low level DC supplies (+20 VDC, -12 VDC, +12 VDC, and COM)
- High-voltage DC bus supply (PS+ and PS COM)

The following subsections provide instructions for connecting both sets of outputs to CL1005 through CL1030 drives.

Note Do not connect either set of outputs in a daisy chain fashion. Each drive must have its own wires connecting it directly to the power supply.

Wiring the low level DC supplies: Use the following equipment to connect the low level DC supplies:

- Four 16-gauge (minimum) wires for each drive

To connect the low level DC supplies to the drives:

1. Strip 1/4 inch of insulation from both ends of each wire, then connect the wires between the power supply and drive as follows:

TB1 on PLS4	TB1 on Drive
+12	+12
COM	COM
-12	-12
+20	+20

See Figure 30.

2. Check that all connections are correct and tight.

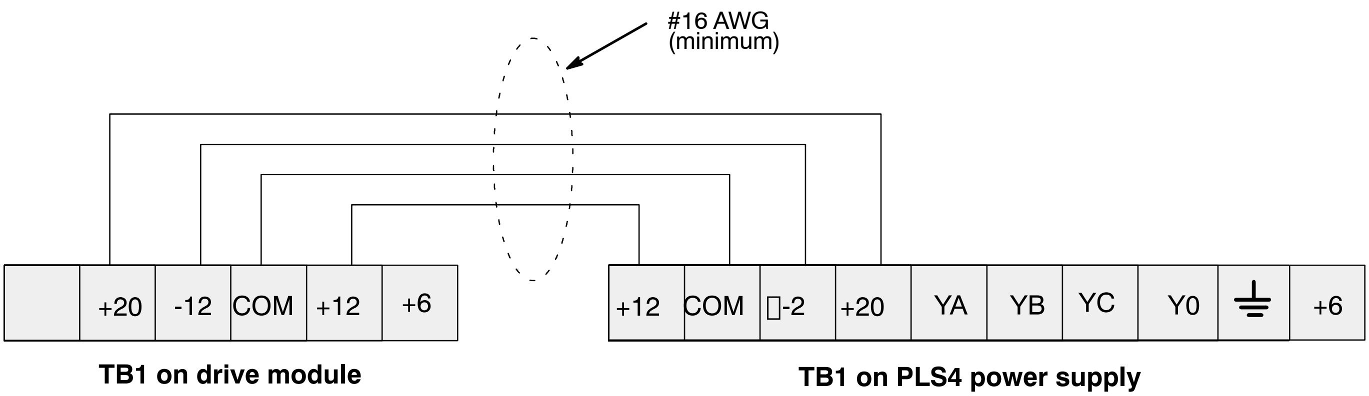


Figure 30 Low Level DC Supply Wiring

Connecting the DC Bus

Use the following equipment to connect the DC bus wires:

- ❒ Two 12-gauge wires for each drive

To connect the PLS4 DC bus supplies to the drives:

1. Strip 1/4 inch of insulation from both ends of each wire, then connect the wires between the PLS4 and the drives as follows:

TB2 on PLS4	TB2 on Drive
	Drive 1
PS+ (1)	PS+ (5)
COM (2)	COM (6)
	Drive 2
PS+ (3)	PS+ (5)
COM (4)	COM (6)
	Drive 3
PS+ (1)	PS+ (5)
COM (2)	COM (6)
	Drive 4
PS+ (3)	PS+ (5)
COM (4)	COM (6)

See Figure 31.

2. Check that all connections are correct and tight.

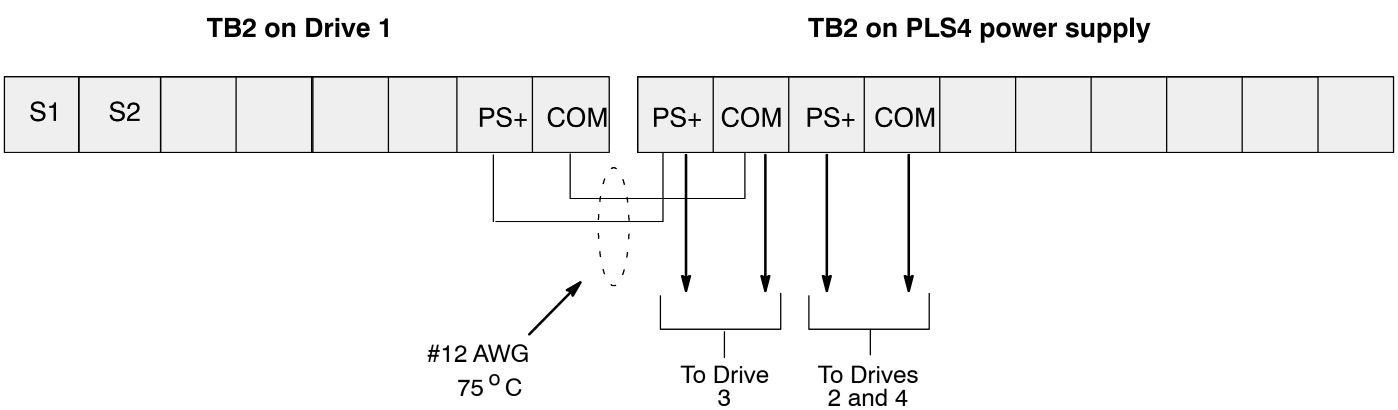


Figure 31 DC Bus Wiring

Wiring the CL1060 Drive

The CL1060 drive and power supply assembly is capable of powering up to three additional CL1005 to CL1030 drives. While the CL1 internal drive is factory wired to the internal power supply, you must wire any additional drives.

Two separate sets of outputs are provided by the CL1060 power supply:

- Low level DC supplies (+20 VDC, -12 VDC, +12 VDC, and COM).
- DC bus supply (PS+ and PS COM).

The following subsections provide instructions for connecting both supplies to CL1005 through CL1030 drives. Do not connect either supply in a daisy chain fashion. Each drive must have its own wires connecting it directly to the power supply.

Wiring the Low Level DC Supplies

☞ **Note** Perform this procedure only if you are connecting additional external drives.

Use the following equipment to connect the low level DC supplies:

- Four 16-gauge (minimum) wires for each drive.

To connect the low level DC supplies to the drives:

1. Strip 1/4 inch of insulation from both ends of each wire. Then connect the wires between the power supply and drive as follows:

TB1 on CL1060 Power Supply	TB1 on Additional Drives
+12	+12
COM (10)	COM
-12	-12
+20	+20

See Figure 32.

2. Check that all connections are correct and tight.

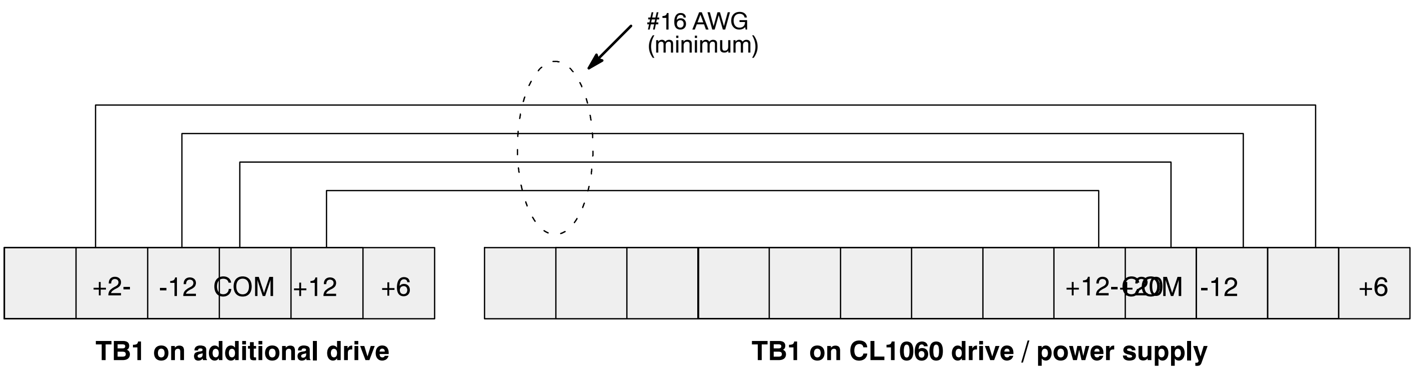


Figure 32 Low Level DC Supply Wiring on CL114D

GI-CYBL-002

Connecting the DC Bus

Note This procedure is necessary only if you are connecting additional external drives.

Use the following equipment to connect the DC bus wires:

- Two 12-gauge wires for each drive

To connect the DC bus supplies to the drives:

1. Strip 1/4 inch of insulation from both ends of each wire. Then connect the wires between CL1060 and the drives as follows:

TB1 on CL1060 Drive / Power Supply	TB2 on Additional Drives
CL1060	**Drive 1**
PS+ (3)	PS+ (5)
COM (4)	COM (6)
	Drive 2
PS+ (5)	PS+ (5)
COM (6)	COM (6)
	Drive 3
PS+ (7)	PS+ (5)
COM (8)	COM (6)

   See Figure 33.

2. Check that all connections are correct and tight.

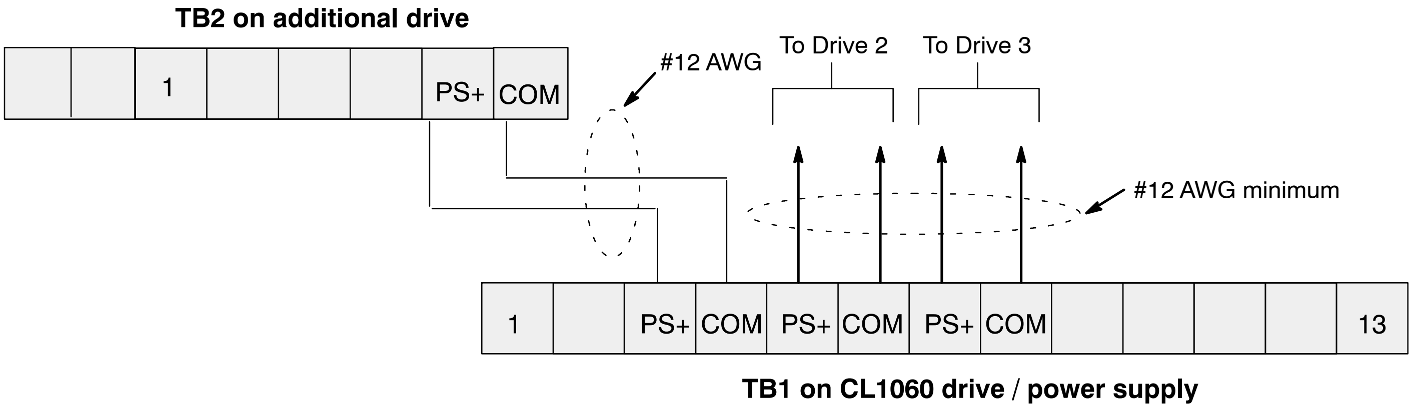


Figure 33 DC Bus Connections from Power Supply to CL1005 - CL1030 Drives

Connecting the Shunt Regulator Resistor to the CL1060

A 5 ohm, 450 watt shunt regulator resistor (supplied with the power supply) must be wired to the R1 and R2 terminals on the CL1060 drive/power supply. (Two 10 ohm, 225 watt resistors can be wired in parallel.) The regulator limits the DC bus voltage during motor regeneration.

Use the following equipment to wire the shunt resistor:

- ❐ 5 ohm, 450 watt resistor (shipped with the CL1060) or two 10 ohm, 225 watt resistors
- ❐ Mounting kit
- ❐ Two lengths of 12-gauge, high-temperature rated wire (155° C or greater)

To wire the shunt regulator resistor:

1. Mount the shunt resistor. There are two mounting kit designs shipped with the resistor. One kit contains end brackets. The second kit contains a long clamping bolt that can be attached to the cabinet. The resistor should be mounted with at least 1 inch clearance on all sides for adequate air flow.

2. Connect the resistor leads to R1 and R2 on the CL1060.

   See Figure 34.

☞ **Note** In applications involving rapidly accelerating and decelerating heavy inertial loads, the regen resistor can become quite warm. If possible, put the regen resistor outside the equipment cabinet in free air flow, away from the drive electronics. The regen wire should be rated for high-temperature operation (155° C copper wire, not aluminum).

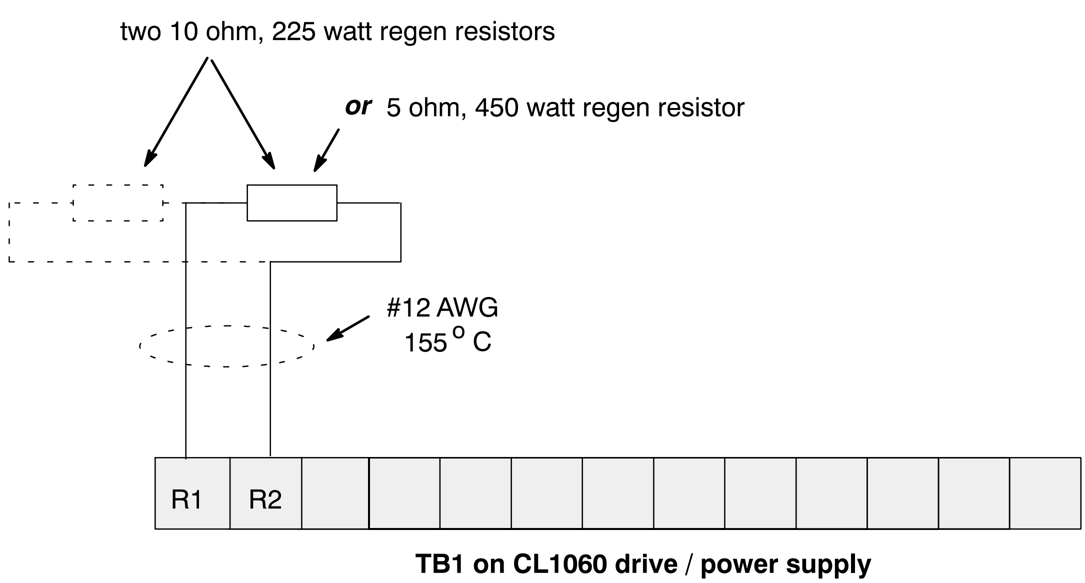


Figure 34 Wiring the Shunt Regulator Resistor to CL1060

Connecting Drives to Controller

This procedure requires the drive-to-controller cable, which should be attached to the controller as outlined in the controller manual. The drive-to-controller cable is equipped with a DB25 connector that attaches to the drive.

⚠ **Caution Do not bundle power wiring to signal wiring to avoid signal noise. Be sure to route signal and power cables in separate conduits or raceways. Signal cables and power cables should cross at right angles. Improper cable routing is one of the most common application problems.**

Use an appropriate cable to connect the drive to the controller. For a list of drive-to-controller cables and their part numbers, see Appendix C *Parts List*.

To connect the drive to controller:

1. At the drive, push the cable DB25 connector into the receptacle mounted above TB1. Refer to Figure 35 to locate the DB25 connector receptacle on drive models CL10005 - CL1030 and on drive/power supply model CL1060.

2. Tighten the two connector screws.

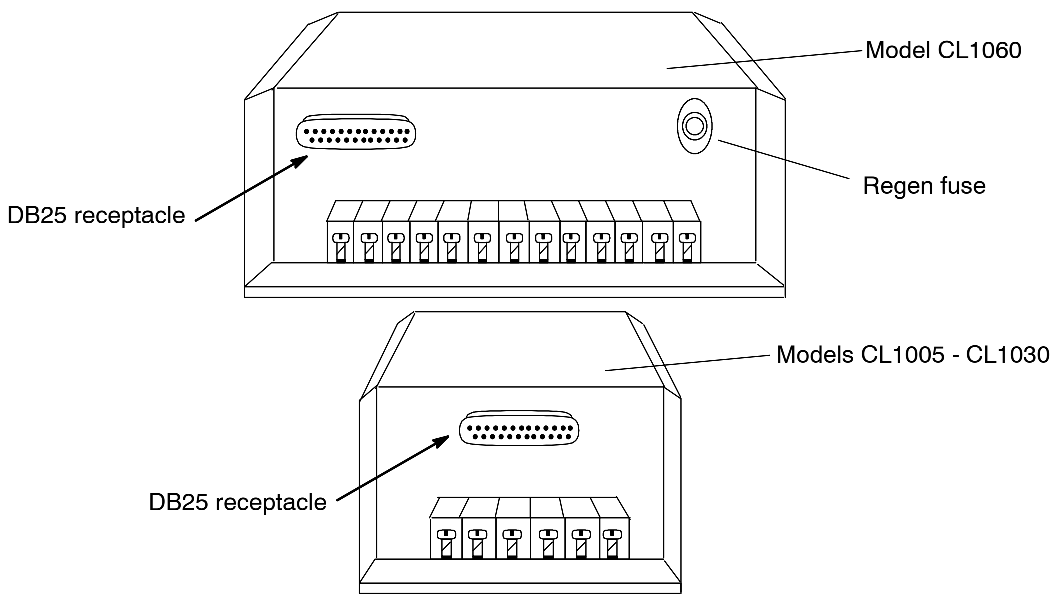


Figure 35 Drive-to-Controller Connector Locations

Figure 36 shows details of the drive/controller interface.

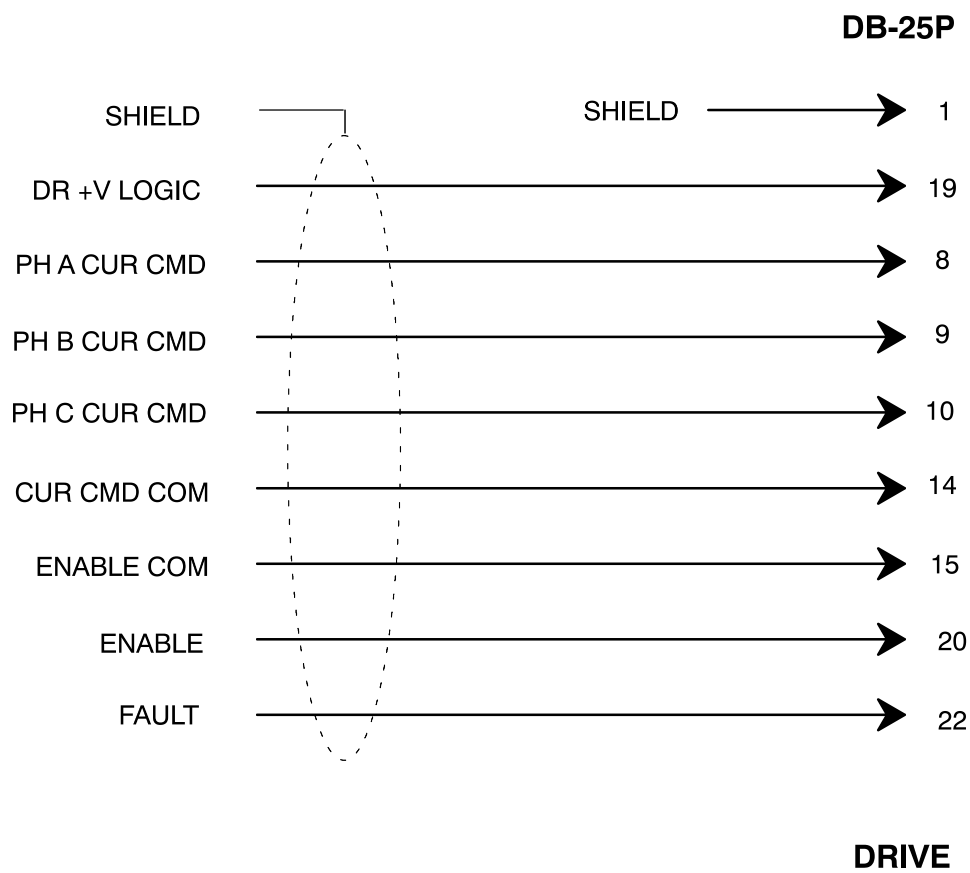
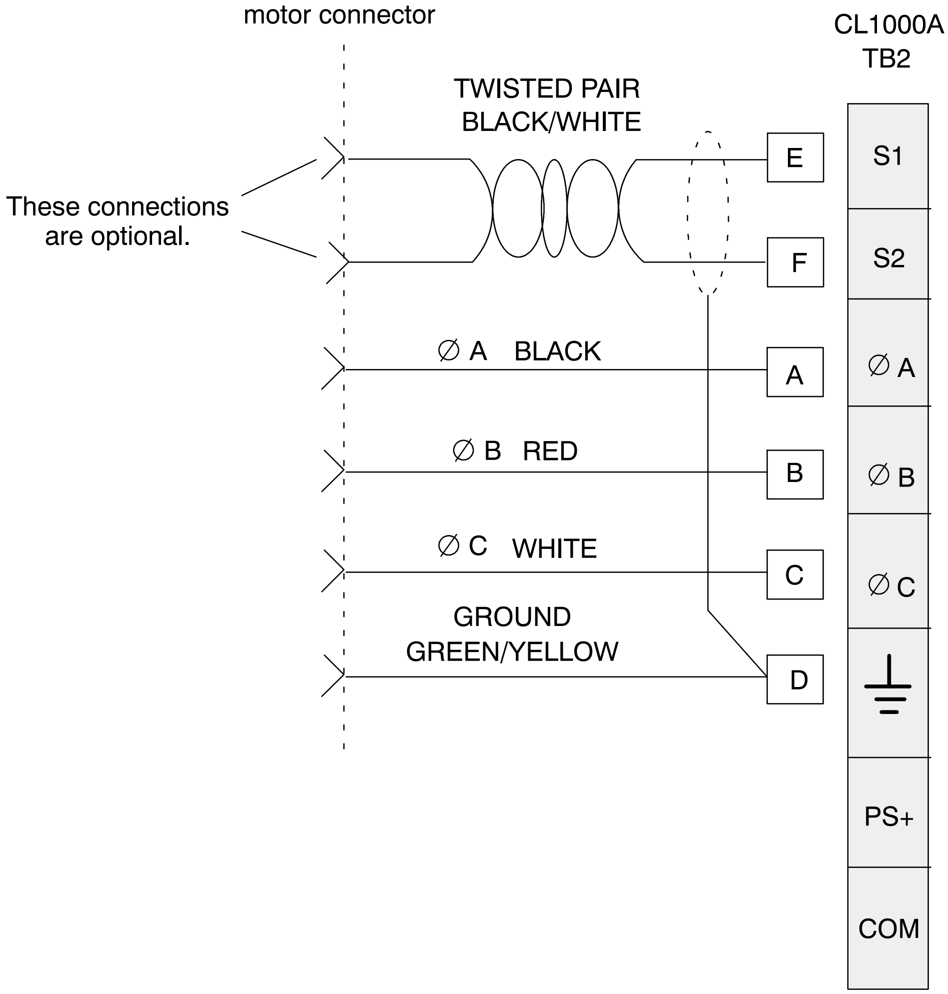


Figure 36 Drive-to-controller Interface

Connecting Drive to Motor Cables

Figure 37 shows the drive s TB2 pin connections to a motor. For a list of drive-to-motor cables and their part numbers, please consult the *Modicon 984 Catalog and Specifier s Guide*, MC-CAT-001, and your Modicon customer service representative.



NOTE 1: Motor connector pin destinations may be labeled 1-2-3-4, respectively.

NOTE 2: If colors of wires in cable do not match the ones shown above, always follow label designations.

NOTE 3: The twisted pair wires, if connected to terminals S1 and S2, will cause a drive fault to occur if the cable is removed from the motor while the drive is enabled. It does not matter which wire is connected to which terminal. If you wish to use this feature you must remove the factory-installed jumper between S1 and S2. If you do not wish to use this feature, leave the jumper in place.

Figure 37 Connecting Drive to Motor Cables

Connecting Line Power to the Fans

The mounting plate fans and the optional fan bracket operate from a single 115 VAC or 220 VAC, 60 Hz, grounded line. You must run a separate power line from the plant 115 VAC supply for the fans. (Fan supply voltages are not available from the isolation transformer.)

Use the following equipment to apply power to the fans:

- A three conductor, 16-gauge (minimum) power cable
- Terminals, such as ring terminals

STOP **Warning SHOCK HAZARD. Be sure the power cable is disconnected from the line power source before connecting it to the mounting plate barrier strip.**

To apply power to the fans:

1. Strip 1/4 inch of insulation from the ends of the three conductors, then crimp a #8 ring terminal to each bare lead.
2. Attach the terminals to the mounting plate barrier strip as follows:

Line Power	Barrier Strip
Hot	1
Neutral	2
Ground	3

See Figure 38.

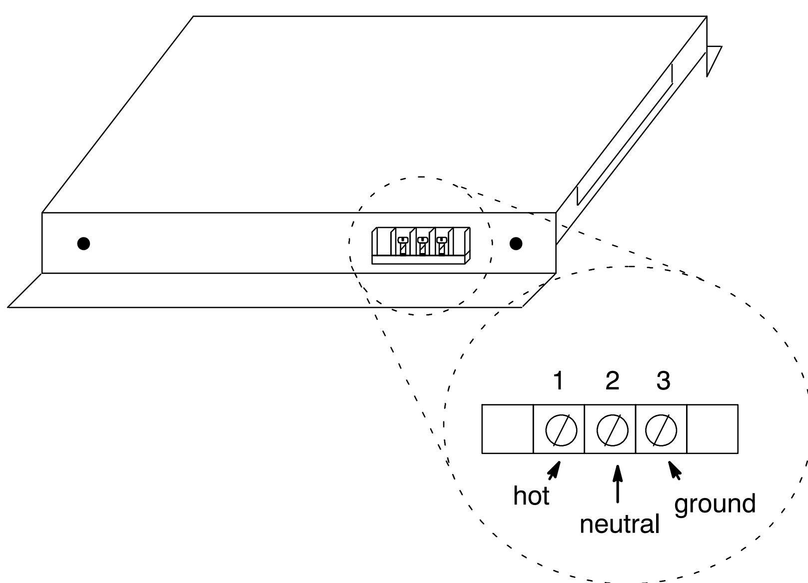


Figure 38 Fan Line Power Connections

Connecting Components to Chassis Ground

Warning SHOCK HAZARD. To avoid serious personal injury or death, all Cyberline equipment should be properly grounded. Your grounding system must comply with NEC (or CSA, CENELEC or other national code) and all prevailing local codes.

Cyberline drives, power supplies, and cold plates must be connected to the cabinet chassis ground stud (star grounding configuration) by separate wires. Each component is equipped with a chassis ground terminal for this purpose.

The cabinet itself must also be connected to the plant grounding system earth ground.

Use the following equipment to ground the components:

- One length of #12 AWG wire to connect each CL1000A drive to the chassis grounding point
- One length of #12 AWG wire for each power supply
- One length of #12 AWG wire for each cold plate
- Terminals, such as ring terminals

To ground the components:

1. Strip 1/4 inch of insulation from both ends of each ground wire, then attach the terminals you will use to connect the wires to the grounding point.
2. For each drive, connect one grounding wire to TB1-1 chassis ground.
3. For each PLS4 power supply, connect one grounding wire to TB1-9 chassis ground.
4. For each cold plate, connect one grounding wire to the grounding electrode.
5. Check that all connections are correct and tight.
6. For ground bus bars on painted panels, be sure all paint is scraped off of the area first.

See Figure 39.

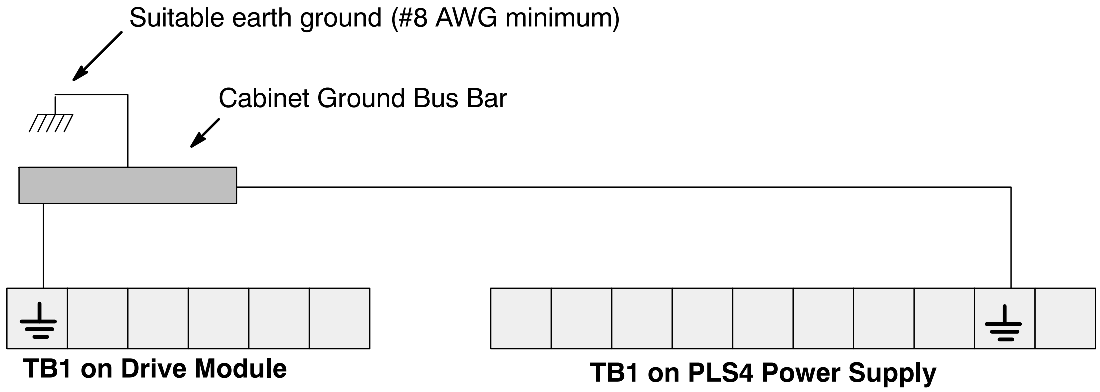


Figure 39 Earth Ground Connections for Drives and Power Supplies

See Appendix A *Grounding and Noise Reduction* for more information on system grounding.

Chapter 6
Initial Power-up and Component Check

- Introduction
- Equipment required for checks
- Initial inspection
- Isolation transformer output check
- Power supply check

Introduction

After mounting and wiring the CL1000A system, you should:

- Inspect the system and wiring.
- Check the isolation transformer output.
- Check the power supply output.

These check procedures are explained in the following sections.

STOP

Warning SHOCK HAZARD. There are lethal voltages at various points on the CL1000A system. To avoid severe personal injury or death, only trained electrical personnel should perform these procedures.

Caution Possibility of equipment damage. Proper setting of the current limiting parameters (IAVG, I PEAK) must be assured. Refer to your controller manual for the proper setting of IAVG.

Equipment Required for Checks

To check the transformer output, you must use a digital voltmeter (DVM), ± 0.5 percent accuracy.

Initial Inspection

Before you apply power to the system:

1. Check all wiring. Compare your equipment configuration to the diagrams in Chapter 5. Make sure the AC power is within the range specified for your system.
2. Securely mount the motors and disconnect the motor shafts from their mechanical loads.
3. Inspect the motor and loads. Be sure it is safe to run the motors.
4. Remove keys from motor shafts.

STOP **Warning OPERATING MACHINERY. During the following tests, the machinery may run at any time. Warn people near the machinery that you are about to start it and that the motors may run unexpectedly.**

Isolation Transformer Output Check

Caution Remove all fuses from the transformer secondary outputs before proceeding. If the transformer outputs are above the acceptable ranges, the power supply and drives could be damaged.

Note The output voltage ranges specified in the following isolation transformer output checks are based on a no-load, ± 3 percent tolerance rating of the transformer s nominal output voltage at the particular secondary output taps. Any fluctuation of the input line voltage to the transformer primary windings will have a direct proportional effect on the secondary output voltage measured.

The voltage tolerances specified in the following checks apply to Modicon products only.

Checking the Low Power Secondary

To check the low power secondary:

1. Apply power to the isolation transformer.
2. Set the DVM to the appropriate scale for reading 25 VAC. Check between the terminals listed in the tables below.

   If these readings are not correct, remove power from the isolation transformer and check the position of the primary jumpers. Jumper wiring is described in Chapter 5.

   If using the 19 VAC connections, measure between the following sets of terminals on the transformer. All readings should be within 18 VAC and 20 VAC:

Open Frame Three-Phase	Open Frame Single-Phase	Enclosed Three-Phase
Y0 to Y1	Y0 to Y1	Y0 to 7
Y0 to Y2	Y0 to Y2	Y0 to 9
Y0 to Y3		Y0 to 11

If using the 21 VAC connections, measure between the following sets of terminals on the transformer. All readings should be within 20 VAC and 22 VAC:

Open Frame Three-Phase	Enclosed Three-Phase
Y0 to Y4	Y0 to 8
Y0 to Y5	Y0 to 10
Y0 to Y6	Y0 to 12

If any one phase differs from the others by more than ± 0.5 VAC, make certain that the input line voltages are balanced.

Checking the High Power Secondary

Warning SHOCK HAZARD. Lethal voltages exist at the connection points of Cyberline equipment. To avoid severe personal injury or death, this procedure should only be performed by skilled technical personnel. Such personnel should be familiar with safe industrial wiring practices.

Note The output voltage ranges specified in the following isolation transformer output checks are based on a no load, ± 3 percent tolerance rating of the transformer s nominal output voltage at the particular secondary output taps. Any fluctuation of the input line voltage to the transformer primary windings will have a direct proportional effect on the secondary output voltage measured.

The voltage tolerances specified in the following checks apply to Modicon products only.

To check the high power secondary:

1. Use a DVM with at least a 250 VAC range.
2. Check between the following three pairs of terminals, as identified in the tables below.

   If the readings are not correct, remove power from the isolation transformer and check the positions of the primary jumpers. Jumper wiring is described in Chapter 5.

   If using the 135 VAC connections, measure between the following sets of terminals on the transformer. All readings should be within 131 VAC and 139 VAC:

Open Frame Three-Phase	Open Frame Single-Phase
X1 to X3	X1 to X2
X3 to X5	
X5 to X1	

If using the 199 VAC connections, measure between the following sets of terminals on the transformer. All readings should be within 193 VAC and 205 VAC:

Open Frame Three-Phase	Open Frame Single-Phase	Enclosed Three-Phase
X2 to X4	X1 to X3	1 to 3
X4 to X6		3 to 5
X6 to X2		5 to 1

If using the 220 VAC connections, measure between the following sets of terminals on the transformer. All readings should be within 213 VAC and 227 VAC:

Open Frame Three-Phase	Open Frame Single-phase	Enclosed Three-phase
X7 to X8	X1 to X4	2 to 4
X8 to X9		4 to 6
X9 to X7		6 to 2

3. Remove power from the isolation transformer and install the low level output fuses only. Now you can go on to the next check.

Power Supply Check

This section provides procedures for a low-voltage and high-voltage power supply check.

Checking Low Voltage

Before attempting this procedure, be sure that:

- The transformer high voltage output fuses (KTK-30) have been removed
- The transformer outputs fall within the acceptable ranges (detailed in the previous section)

To verify that the power supply is working properly:

1. Apply power to the isolation transformer.
2. The Voltage Fault light (on the power supply panel) should be off. If the light is on, remove power and check the low level DC wiring between the power supply and the drives. This is detailed in Chapter 5 for the PLS4 and the CL1060.
3. Set the DVM to the 20 VDC range. (You may need to set the voltmeter to the next highest range to check the +20 VDC line.)
4. Measure the DC voltages of each drive at TB1 as follows:

TB1 Points at Drive	Normal Voltage Range
+ 12 to COM (4)	+13.5 to +14.5 VDC
–12 to COM (4)	–13.5 to –14.5 VDC
+ 20 to COM (4)	+19 to +27 VDC

See Figure 40.

Note If the +20 V supply is at the low end of the normal range, power line dips may cause voltage faults. To avoid this, you can decrease the load on the power supply or increase the AC drive to the power supply.

	+20	–12	COM	+12	+6

TB1 on drive module

Figure 40 DC Low Level Test Points

If any reading is outside of this range, make sure that the low level DC wiring is correct. If the wiring is correct, the cause is either:

- An excessive load on one of the drives
- A defective power supply

Checking High Voltage

Before attempting this procedure, be sure that the transformer high voltage output fuses (KTK-30) have been replaced.

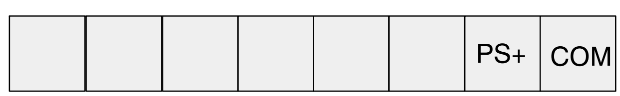
To check the supply:

1. Apply power to the isolation transformer.
2. Make sure the power supply green DC BUS ON light is on.
3. Make sure all drive indicator lights are off.
4. Check TB2 7-8 on each drive for high voltage DC between 160 VDC and 360 VDC. (The voltage you read will depend on the way the transformer secondary is wired.)

   If any reading is outside of this range, make sure that the high level DC wiring is correct. If the wiring is correct, the cause is either:

   - An excessive load on one of the drives
   - A defective power supply

   See Figure 41.



TB2 on drive module

Figure 41 DC High Level Test Points

If all voltage readings are within acceptable ranges, remove power and install the isolation transformer high power secondary fuses. The system is now ready for operation.

Chapter 7
CL1000A and PLS4 Indicator Lights

- Introduction
- CL1000A drive indicators
- PLS4 power supply indicators

Introduction

The front panels of CL1000A series drives and PLS4 power supplies have light emitting diode (LED) indicators. These indicators will tell you:

- The current status of the component
- If a fault exists and what type it is

The following sections describe the indicators and their meanings.

CL1000A Drive Indicators

CL1000A drives have five drive status indicator lights. They are:

Drive enable
Phase error
Voltage fault
Short circuit
Over temperature

See Figure 42.

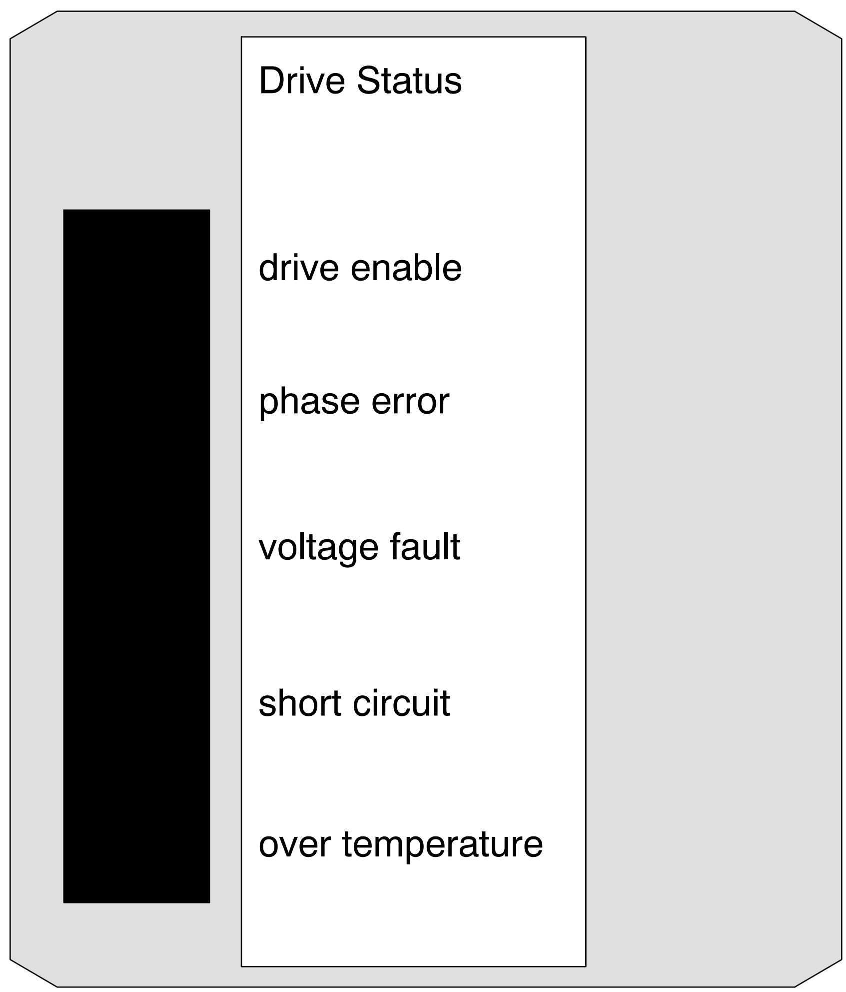


Figure 42   CL1000A Indicator Lights

Drive Enable

The Drive Enable indicator will light green when the drive is supplying voltage and current to terminals TB2-1 through TB2-3. These are the servo-motor connection terminals. The drive will only enable when DB25 connector pin 25 (+ 12V) is pulled to signal common (pins 14 and 15). This is controlled by the controller.

During initial power-up of a drive, the Phase Error indicator often lights. This indicator will go out when the drive is enabled.

Phase Error

The Phase Error indicator will light red when the three torque command voltages (input from the controller) are not balanced. The detection circuit operates when the low-level DC voltages are applied to the drive, regardless of drive enable status.

If the indicator lights dimly, the torque command voltages are unbalanced, but the imbalance is less than plus or minus 1 volt. The drive will continue to function normally as long as the imbalance remains below the 1 volt level.

A brightly lit indicator means the imbalance has exceeded 1 volt. This causes the drive to fault, shutting off the Drive Enable indicator. The drive will not enable again unless both of these conditions are met:

- The imbalance is corrected.
- The drive receives an enable signal from the controller. (The Drive Enable is cycled after the fault is cleared.)

Note The phase error could be caused by incorrect commands from the controller.

Voltage Fault

The Voltage Fault indicator will light red when the drive has detected an unsafe operating condition, and the low-level DC supply voltages have dropped below acceptable ranges. The +12 VDC or -12 VDC supplies may have fallen below 10 VDC, or the +20 VDC supply may have fallen below 19 VDC.

If this indicator lights, the drive sends a disable pulse to the controller. The drive will reenable when both of these conditions are met:

- The condition that caused the fault has been corrected.
- The drive receives an enable signal from the controller. (The Drive Enable is cycled after the fault is cleared.)

Caution Depending on how your control software is written, it is possible for your drive to fault and then reenable without warning or intervention. Appropriate precautions must be taken when programming your controller to ensure that faulted drives are not automatically restarted.

Short Circuit

This indicator will light red when the drive detects a short circuit in the drive, the servo motor, or the cable to the servo motor. The drive also transmits a disable pulse to the controller, alerting it that a fault has occurred. The drive will reenable when both of these conditions are met:

- The short circuit no longer exists.
- The drive receives an enable signal from the controller. (The Drive Enable is cycled after the fault is cleared.)

⚠ **Caution Depending on how your control software is written, it is possible for your drive to fault and then reenable without warning or intervention. Appropriate precautions must be taken when programming your controller to ensure that faulted drives are not automatically restarted.**

There are many situations that could cause the drive to report a short circuit. Internal failures can cause this fault, but the drive could be reporting a problem elsewhere in the installation wiring or motor, and has shut down to protect itself. (For example, many times an intermittent short circuit fault condition can exist if moisture is allowed to accumulate in or around the motor power connections.) The installation should be fully inspected, and installation problems should be corrected before you assume the drive itself has failed. Troubleshooting procedures are covered in Chapter 8.

⚠ **Caution The drive is designed to fault without any damage occurring if an attempt is made to enable while a short circuit exists. This is a high-stress condition for the drive, as some high currents inevitably occur before the drive faults out. Modicon recommends you do not make repeated attempts to enable the drive while a short circuit exists. The problem causing the short circuit condition should be corrected as soon as possible.**

Over Temperature

The Over Temperature indicator will light red whenever the drive detects a drive baseplate temperature of 194°F (90°C). If this occurs, the drive also sends a disable pulse to the controller.

The Over Temperature indicator will also light whenever any drive detects that the cable to the motor has been disconnected (if this feature was set up at the time that the motor cabling was wired to the drive).

The drive will reenable when both of these conditions are met:

1. The drive baseplate temperature drops about 68°F (20°C) below the thermal trigger point, or cable continuity to the motor is restored.
2. The drive receives an enable signal from the controller. (The Drive Enable is cycled after the fault is cleared.)

Caution   Depending on how your control software is written, it is possible for your drive to fault and then reenable without warning or intervention. Appropriate precautions must be taken when programming your controller to ensure that faulted drives are not automatically restarted.

Repeated over-temperature faults are a symptom of an improper installation or application. Resetting drive faults in order to resume operation without investigating and correcting the cause of the faults puts undue strain on the drive, and could result in premature drive failure. Installations should be inspected for proper sizing of components and cabinet, configuration, and use of good thermal management procedures.

Be sure to use the motor thermal switch in your system, if your motors are so equipped. If motor over temperature should occur, this should cause operation to stop in order to protect equipment.

PLS4 Power Supply Indicators

The PLS4 power supply and one side of the CL1060 drive/power supply have the following indicator lights:

- Regen active
- Voltage fault
- Over temperature
- D.C. bus on

See Figure 43.

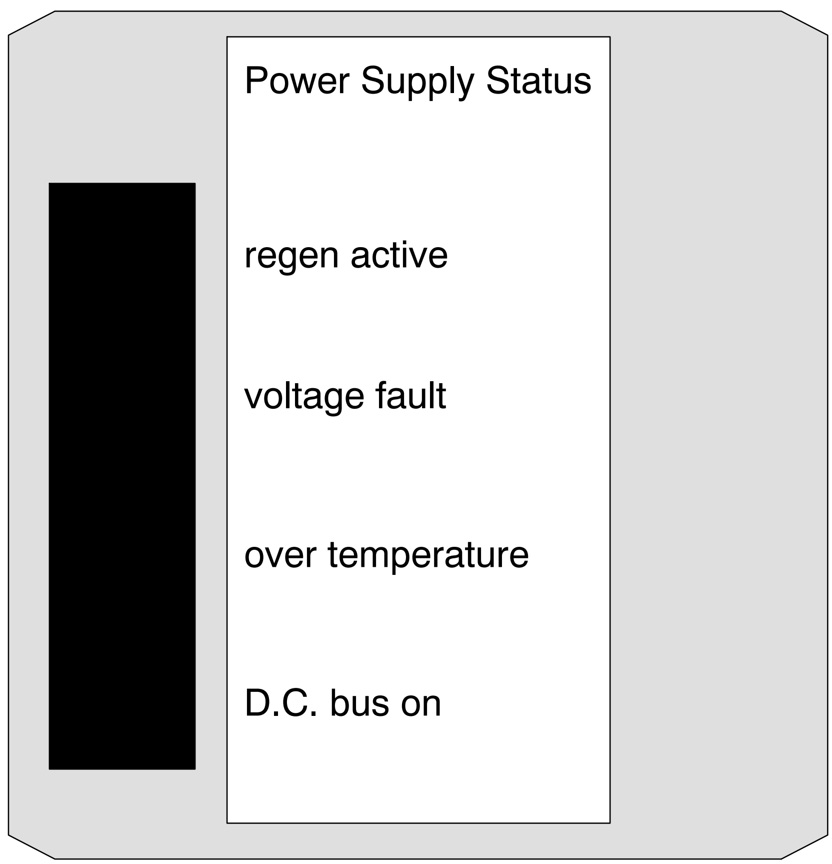


Figure 43 PLS4 Power Supply CL1060 Drive / Power Supply Indicator Lights

Regen Active

The Regen Active indicator will light green whenever the bus voltage exceeds 370 VDC. During this time the shunt regulator circuit is active. It is normal for the indicator to flash when a servo motor is slowing a high-inertia load.

If this indicator stays on, the shunt regulator resistor may not be wired properly or may be defective. (See Chapter 5 for PLS4 and CL1060 wiring.) It can also point to a blown or missing Regen fuse.

VoltageFault

The Voltage Fault indicator will light red when the DC bus voltage exceeds 400 VDC. This may indicate a problem within the regeneration circuit. If this occurs, the power supply disables all connected drives. (The power supply removes the 12 VDC supply to all connected drives.) It will not allow them to be enabled until:

1. The DC bus voltage drops below 400 VDC.
2. You remove and reapply power to the power supply. (This resets the voltage fault circuit.)

You may notice the Regen Active indicator light on, at least for a short time, if the Voltage Fault indicator is lit. This means the shunt regulator is attempting to reduce the voltage.

An illuminated Voltage Fault indicator usually means that the shunt regulator resistor is defective, or improperly wired, or the regen fuse is missing or has blown. (See Chapter 5 for PLS4 and CL1060 wiring.)

An illuminated Voltage Fault indicator could also mean the low voltage section of the power supply is out of tolerance. (See Chapter 8 for testing procedure.)

Over Temperature

The Over Temperature indicator will light red when the drive baseplate temperature for the PLS4 or the mounting plate temperature for the CL1060 drive/power supply is too high for safe operation. After the mounting plate temperature has sufficiently cooled, you can reset this circuit by removing and reapplying power from the power supply.

DC Bus On

The DC Bus On indicator will light green when the DC bus is carrying voltage. The bus can be energized even when you are powering the system down (usually about five seconds). If the indicator stays on longer, there could be an internal fault in the power supply.

STOP **Warning SHOCK HAZARD. To avoid severe injury or death, do not come in contact with the DC bus connections. This line carries lethal voltages. It is active whenever the DC Bus On indicator is lit. Always be sure AC line power is removed before attempting service.**

Chapter 8
Troubleshooting

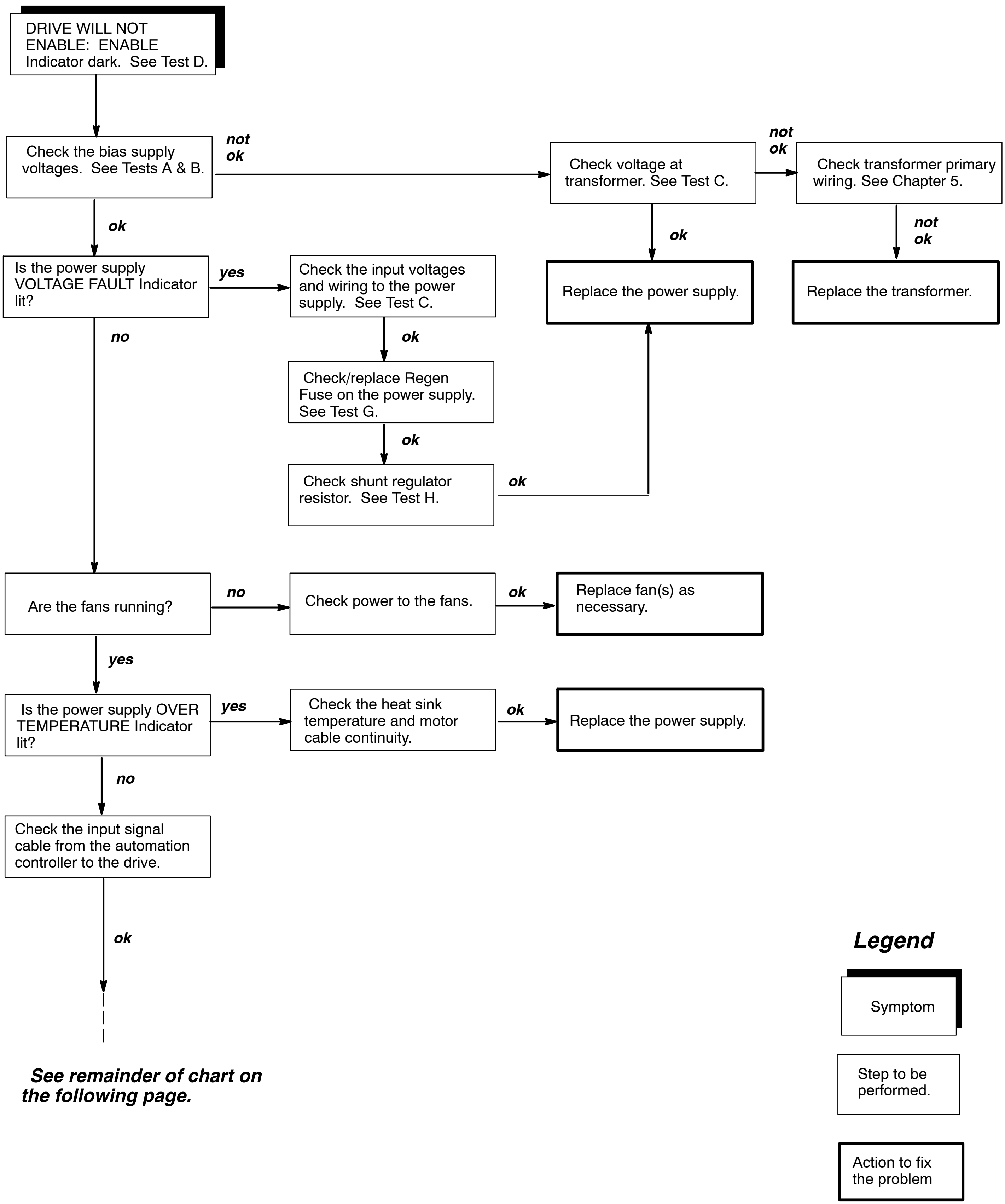
- Decision trees
- Test procedures
- Replacing CL1000 drive with CL1000A drive

Decision Trees

This section contains decision tree flowcharts that help you find the cause to a problem. To use the trees, compare your problem with the symptom box at the top of each tree. When you find the one that best describes your problem, follow the arrows to the various test procedures presented in the next section or to a chapter reference.

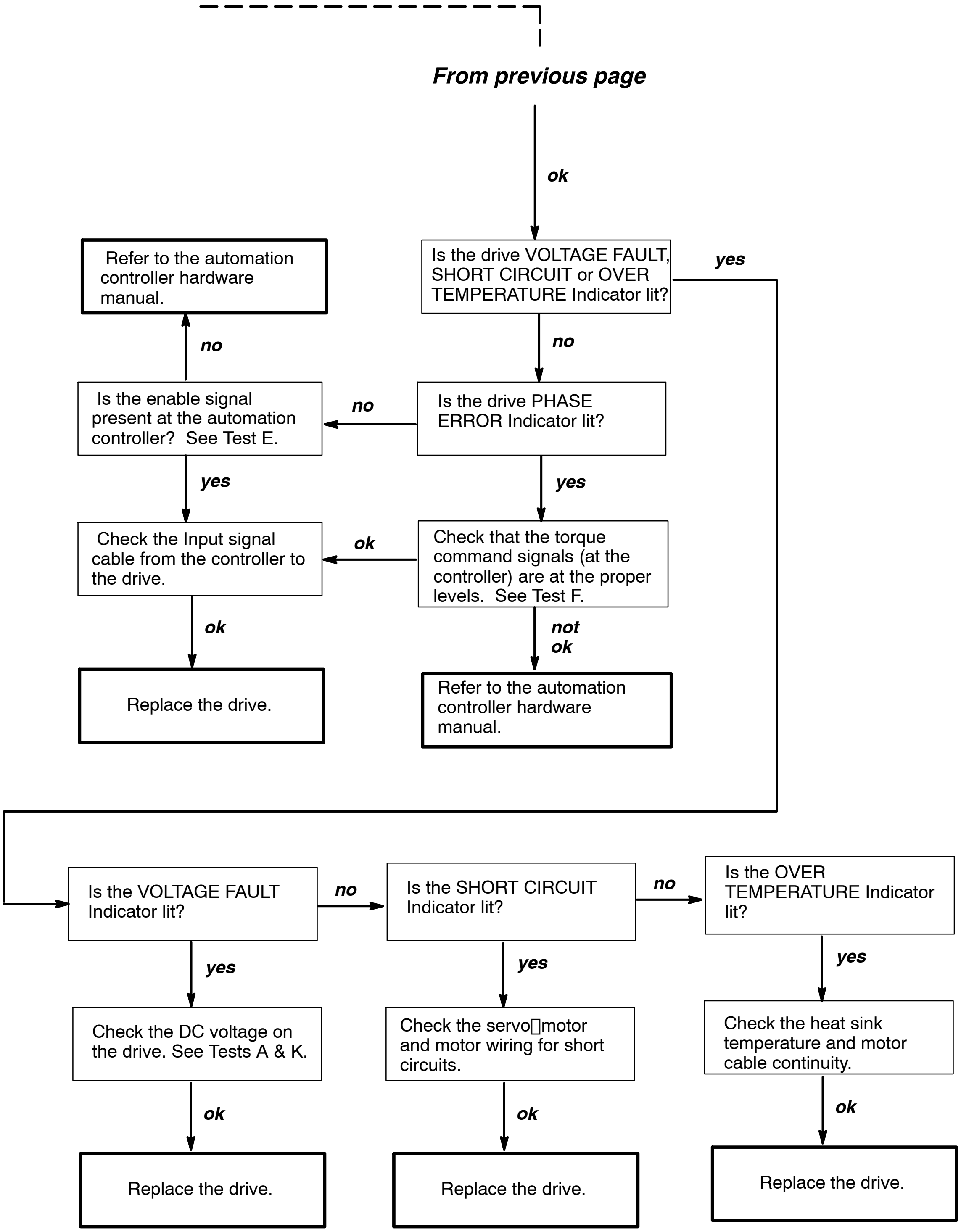
Decision tree flowcharts appear in Figure 44 through Figure 47.

Warning SHOCK HAZARD. Lethal voltages exist at the connection points of Cyberline equipment. To avoid severe personal injury or death, the procedures in this chapter should only be performed by skilled technical personnel. Such personnel should be familiar with safe industrial wiring practices.



See remainder of chart on the following page.

Figure 44 Drive will not enable. Enable indicator dark.


From previous page
ok
Is the drive VOLTAGE FAULT, SHORT CIRCUIT or OVER TEMPERATURE Indicator lit?
yes
no
Is the drive PHASE ERROR Indicator lit?
no
Is the enable signal present at the automation controller? See Test E.
no
Refer to the automation controller hardware manual.
yes
Check the Input signal cable from the controller to the drive.
ok
Replace the drive.
yes
Check that the torque command signals (at the controller) are at the proper levels. See Test F.
ok
not ok
Refer to the automation controller hardware manual.
Is the VOLTAGE FAULT Indicator lit?
no
Is the SHORT CIRCUIT Indicator lit?
no
Is the OVER TEMPERATURE Indicator lit?
yes
Check the DC voltage on the drive. See Tests A & K.
ok
Replace the drive.
yes
Check the servo-motor and motor wiring for short circuits.
ok
Replace the drive.
yes
Check the heat sink temperature and motor cable continuity.
ok
Replace the drive.

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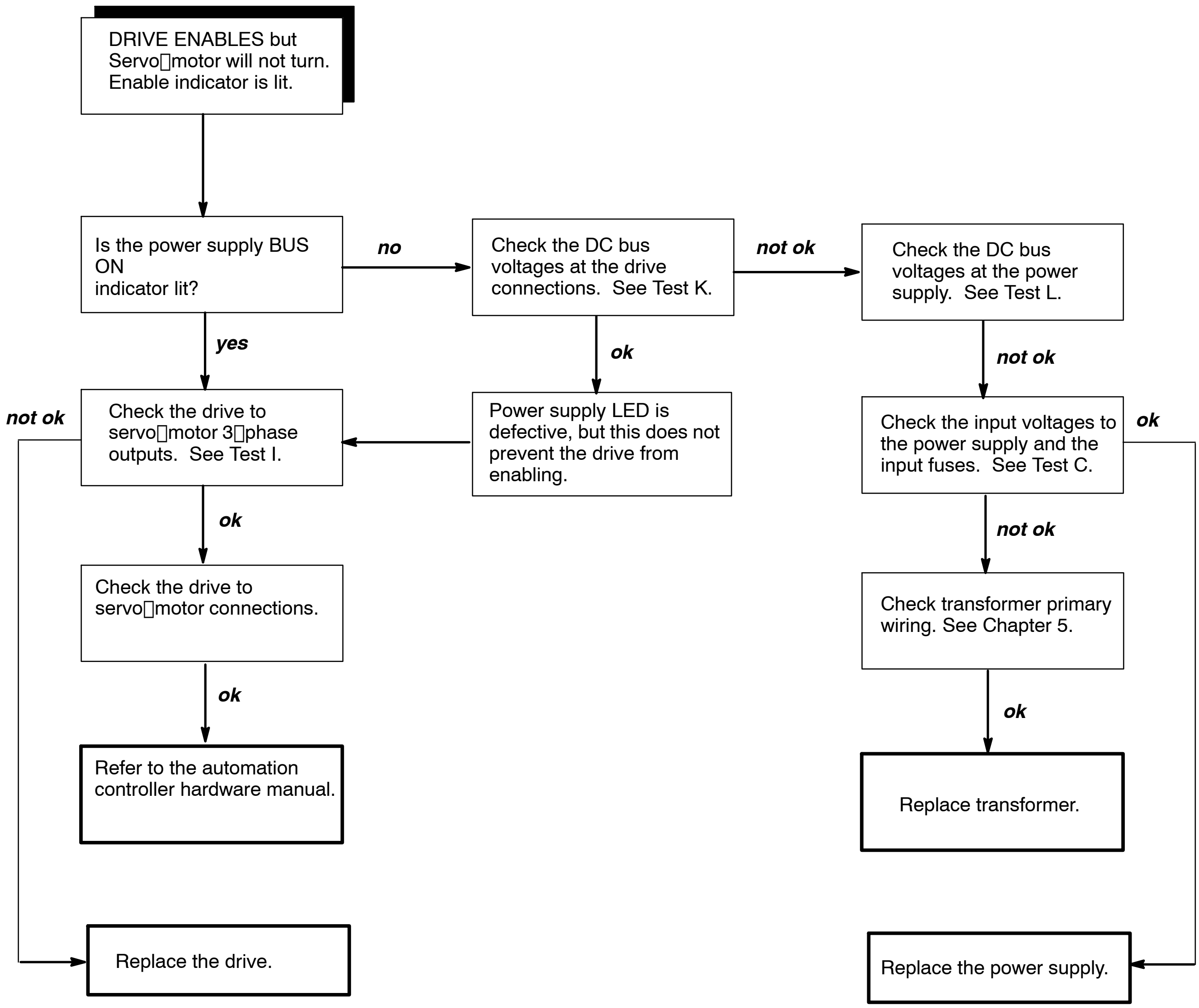


Figure 45 Drive enables but servo motor will not turn. Enable indicator is lit.

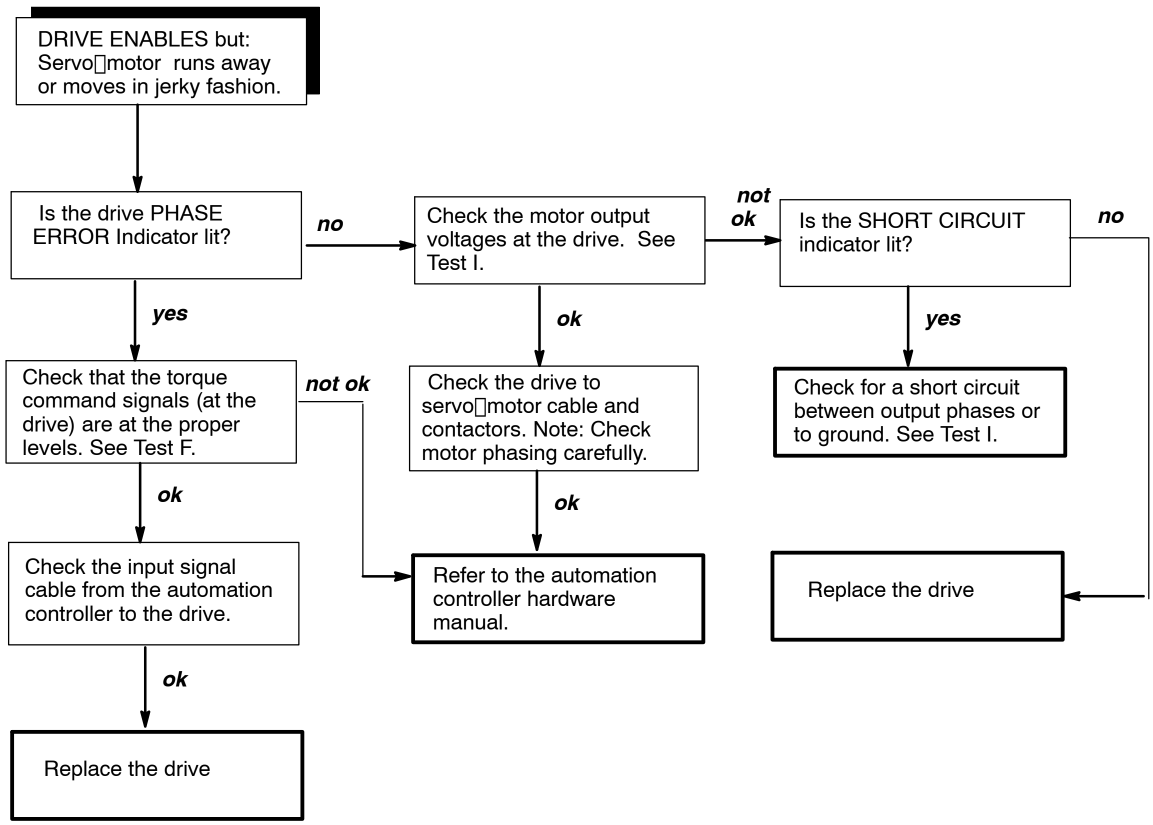


Figure 46 Drive enables but servo motor runs away or moves in a jerky fashion.

GICYBL002

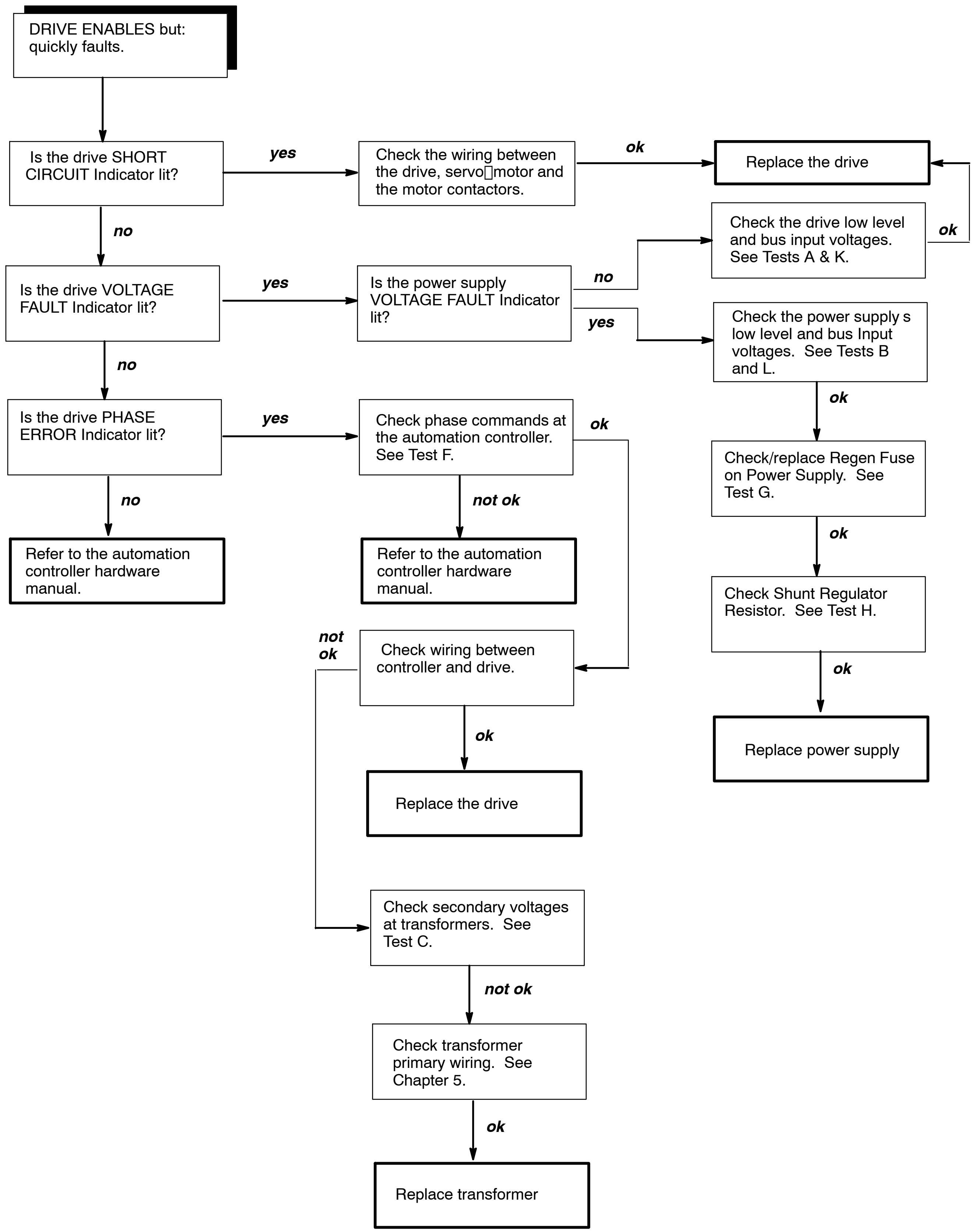


Figure 47 Drive enables but quickly faults.

Test Procedures

This section provides several procedures for testing various parts of the CL1000A system. The only test equipment you will need is a digital voltmeter with three-and-one-half digit resolution and 0.5 percent accuracy.

The following subsections provide test procedures A through L for CL1000A system components.

Warning SHOCK HAZARD. Lethal voltages exist at the connection points of Cyberline equipment. To avoid severe personal injury or death, the procedures in this chapter should only be performed by skilled technical personnel. Such personnel should be familiar with safe industrial wiring practices.

Test Procedure A: Checking Low Level Voltage at Drive

Note These points are internally wired on the CL1060 drive/power supply for its drive. Skip this test if you have a CL1060.

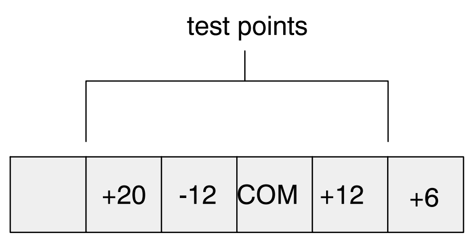
Check the low level DC voltages at TB1 of the CL1005 through CL1030 drives as follows.

Measure from TB1 (+)	To TB1(-)	Result
+ 12	COM	+13.5 to +14.5 VDC
- 12	COM	-13.5 to -14.5 VDC
+ 20	COM	+19 to +27 VDC

See Figure 48.

If any reading is outside of this range, make sure that the low level DC wiring is correct. If the wiring is correct, the cause is either:

- An excessive load on one of the drive modules
- A defective power supply



TB1 on drive

Figure 48 Location of Low Level DC Test Points on Drive

Test Procedure B: Testing Low Level DC Power Supply Outputs

Check the low level output voltages on TB1 of the PLS4 power supply or the CL1060 drive/power supply as follows:

Measure from TB1 (+)	To TB1(-)	Result
+ 12	COM	+13.5 to +14.5 VDC
- 12	COM	-13.5 to -14.5 VDC
+ 20	COM	+19 to +27 VDC

See Figure 49 and Figure 50.

Note Test point locations on TB1 are different for the PLS4 and CL1060.

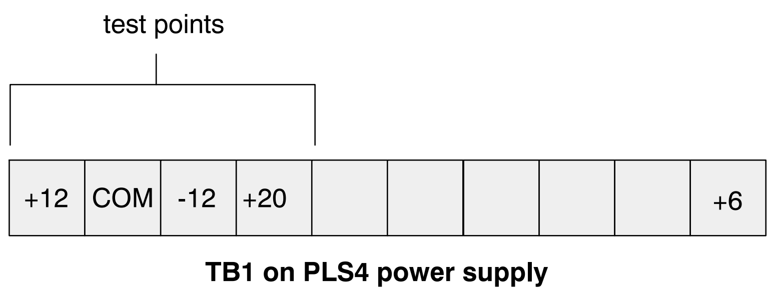


Figure 49 Low Power DC Test Points on the PLS4

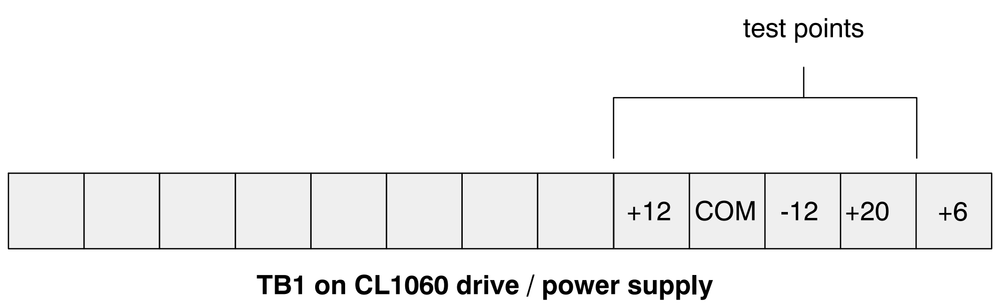


Figure 50 Low Power DC Test Points on the CL1060

Test Procedure C: Testing the Transformer AC Outputs

Warning SHOCK HAZARD. Lethal voltages are at the transformer high power secondary outputs. Use caution when testing these outputs.

Testing the Transformer Secondary Low Power Outputs

Check the voltages between each phase and ground at the following test points on the PLS4 power supply or CL1060 drive/power supply:

Measure from TB1	To TB1	Result
YA	Y0	16.0 to 21.0 VAC
YB	Y0	16.0 to 21.0 VAC
YC	Y0	16.0 to 21.0 VAC

Voltages below 16 VAC may be caused by low line power to the transformer.

See Figure 51 and Figure 52.

Note Test point locations on TB1 are different for the PLS4 and CL1060.

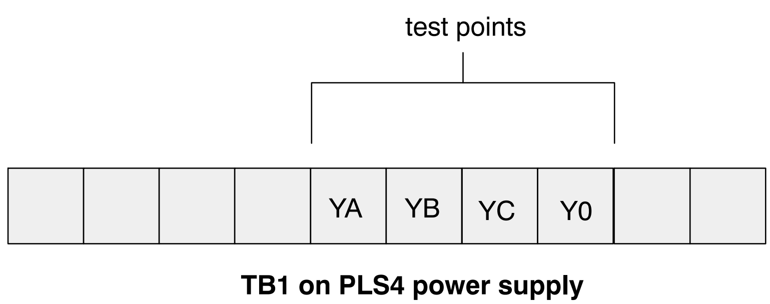


Figure 51 Low Power AC Test Points at PLS4 Power Supply

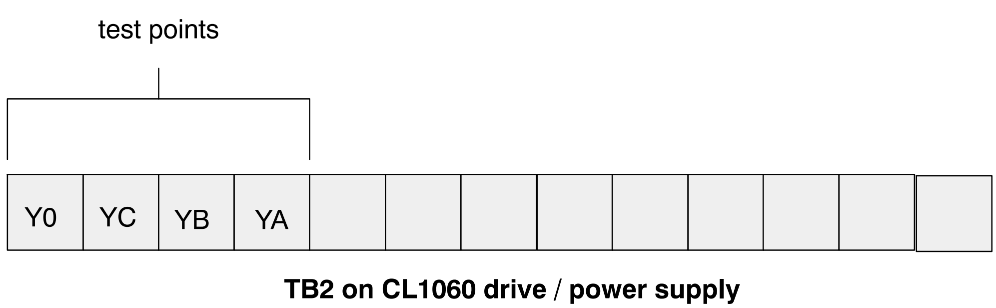


Figure 52 Low Power AC Test Points at CL1060 Drive/Power Supply

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Testing the Transformer Secondary High Power Outputs

Check the voltages on the mid-range tap between each phase and ground, at the following test points on the PLS4 power supply or CL1060 drive/power supply:

Measure from TB2	To TB2	Result
XA	XB	180 to 219 VAC
XB	XC	180 to 219 VAC
XC	XA	180 to 219 VAC

See Figure 53 and Figure 54.

If any line-to-line voltage measurement is out of tolerance, remove power from the transformer and check the transformer primary wiring. (See Chapter 5.) No voltage usually indicates a blown fuse.

☞ **Note** Test point locations are different for the PLS4 and CL1060.

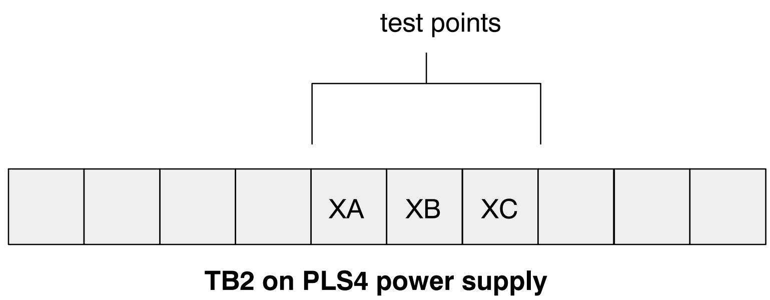


Figure 53 High Power AC Test Points at the PLS4 Power Supply

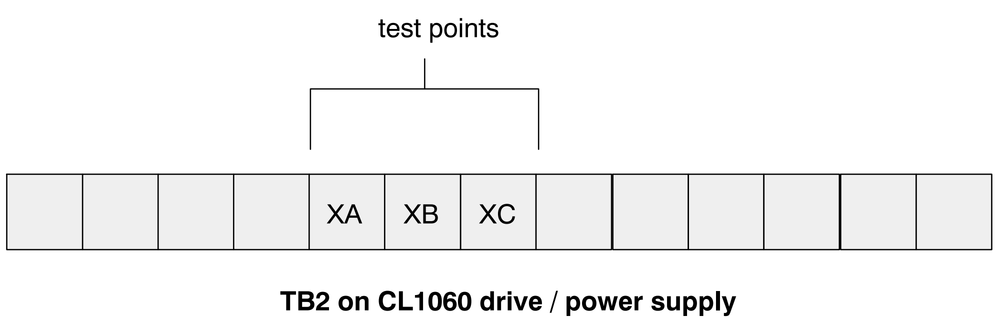


Figure 54 High Power AC Test Points at the CL1060

Test Procedure D: Checking for Enable Signal at Drive

The Drive Enable indicator will light green, as shown in Figure 55, to show the drive is active. This indicator must be solidly lit green when the drive is enabled.

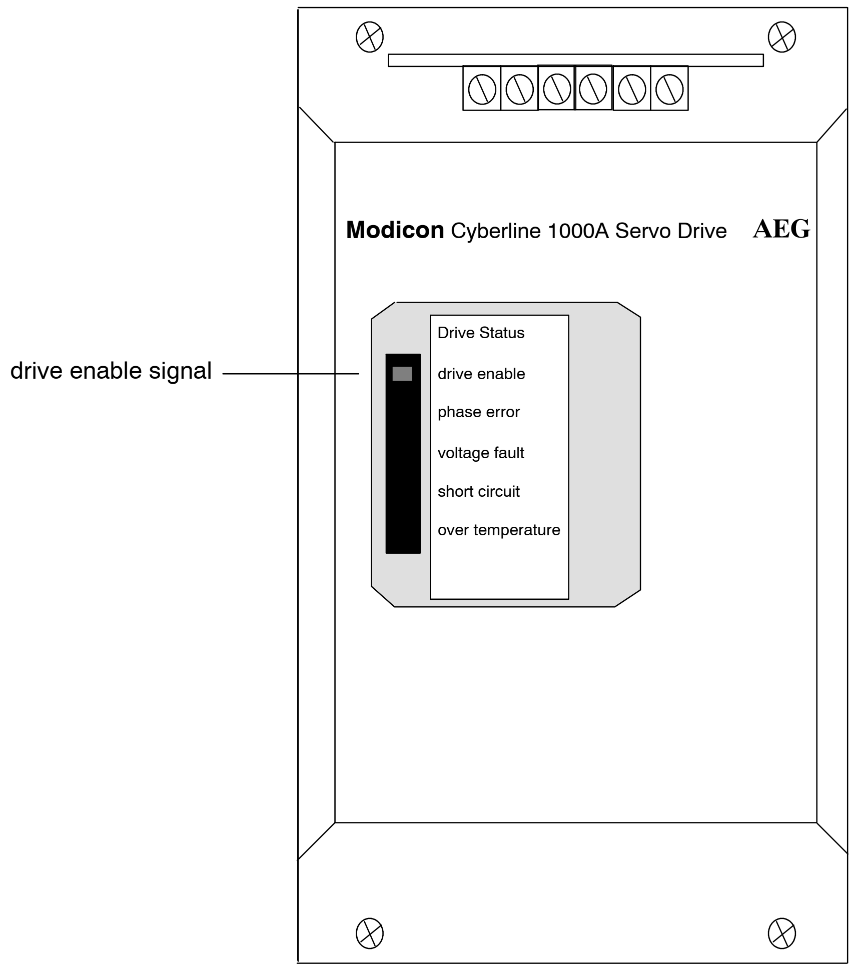


Figure 55 Drive Enable Indicator Lit

Test Procedure E: Checking for Drive Enable Signal at Controller

When the controller enables a drive, an open collector transistor turns on and sinks current to the signal common collector. To test that the enable signal is present at the controller:

1. Refer to your controller manual to locate the Drive Enable and Signal Common terminals.

2. Measure from terminal Drive Enable (+) to terminal Common (-).

   The voltmeter indication should be 1.5 VDC or less. Approximately 12 VDC indicates that the enable signal is not present.

Test Procedure F: Checking Torque Command Signals at Controller

To perform the following procedure, the controller must be attempting to hold the motor in a fixed position (as during an motor setup procedure, for example) and the drive must be enabled.

1. Refer to your controller s manual and locate the ∅A, ∅B, ∅C, and COM terminals.

2. Measure the following with a voltmeter:

Measure from Terminal	To Terminal
∅A Out	COM
∅B Out	COM
∅C Out	COM

3. Add the voltages together. The total should be ± 0.5V.

Test Procedure G: Checking the Regen Fuse

The Regen fuse is a KTK-10 fuse that is easily accessible on the PLS4 power supply and the CL1060 drive/power supply. Figure 56 shows the location of the fuse on each assembly.

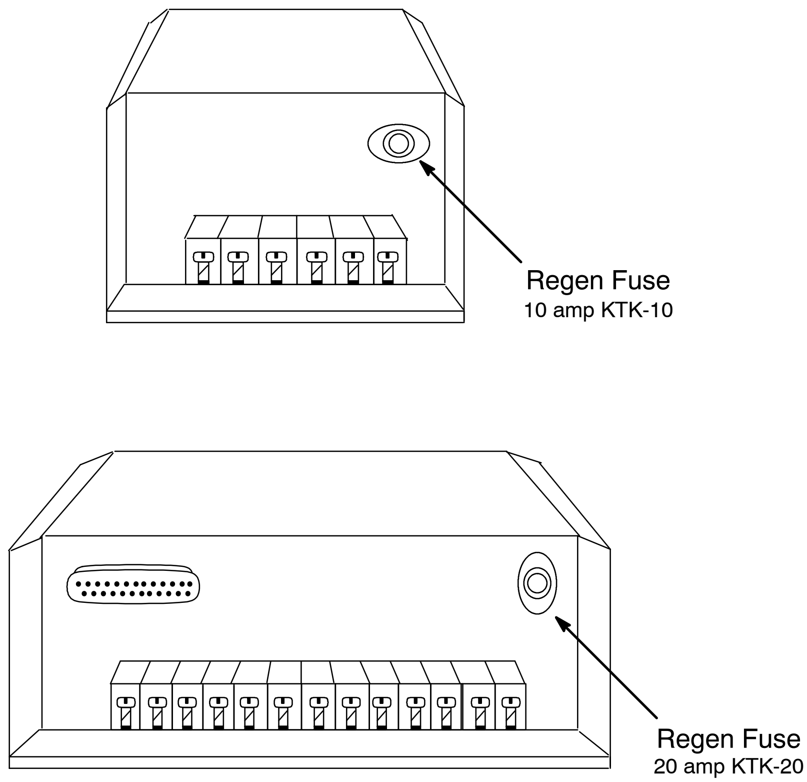


Figure 56   Regen Fuse Locations

Test Procedure H: Checking for Shunt Regulator Resistor

The PLS4 power supply must have a 10 ohm, 225 W resistor connected between terminals R1 and R2 on TB2. Be sure the resistor is properly wired and is not defective. See Figure 57.

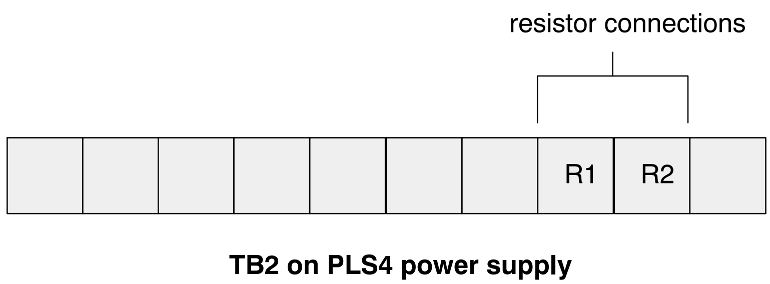


Figure 57 Shunt Regulator Resistor Connections on the PLS4 Power Supply

The CL1060 drive/power supply must have a 5 ohm, 450 W resistor connected between terminals R1 and R2 on TB1. The CL1060 can also use two 10 ohm, 225 W resistors in parallel. Be sure these resistors are properly wired and are not defective. See Figure 58.

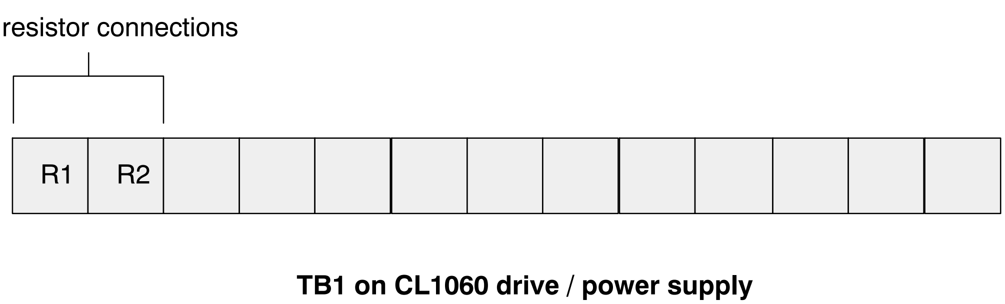


Figure 58 Shunt Regulator Resistor Connections on CL1060 Drive/Power Supply

Test Procedure I: Checking the Drive Three-Phase Output

Warning SHOCK HAZARD. Lethal voltages may exist at the drive to servo-motor three-phase outputs. Exercise caution when performing this test.

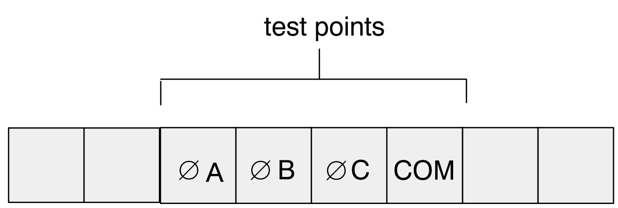
Check the AC voltages at the following test points for drives CL1005 through CL1030, or the CL1060 drive/power supply, using a true RMS voltmeter.

Measure from TB2	To TB2
∅A	COM
∅B	COM
∅C	COM

See Figure 59 and Figure 60.

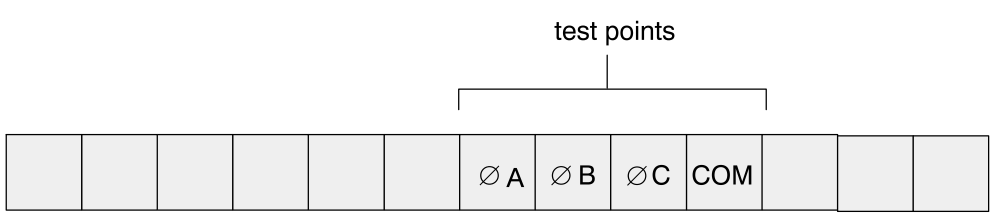
Note Note that these readings are taken on the AC scale, as this is a high frequency switching waveform. The reading may vary due to the frequency response of your meter. For each reading, the result should be a number that is approximately half of the system DC bus voltage value.

Note The test point locations are different for the CL1005-CL1030 and CL1060.



TB2 on CL1005 - CL1030

Figure 59 Locations of Drive to Servo-motor Test Points on Drive



TB2 on CL1060

Figure 60 Locations of Drive to Servo-motor Test Points on CL1060 Drive / Power Supply

Test Procedure J: Testing the Controller

Specific tests for the controller are documented in the controller manual. Refer to chapters that discuss specific hardware troubleshooting procedures and software parameters that can affect servo motor performance.

Test Procedure K: Checking Bus Voltages at the Drive

Warning SHOCK HAZARD. Lethal voltages may exist at the bus connections. Exercise caution when performing this test.

Check the DC bus voltages at TB2 for drives CL1005 - CL1030, and at TB1 for CL1060 drive / power supplies, as follows.

Measure from TB (+)	To TB (-)	Result (DC bus voltage)
PS+	COM	180 VDC if isolation transformer high voltage secondary is 135 VAC. 280 VDC if isolation transformer high voltage secondary is 199 VAC. 325 VDC if isolation transformer high voltage secondary is 220 VAC.

See Figure 61.

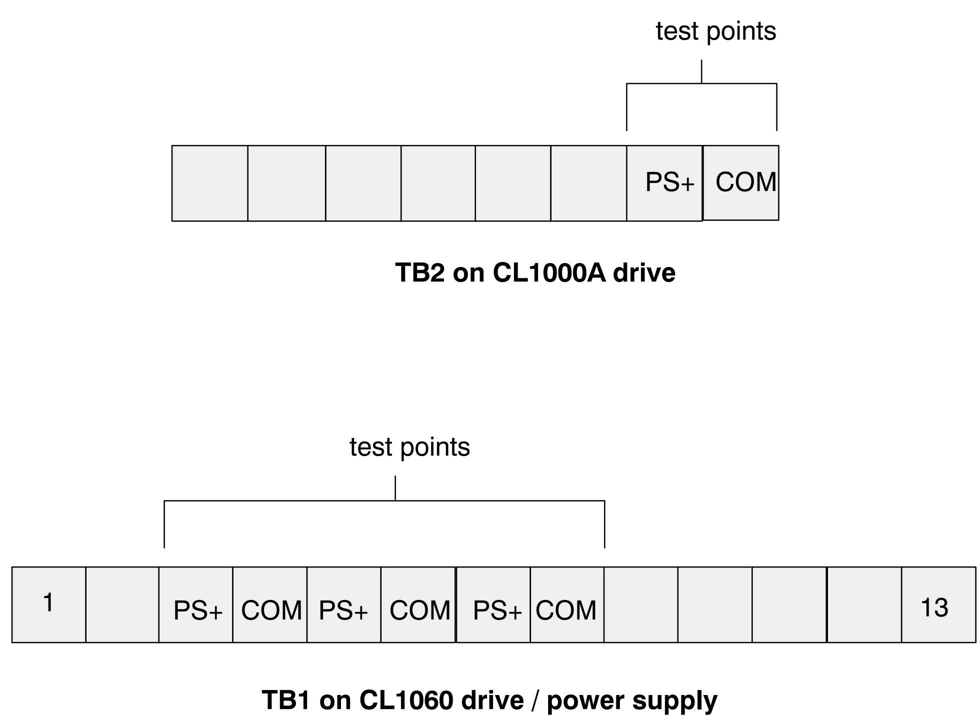


Figure 61 Drive DC Bus Test Points

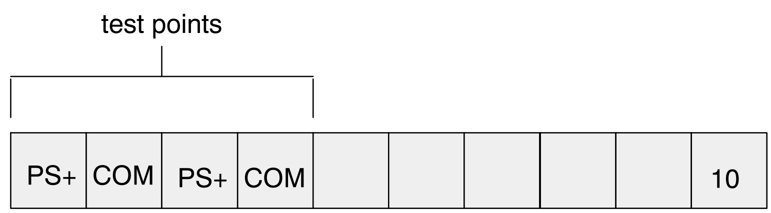
Test Procedure L: Checking Bus Voltages at the Power Supply

Warning SHOCK HAZARD. Lethal voltages may exist at the bus connections. Use caution when performing this test.

Check the DC bus voltages at TB2 on the PLS4 power supply as follows.

Measure from TB2 (+)	To TB2 (-)	Result
PS+ (1) PS+ (3)	COM (2) COM (4)	180 VDC if isolation transformer high voltage secondary is 135 VAC. 280 VDC if isolation transformer high voltage secondary is 199 VAC. 325 VDC if isolation transformer high voltage secondary is 220 VAC.

See Figure 62.



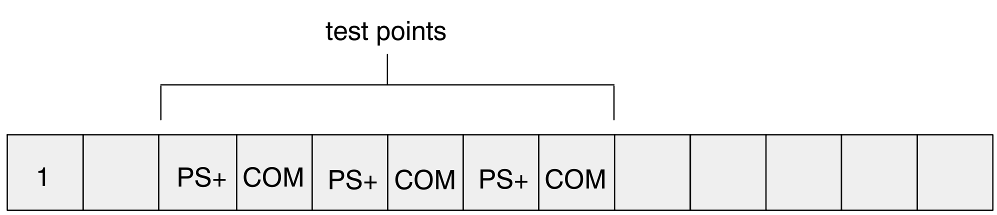
TB2 on PLS4 power supply

Figure 62 Bus Voltage Test Points on the PLS4

Check the DC bus voltages at TB1 on the CL1060 drive/power supply as follows:

Measure from TB1 (+)	To TB1 (-)	Result
PS+ (3) PS+ (5) PS+ (7)	COM (4) COM (6) COM (8)	180 VDC if isolation transformer high voltage secondary is 135 VAC. 280 VDC if isolation transformer high voltage secondary is 199 VAC. 325 VDC if isolation transformer high voltage secondary is 220 VAC.

See Figure 63.



TB1 on CL1060 drive / power supply

Figure 63 Bus Voltage Test Points on the CL1060

Replacing CL1000 Drive with CL1000A Drive

If you are replacing an existing CL1000 series drive with a CL1000A series drive, please be aware:

- The CL1000A drive operates at a higher switching frequency. This may cause changes in your servo operation in an improperly grounded system. Review system grounding/shielding. (See Appendix A.) Ensure that the motor case is grounded to a factory central earth ground.

- The CL1000A series drive has some subtle design differences that may affect the overall performance of the servo loop.

After replacing a CL1000 with a CL1000A, and testing the CL1000A according to the test procedures in the previous sections you may experience:

- A marginally stable servo loop (excessive vibration of the motor shaft or mechanical load)

- An excessive amount of servo faults (excess average current fault, Following Error fault, and so on) during normal operation

- Less servo system performance in general

If you experience these problems, proceed as follows until they are corrected:

1. Revisit the procedure for setting the servo gains. This is typically found in the motion controller s system design and installation manual under RIG, RPG, and ATC. Make small changes (five units at a time) in the system parameters until you achieve a stable, desirable servo loop, or follow the recommended procedure for retuning (stabilizing) your servo motor.

2. Ensure that the average current and peak current limits are set to their optimum value. Refer to your motion controller s system design and installation manual for calculation example.

3. Modify the motion controller s Base Speed setting. Refer to the motion controller s system design and installation manual under Base Speed for more information on the Base Speed parameter. Make small reductions (100 RPM or less at a time) until you achieve the desired performance.

Appendix A
Grounding and Noise Reduction

- Introduction
- System design and wire routing
- System grounding
- Shielded wiring installation techniques
- Noise suppression devices for discrete I/O

Introduction

Modicon designs its automation control equipment to be as electrically safe and immune to electrical noise as possible. Nevertheless, because you install automation control systems in electrically severe environments, you must install them properly for both safety and proper performance.

This section covers the following subjects:

- Overall system design and wire routing
- System grounding
- Shielded wiring installation techniques
- Noise suppression devices for discrete I/O
- Noise reduction techniques

System Design and Wire Routing

Use Steel Enclosures

Use steel enclosures for automation control cabinets. Steel provides shielding from electrostatic, electromagnetic and magnetic noise. Try to avoid installing windows in cabinets containing electronic circuits. If a window is unavoidable, particularly in electrically noisy locations, a grounded copper mesh behind the window will provide some protection.

Use Steel Wire Troughs

Use steel raceways for wiring between equipment cabinets. As with cabinets, steel wireways provides shielding from electrostatic, electromagnetic, and magnetic noise. Using dissimilar metals for cabinets and raceways can result in eventual corrosion at joints, degrading the electrical bond. Steel also provides better physical protection than softer materials.

Route Power, Digital, and Signal Wiring

Separately route different types of wiring through separate wire raceways. In a typical automation control system there are three major types of wiring:

Power wiring carries high voltage with a high current rating. Such wiring is insensitive to noise but can generate large amounts of it. Examples of power wiring are:

- AC line inputs
- Motor drive outputs
- Discrete I/O and limit switches

Digital signal wiring is low voltage and low current, and is operating very fast. It is sensitive to noise from power conductors but can also generate high frequency noise that can affect analog signal wiring. Examples of digital signal wiring are:

- MODBUS cable RS-232

- 5 volt TTL (transistor-transistor-logic) level control signals

Analog signal wiring is the most sensitive wiring in the system. The signals carried are usually very low voltage, very low current. These are the most likely to have problems. Examples of analog signal wiring are:

- Axis signals (resolver or encoder wiring, or controller inputs)

- Analog I/O such as from level sensors or dancers

Never tightly bundle wires, even if the same type. Tight bundling encourages noise coupling between wires.

Never Use a Wireway as a Ground Connection

Connect metal wireways to ground. But NEVER use a metal wireway as a cabinet or chassis earth ground connection. You MUST use a separate ground connection.

Separate Different Wiring Types Inside a Cabinet

Within an enclosure, try to keep low and high level wires as far apart as possible. Avoid parallel runs and make them cross at right angles to each other.

System Grounding

Proper grounding is vital to the safety of operating personnel, as well as to the operation of your motion control system. Grounding is done for two reasons:

- To protect operators in case of an electrical malfunction
- To minimize and protect equipment from electrical noise.

You MUST properly ground all equipment in your control system.

Earth Ground

Connect All Chassis and Cabinet Grounds to Central Ground

Connect all electrical chassis and cabinets to the factory s central earth ground. An earth ground is the central ground point for all AC power and electrical equipment within a factory. Existing factories usually have a grounding electrode system. For more details on the definition of ground and grounding electrodes, see Articles 100 and 250-81 of the National Electrical Code (NFPA 70), published by the National Fire Protection Association. See also Appendix D *System Wiring Diagrams*.

The minimum conductor size you should use is #6 AWG. These conductors must be sized to provide full protection in case of an AC wiring fault. Consult your local building and wiring codes.

Use Copper for Ground Wiring

Use only copper conductors for ground wiring. Aluminum is subject to corrosion and has a higher resistance than copper.

Connect the Ground Electrode to a Ground Bus Bar

Install a grounding conductor between the grounding electrode and an earth ground bus bar in the AC power distribution panel. The earth ground bus bar is typically a copper bar with threaded holes for connections. Typical dimensions are 1 by 0.5 by 6 inches. Securely bond the earth ground bus bar to the distribution panel cabinet. Do this either by bolting the bus bar to the cabinet or by using a very short piece of #6 AWG or larger wire. Bond this securely to clean, bare metal, not a painted surface.

Do Not Switch Ground Connections

The main disconnect switch must NOT break any ground connection.

Cabinet Ground

Use a Ground Bus in Each Cabinet

Every equipment cabinet must have a ground bus that connects directly to the earth ground bus bar in the power panel. The cabinet ground bus is similar to the earth ground bus bar in the power panel. It can, however, be lighter. Bond it directly and securely to the cabinet. Once again, be sure to scrape all paint from the bond area.

Connect the cabinet ground to the ground bus bar in the power panel using #6 AWG wire and ring connectors. This wire should have green insulation (or, in some areas, green with a yellow stripe). Route this through the same wire trough as AC power lines. It should be as short as possible (75 feet maximum).

Connect Grounds

Normally, a series ground makes noise signals additive, turning several low-level noise signals into one large noise signal. This can result in noise problems and improper controller operation. Instead of a series ground system, Modicon normally recommends a star system, with individual ground wires going to the system ground.

Figure 64 shows star and series ground systems.

A Ground Is Not a Common or a Return

Sometimes the term *ground* is used interchangeably with *common* or *(power) return*. This is incorrect. Although commons or returns may connect to chassis or earth ground at some point, DO NOT use them as chassis or cabinet ground connections.

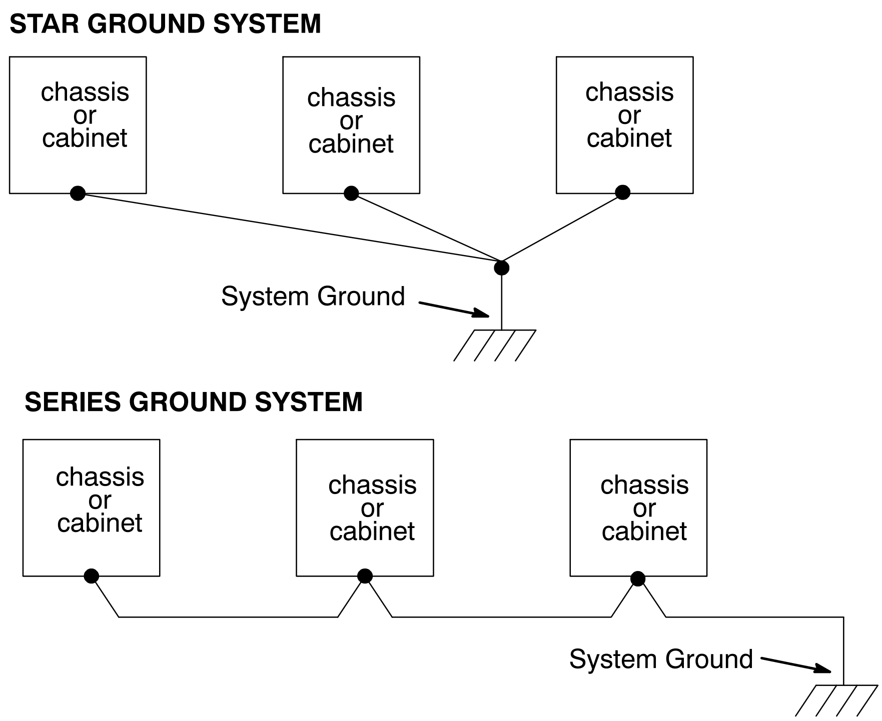


Figure 64 Star versus Series Grounding

Chassis Grounds Within Cabinets

Within each cabinet, separately connect every electrical chassis to the cabinet bus bar using #8 AWG wire and ring connectors. Connect the ground to a mounting nut or screw on each chassis. Use a separate ground wire for each chassis in the cabinet (even though you are grounding the cabinet itself) because:

- It is safer and easier to attach a wire properly to a visible chassis part than to a blind connection between a chassis and cabinet.
- Your cabinet may not be of entirely welded construction. Therefore, ground connections through the cabinet may not be secure.

Some equipment requires an additional earth ground connection as part of its AC power terminals.

Shielded Wiring Installation Techniques

Why Shields?

Use shielded cable for low-level analog signal cables. Shielded cable is particularly effective in reducing electrostatic (capacitive) coupling between parallel cables running together in a wiring trough. Shielded cable also provides protection from electromagnetic noise in the RF (radio frequency) range. Shielded cable is not effective against magnetic noise or low frequency electromagnetic noise.

Shield Analog Signal Wiring

In general, shield all low-level signal wiring. This includes motor resolver wiring and RS-232 serial communication wiring. Occasionally you also need to use shielded wiring for digital signals. (Shielded ribbon cable is available.)

Keep Exposed Signal Wires Short

Keep both exposed signal wires and the bare shield drain wire as short as possible. If shorting is a possibility, insulate the bare drain wire with plastic sleeving or tape.

Avoid Terminal Strips

Avoid terminal strips. (Connections can loosen or corrode.) If you use them, maintain shields through the terminal strip.

Connect Shields to Ground at only One End

Connect shield drain wires to ground at only one end (preferably at the module). At the other end, insulate the shield with shrink tubing or tape to prevent it from shorting to ground or other wiring.

Some controls do not provide terminals for shield connections. In such cases use heavy, solid copper wire or light copper strap to make a shield bus.

Shields Are Never Used as Commons

NEVER use a shield as a ground, common, or return wire. Use it ONLY as a shield.

Noise Suppression Devices for Discrete I/O

Use Suppressors on All Inductive Loads

All inductive loads should have noise suppression networks attached to them. Solenoids, relays, grippers and air coils are all examples of inductive loads. Inductors can generate large electrical noise transients when contacts controlling them open. These transients can affect low-level control signals or cause malfunctions in high-speed digital (computer) circuits. High-voltage transients can also damage loads, switch contacts and transistor outputs. A suppressor usually limits peak noise to a voltage slightly higher than the peak voltage applied.

Any inductive load that can generate a noise transient near the automation equipment must have suppressors. It does not matter whether the device is controlled by the automation controller or other devices.

Install each suppressor in parallel with each inductive load. Install these suppressors as close to the load as possible.

Three Basic Types of Suppressors

Three basic types of devices are used for noise suppression:

- RC (resistor-capacitor) combinations
- MOVs (Metal Oxide Varistors)
- Diodes

Use these alone or in combination depending upon the voltage and the load size.

Use Commercial Suppressors or Make Your Own

You can use either commercial encapsulated suppressors or you can make your own. Commercial suppressors are insulated and are easy to install. If you make your own, you must solder them together. Their leads are all that supports these components. You must insulate bare wires with tape or shrinkable tubing. On the other hand, parts are more readily available. The diagrams that follow show how to use discrete components for suppressors.

If you use discrete parts, here are some general rules for parts ratings:

- Capacitors: at least three times the applied AC RMS voltage
- Resistors: 1/2 watt for small loads, 1 watt for large loads
- Diodes: PIV (peak inverse voltage) rating of at least twice the applied voltage: 1 A rating for small loads, 5 A for large loads.
- MOVs: General Electric is the best-known manufacturer of MOVs. When used with RC suppressors, a small MOV is normally adequate. For 115 volt AC applications, V130LA1 is a good choice. For 220 volt AC applications, use V250LA2.

A typical choice for manufactured RC suppressors is Paktron 504M060E220.

An example of an RC network with a MOV is Electrocube RG1676-14.

Five Basic Suppressor Applications

There are five basic types of applications for suppressors, described on the following pages:

- Small single-phase AC inductive loads
- Large single-phase AC inductive loads
- Large three-phase AC inductive loads
- Small DC loads
- Large DC loads

Suppressors for Small Single-Phase AC Inductive Loads

Small AC inductive loads such as relays operated through pushbuttons usually require only simple RC suppressors, as shown in Figure 65.

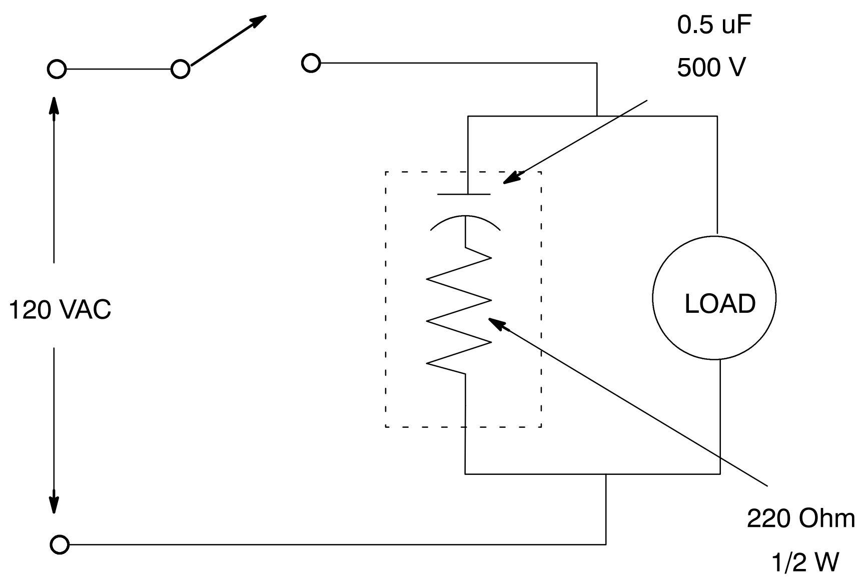


Figure 65 Small AC Inductive Load Suppression

Suppressors for Large Single-Phase AC Inductive Loads

Large inductive loads such as AC motors operated through contactors may require a MOV in addition to the RC suppressor, as shown in Figure 66.

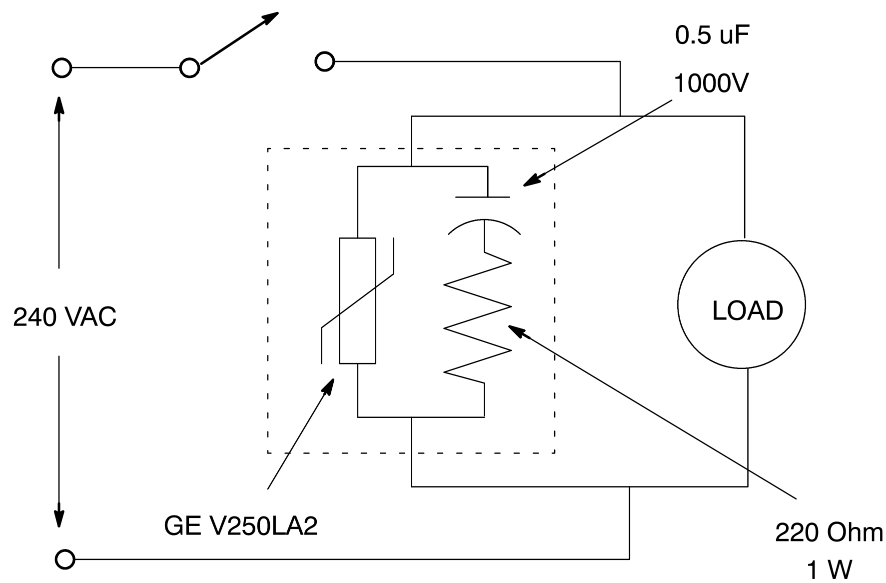


Figure 66 Large AC Inductive Load Suppression

Suppressors for Large Three-Phase AC Inductive Loads

Although treated like single-phase loads, three-phase inductive loads need three sets of suppressors. Connect one suppressor across each phase, as shown in Figure 67.

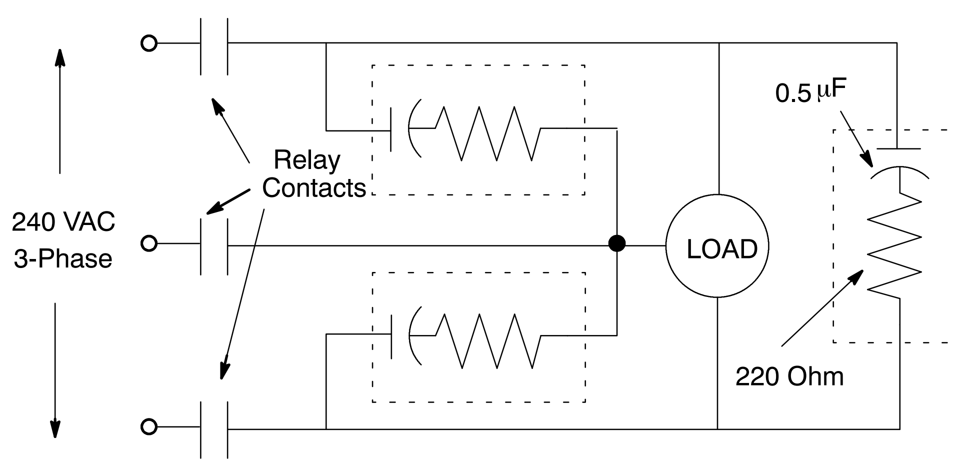


Figure 67 Three-Phase AC Inductive Load Suppression

Suppressors for Small DC Loads

A small DC load such as a small relay requires a suppressor diode. Connect the diode with its cathode (the banded end of its body) on the positive side of the load, as shown in Figure 68.

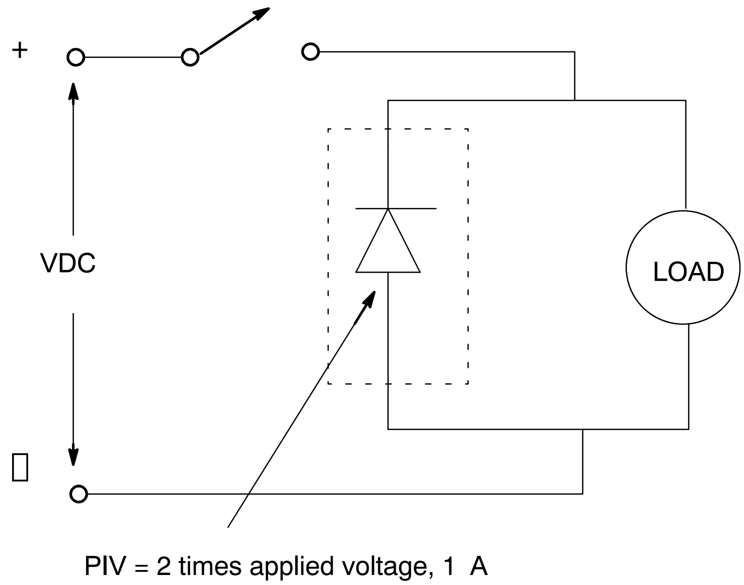


Figure 68 Small DC Inductive Load Suppression

Suppressors for Large DC Loads

Large DC inductive loads require RC networks in addition to the diodes, as shown in Figure 69.

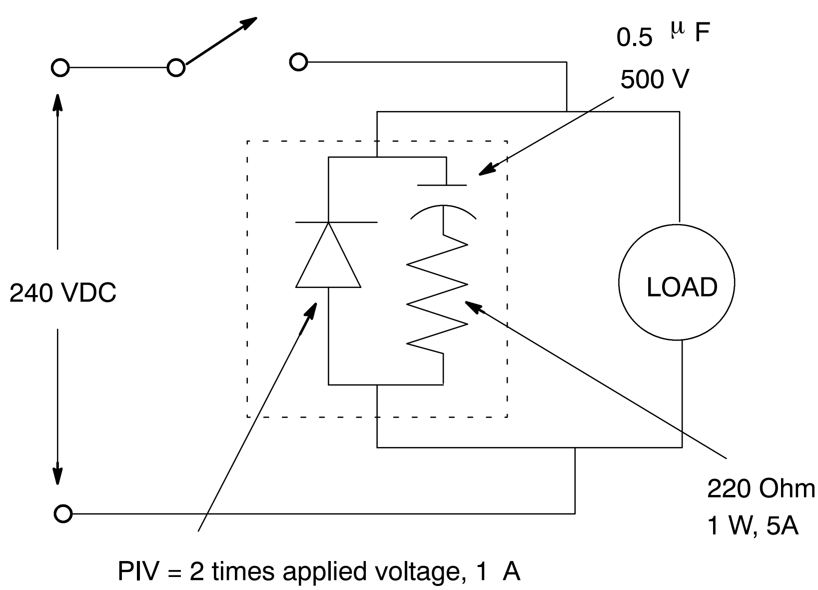


Figure 69 Large DC Inductive Load Suppression

Appendix B
Sizing an Isolation Transformer

- SIzing a transformer for loading conditions that are not well defined
- Sizing a transformer for well-defined loading conditions

Sizing a Transformer - Method 1

If your system s loading conditions are not well defined, follow this procedure for sizing an isolation transformer:

1. From the motor torque-speed curve, choose an operating point along the Y (speed) axis using the motor peak speed (with no phase advance) for the given drive and line voltage conditions. Calculate motor peak speed as follows:

   $$\omega_{peak} = (.6) * Vbus * (1/Kv) * 1000 \quad \text{RPM}$$

   where Kv is the motor voltage constant in volts line-line (RMS)/KRPM, and Vbus is the nominal value of the amplifier bus voltage (DC). Determine the corresponding torque point on the X (torque) axis based on the continuous torque-speed curve. Record torque (T) in units of lb*in.

2. Calculate shaft power in watts as follows:

   $$P_{shaft} = (11.8 * 10^{-3}) (T) (\omega peak) \quad \text{Watts}$$

   where $11.8 * 10^{-3}$ is a conversion factor from English to metric units.

3. Calculate continuous power into the motor given a worst case motor efficiency of 75% as follows:

   $$P_{motor} = P_{shaft} / .75 \quad \text{Watts}$$

4. Calculate approximate power into power supply/drive combination assuming an aggregate efficiency of 92% as follows:

   $$P_{servo} = P_{motor} / .92 \quad \text{Watts}$$

5. Assuming a three-wire connected isolation transformer, create a relationship between the power into the servo drive/power supply and the AC line voltage and line currents as follows:

   $$P_{servo} = 1.73 * V_{1\text{-}1} * I_{line} * (pf) \quad \text{Watts (all AC values RMS)}$$

   where pf is the load power factor (approximately .85).

6. Choose an isolation transformer with a 5% or better regulation characteristic at this VA rating. Regulation is defined as the percentage of change in the output voltage while the transformer load current is varied from 10 - 90% of the transformer rating.

Sizing a Transformer - Method 2

If your system s loading conditions are well defined, follow this procedure for sizing an isolation transformer:

1. Determine required continuous shaft power conditions from the application information (the required shaft RPM and required shaft continuous torque). If they are significantly less than the values found in Method 1 from the motor torque speed curves, then a determination of the acceleration requirements must be made.

   If the total load inertia is relatively light and peak servo performance (acceleration) is not required, then proceed to Step 2. However, if the load profile is similar to that shown in Figure 70, where I_{peak} is significantly greater than $I_{steady\text{-}state}$ then there is a large load inertia present (many times the given motor rotor inertia) and/or there are extremely fast accelerations required in order to meet cycle times, then the transformer should be sized as recommended in Method 1. See Figure 70.

   The following equation provides an estimate of the peak RMS currents that would be required to accelerate a given load inertia through a given velocity profile:

$$I_{peak} \approx \frac{.93 * J_{load}}{K_t} * \frac{\triangle \omega}{\triangle t}$$

   where

   J_{load} is the total load inertia (lb * in * s^2)

   K_t is the motor torque constant (lb * in / Amp RMS)

   $\triangle \omega$ is the required delta velocity in application information in RPM

   $\triangle t$ is the required delta time for the acceleration to take place

2. Substitute the required speed for ω_{peak} and the required torque for T.

3. Continue this procedure at Step 2 , Method 1, on the previous page.

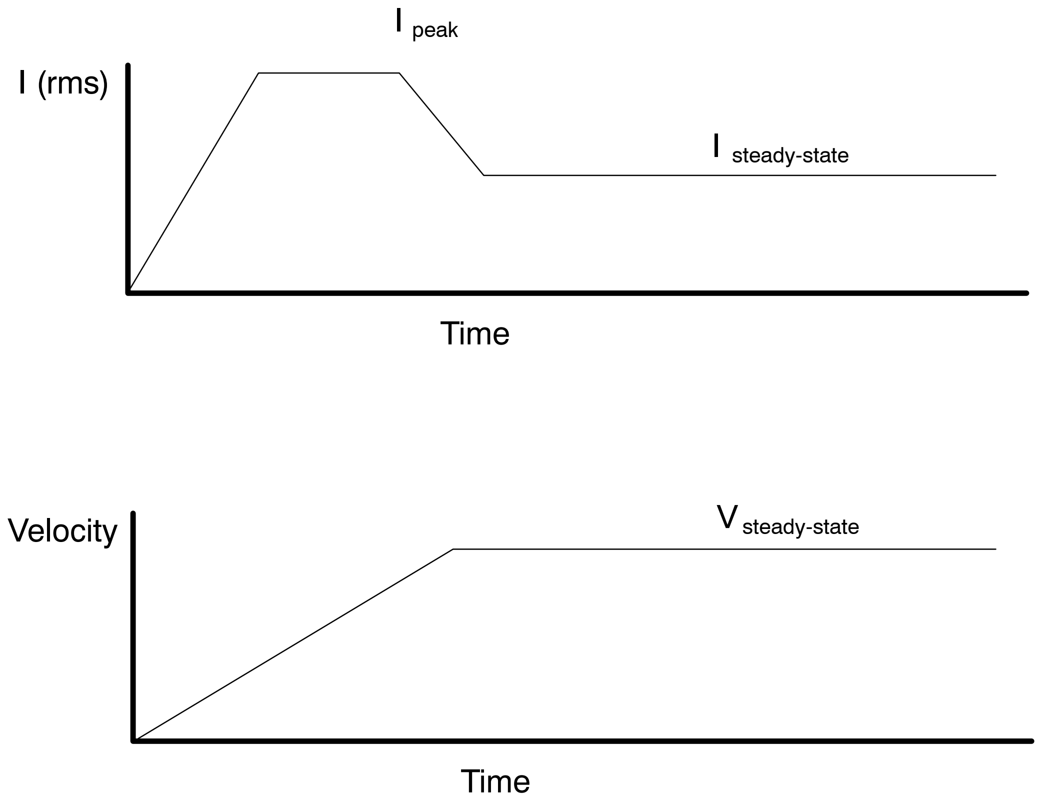


Figure 70 Profile Showing Large Load Inertia

☞ **Note** Transformer VA rating is primarily based on thermal capability that ultimately determines the percent of regulation. It is possible to reduce the required transformer size significantly in applications where the motor duty cycle is significantly lower than unity and where peak servo acceleration is not required, as explained above. However, the regulation requirement given in Step 6 should never be violated.

Appendix C
Parts List

- Cyberline drive and power supply parts list
- Isolation transformer parts list
- Mounting plate mounting system parts list
- Drive to controller cable parts list
- Drive to motor cables
- Spare parts

Cyberline Drives and Power Supply

Part Number	Description
DR-1005-000	CL1005 5/7 A, 325 VDC
DR-1010-000	CL1010 10/14 A, 325 VDC
DR-1020-000	CL1020 20/28 A, 325 VDC
DR-1030-000	CL1030 30/42 A, 325 VDC
DR-1060-100	CL1060 60/84 A, 325 VDC with integral power supply, mounted on CPM mounting plate with 110 VAC fans. (Does not require PLS4.)
DR-1060-200	CL1060 60/84 A, 325 VDC with integral power supply, mounted on CPM mounting plate with 220 VAC fans. (Does not require PLS4.)
DR-1060-300	CL1060W 60/84 A, 325 VDC with integral power supply, mounted on CWM mounting plate. (Does not require PLS4.)
DR-PLS4-000	PLS4, 50 A, 325 VDC power supply capable of providing power for up to four CL1000A series drives.

Isolation Transformers

Open Frame Transformers

Part Number	Description
800-110	1.5 kVA, 60 Hz three-phase transformer
800-111	3.2 kVA, 60 Hz three-phase transformer
800-112	6.4 kVA, 60 Hz three-phase transformer
800-113	9.6 kVA, 60 Hz three-phase transformer
800-125	13 kVA, 60 Hz three-phase transformer
800-026	2.0 kVA, 60 Hz single--hase transformer
800-027	0.75 kVA, 60 Hz single-phase transformer
800-033	0.5 kVA, 60 Hz three-phase bias transformer
110-116	Fusing kit for secondary wiring of all transformers to PLS4. Includes fuses and fuse holders.

NEMA 12 Enclosed Transformers

Part Number	Description
800-060	1.5 kVA, 60 Hz three-phase transformer
800-061	3.2 kVA, 60 Hz three-phase transformer
800-062	6.4 kVA, 60 Hz three-phase transformer
800-063	9.6 kVA, 60 Hz three-phase transformer
800-064	13 kVA, 60 Hz three-phase transformer

Mounting Plate Mounting System

Part Number	Description
110-200	CPM mounting plate (two position) with 110 VAC fans
110-200-2	CPM mounting plate (two position) with 220 VAC fans
110-131	CPM mounting plate (three position) with 110 VAC fans
110-131-2	CPM mounting plate (three position) with 220 VAC fans
110-180	CWM through-the-wall (two position) mounting panel/heat sink
110-061	CWM through-the-wall (three position) mounting panel/heat sink

Options

Part Number	Description
110-201	Optional two fan bracket, 110 VAC
110-201-2	Optional two fan bracket, 220 VAC
110-266	Optional two fan bracket for 110-180, 110 VAC
110-266-2	Optional two fan bracket for 110-180, 220 VAC
110-062	Optional three fan bracket, 110 VAC
110-062-2	Optional three fan bracket, 220 VAC
110-119	Optional three fan bracket for 110-061, 110 VAC
110-119-2	Optional three fan bracket for 110-061, 220 VAC
820-004	Optional Inductor, 1.5mH, 38 Amps
820-005	Optional Inductor, 1.5mH, 60 Amps

Drive to Controller Cables

Part Number	Description
AS-W920-008	Eight-foot Cyberline drive-to-controller universal design cable with DB25/tinned leads.
AS-W920-015	Fifteen-foot Cyberline drive-to-controller universal design cable with DB25/tinned leads.
AS-W921-008	Eight-foot Cyberline drive-to-MOT 202 motion module cable with DB25/MT connectors.
AS-W921-015	Fifteen-foot Cyberline drive-to-MOT 202 motion module cable with DB25/MT connectors.
110-050-8	Eight-foot Cyberline drive-to-3220 controller cable, complete with connectors and pre-wired, snap-in terminal blocks.
110-050-12	Twelve-foot Cyberline drive-to-3220 controller cable, complete with connectors and pre-wired, snap-in terminal blocks.
110-143-8	Cyberline drive-to-3220 controller cable with external ENABLE wire (ENABLE can be wired through a contact) complete with connectors and pre-wired, snap-in terminal blocks.
100-338-8	Eight-foot Cyberline drive-to-3240 controller cable with DB25/tinned leads.
100-338-15	Fifteen-foot Cyberline drive-to-3240 controller cable with DB25/tinned leads.

Drive to Motor Cables

Modicon recommends standard cables for most general industrial environments and heavy duty cables for wet and/or repeated flexing applications.

Consult the *Modicon 984 Catalog and Specifier s Guide*, MC-CAT-001, and your Modicon customer services representative for drive-to-motor cable part numbers and motor part numbers.

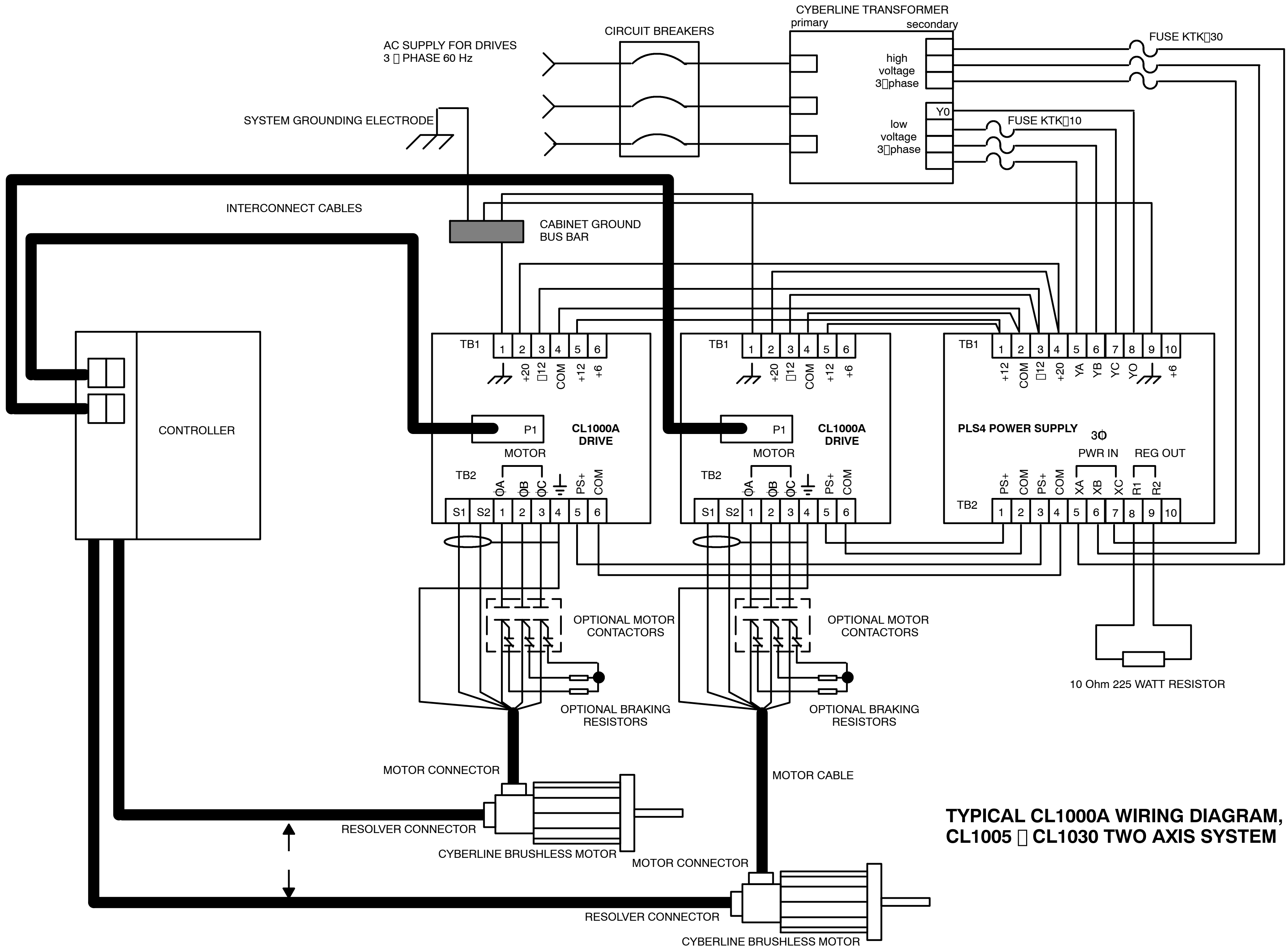
Spare Parts

These spare parts are available through Modicon s Customer Service (1-800-468-5342 in North America).

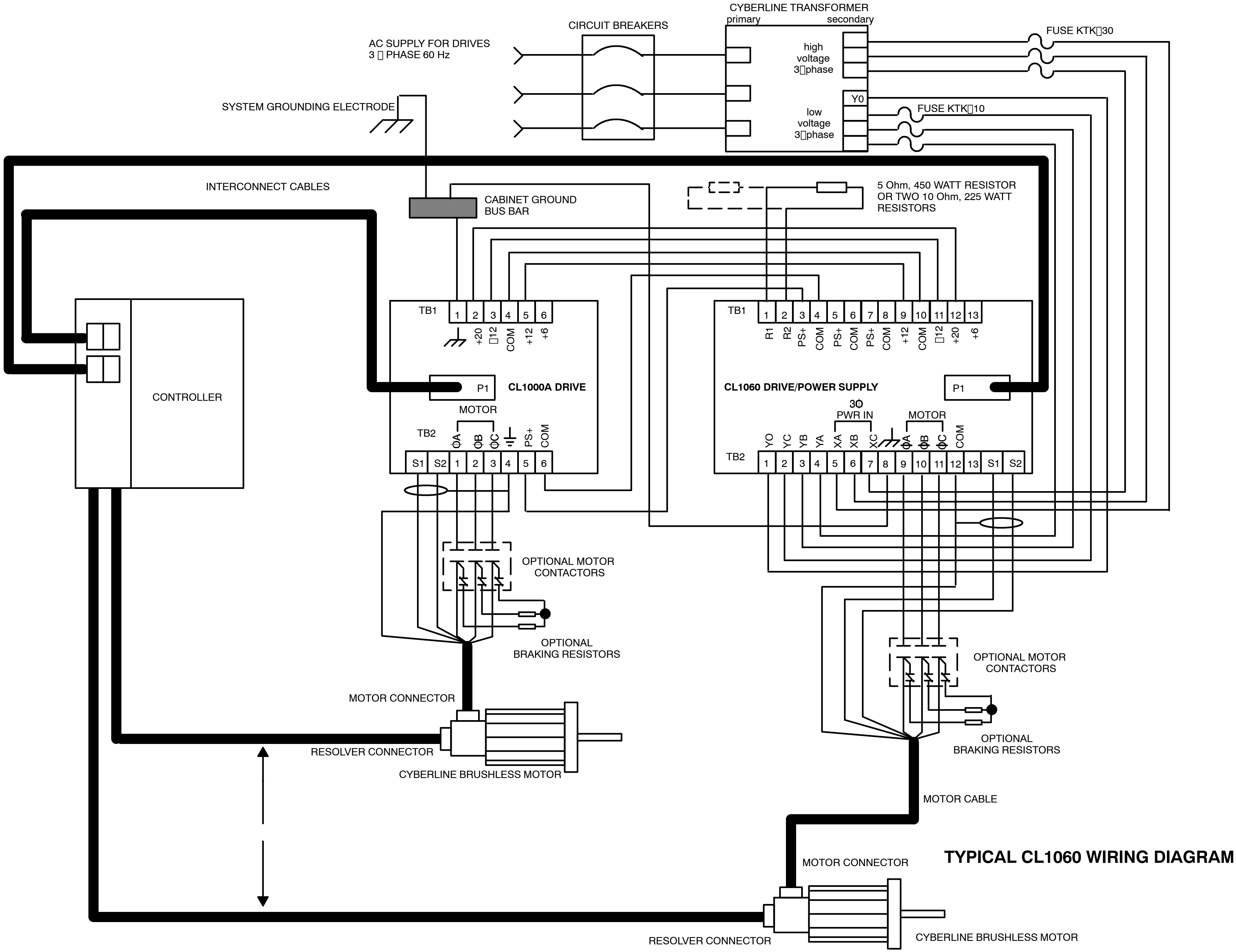
Part Number	Description
110-191	Spare KTK-10 fuses (10) for low voltage transformer secondary or regen circuit.
110-193	Spare KTK-30 fuses (10) for high voltage transformer secondary.
950-020	10 ohm, 225 W resistor for shunt regulator (included with the PLS4 power supply (part number DR-PLS4-000).
950-023	5 ohm, 500 W resistor for shunt regulator on all CL114A integrated drive/power supplies (included with 110-094, 110-094-2 or 110-129).
60-0609-000	Replacement fan, 110 VAC.
60-0614-000	Replacement fan, 220 VAC.

Appendix D
System Wiring Diagrams

- Typical CL1000A (CL1005 -   CL1030) system wiring diagram
- Typical CL1060 system wiring diagram



TYPICAL CL1000A WIRING DIAGRAM,
CL1005 CL1030 TWO AXIS SYSTEM



TYPICAL CL1060 WIRING DIAGRAM

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