Parker Hannifin plc
Digiplan Division
21 Balena Close
Poole, Dorset
England, BH17 7DX
Tel: 0202 690911
Fax: 0202 600820
Telex: 417217

Parker Hannifin Corporation
Digiplan Division
5500 Business Park Drive
Rohnert Park, CA 94928, USA
Tel: 0101 800 358 9070
Fax: 0101 707 584 8015

Digiplan, Compumotor and Daedal form part of the Parker Hannifin Applied Technologies Group. Products include stepper, brush and brushless servo systems, controllers and positioning stages, as well as complete custom-designed systems.

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Digiplan

Electronic Motion Control

SD2, SD3 & SD5 Stepper Drives User Guide

Parker

IMPORTANT INFORMATION FOR USERS

Installation and Operation of Digiplan Equipment

It is important that Digiplan motion control equipment is installed and operated in such a way that all applicable safety requirements are met. It is your responsibility as a user to ensure that you identify the relevant safety standards and comply with them; failure to do so may result in damage to equipment and personal injury. In particular, you should study the contents of this user guide carefully before installing or operating the equipment.

Under no circumstances will the suppliers of the equipment be liable for any incidental, consequential or special damages of any kind whatsoever, including but not limited to lost profits arising from or in any way connected with the use of the equipment or this user guide.

SAFETY WARNING

High-performance motion control equipment is capable of producing rapid movement and very high forces. Unexpected motion may occur especially during the development of controller programs. ***KEEP WELL CLEAR*** of any machinery driven by stepper or servo motors. Never touch it while it is in operation.

High voltages exist within enclosed units, on rack system backplanes (motherboards) and on transformer terminals. Keep clear of these areas when power is applied to the equipment.

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How To Use This Manual

This manual is designed to help you install, develop, and maintain your system. Each chapter begins with a list of specific objectives that should be met after you have read the chapter. This section is intended to help you find and use the information in this manual.

Assumptions

This user guide assumes that you have the skills or fundamental understanding of the following:

- Basic electronics concepts (voltage, switches, current, resistors, etc.)
- Basic motion control concepts (torque, velocity, distance, etc.)

With this basic level of understanding, you will be able to effectively use this manual to install, develop, and maintain your system.

Contents of This Manual

This user guide contains the following information:

Chapter 1: Introduction

This chapter provides a description of the product and a brief account of its specific features.

Chapter 2: Getting Started

This chapter contains a detailed list of items you should have received with your SD Drive system shipment. It will help you become familiar with the system and ensure that each component functions properly. In this chapter, you will perform a preliminary configuration of the system.

Chapter 3: Installation

This chapter provides instructions for you to properly mount the system and make all electrical and non-electrical connections. Upon completion of this chapter, your system should be completely configured, installed, and ready to perform basic operations.

Chapter 4: Application Design

This chapter will help you customize the system to meet your application's needs. Important application considerations are discussed. Sample applications are provided.

Chapter 5: Hardware Reference

This chapter contains information on system specifications (dimensions and performance). This chapter may be used as a quick-reference tool for proper switch settings and I/O connections.

Chapter 6: Maintenance & Trouble-shooting

This chapter describes recommended system maintenance and troubleshooting procedures. It also provides methods for isolating and resolving hardware and software problems.

Installation Process Overview

To ensure trouble-free operation, you should pay special attention to the following:

- The environment in which the SD Drive system will operate
- The system layout and mounting
- The wiring and grounding practices used

These recommendations are intended to help you easily and safely integrate the SD Drive system into your manufacturing facility. Industrial environments often contain conditions that may adversely affect solid state equipment. Electrical noise or atmospheric contamination may also affect the SD Drive system.

Installation Recommendations

Before you attempt to install this product, you should complete the following steps:

Step 1

Review this entire manual. Become familiar with the manual's contents so that you can quickly find the information you need.

Step 2

Develop a basic understanding of all system components, their functions, and interrelationships.

Step 3

Complete the basic system configuration and wiring instructions provided in Chapter 2, Getting Started. Note that this is a preliminary configuration, not a permanent installation, usually performed in a bench-top environment.

Step 4

Perform as many basic moves and functions as you can with the preliminary configuration. You can perform this task only if you have reviewed the entire manual. You should try to simulate the task(s) that you expect to perform when you permanently install your system. *However, do not attach a load at this time.* This will give you a realistic preview of what to expect from the complete configuration.

Step 5

After you have tested all of the system's functions and used or become familiar with all of the system's features, carefully read Chapter 3, Installation.

Step 6

After you have read Chapter 3 and clearly understand what must be done to properly install the system, you should begin the installation process. **Proceed in a linear manner**; do not deviate from the sequence or installation methods provided.

Step 7

Before you begin to configure your system, check all of the system functions and features to ensure that you have completed the installation process correctly.

The successful completion of these steps will prevent subsequent performance problems and allow you to isolate and resolve any potential system difficulties before they affect your system's operation.

Conventions

To help you understand and use this user guide effectively, the conventions used throughout this manual are explained in this section.

Highlighted Text

Several methods are used to highlight text. Explanations of special text and the way it is highlighted are presented below.

Warnings & Cautions

Warning and caution notes alert you to possible dangers that may occur if you do not follow instructions correctly. Situations that may cause bodily injury are presented as warnings. Situations that may cause system damage are presented as cautions. Refer to the examples shown below.

WARNING

Do not touch the motor immediately after it has been in use for an extended period of time. The unit will be hot.

CAUTION

System damage will occur if you power up the system improperly.

Italics

Italics are used to highlight other important material. Refer to the example below.

Adding a 10µf capacitor at C25 will double the acceleration and deceleration rates.

Related Publications

The following publications may be helpful resources:

- *Digiplan & Compumotor Programmable Control Systems & Drives Catalogue*
- Schram, Peter (editor). *The National Electric Code Handbook (Third Edition).* Quincy, MA: National Fire Protection Association

Chapter 1. INTRODUCTION

Chapter Objective

The information in this chapter will enable you to understand the product's basic functions & features.

Product Description

SD-Series Drives

The SD-Series consists of the SD2, the SD3 and the SD5 drives. SD drives are high-performance, bipolar, chopper-regulated stepper drives designed for optimum performance in low and medium power applications. They may be powered by either an unregulated power supply or directly from the secondary winding of an isolating transformer without any additional components. One transformer can power several drives in a multi-axis system.

SD drives operate rotary stepper motors at resolutions of either 200 steps/rev (full-step) or 400 steps/rev (half-step).

When supplied as stand alone units the SD drives may be plugged into a standard SD Motherboard, a standard SDC Motherboard or the 32 way connector supplied with each drive, the latter allowing direct integration into the user system. The SDC Motherboard is for use in high noise environments. It provides opto-isolation for the clock, direction, shutdown and fault lines.

SD drives are available in multiple configurations in SR- and SC-Series rack assemblies, or separately as stand-alone units.

SC- and SR-Series Racks

The SC/SR-series pre-wired rack assemblies can house up to six SD drives. Each rack system is based on a 19"(48.26cm.)-long, 5.2"(13.21cm)-high rack with individual motherboards mounted on the back. The drives are mounted into the rack and plugged directly into their corresponding motherboards. This design provides a compact package, maximum flexibility, and simple solder-free screw terminal connectors. All racks fit into standard 19" rack-mount system cabinets. Table 1-1 identifies the racks and the number of drives each type of rack is capable of accommodating.

Rack Model No.	SD Drives
SC/SR10	1
SC/SR20	2
SC/SR30	3
SC/SR40	4
SC/SR50	5
SC/SR60	6

Table 1-1. SR-Series Rack Configurations

Product Features

SD Series Drives

Features of the SD Drives are as follows:

- A recirculating chopper regulator improves operating efficiency, eliminates the need for ballast resistors, minimizes power consumption, and reduces motor and drive heating.
- The motor current selecting DIP switch, mounted on the drive, allows you to configure the drive for a wide range of stepper motors (frame sizes 08 - 34).
- A facility for installing remote CW and CCW advance switches allows you to have manual control over the motor.
- The output drivers have thermal protection.
- Motor short-circuit protection is assured across and between phases (not phase-to-ground).
- Motor step pulses may be derived from the SD Drive's built-in oscillator or from a user-supplied controller.
- SD Drives operate rotary stepper motors at resolutions of either 200 steps/rev (full-step mode) or 400 steps/rev (half-step mode). SD Drives can also operate linear stepper motors.
- Using the internal oscillator and motherboard-mounted step rate potentiometers, SD Drives in SR/SC racks can produce speeds between 40 and 1,000 steps/sec (slow rate) or between 400 and 10,000 steps/sec (fast rate).
- One transformer can power several drives in a multi-axis system.
- Separate logic and motor supply inputs allow you to use a 36-volt motor supply, providing extra torque at high speeds. The 36 volt motor supply is recommended for SD5 Drive operation

Motor rotational speed and direction are controlled by signals on the CLOCK IN and DIRECTION inputs which are accessed through the drive interface. The system may be configured to allow the clock signal to be provided by the on-board oscillator. Two separate adjustable speeds are available when the two motherboard mounted variable resistors are used. Alternatively external circuitry may be used to set the speeds. The running speed is selected remotely and the acceleration and deceleration times between the speeds, although preset at shipment, may be altered by the addition of a capacitor to the drive board. A separate selectable ENERGISE input allows disabling of the drive to allow free mechanical rotation of the motor.

Theory of Operation

The external indexer typically receives ASCII commands (from a computer or PLC) or binary signals (from remote switches, PLC, or thumbwheel interface). The indexer then converts these commands or signals to step pulses and sends them to the SD drive via the motherboard (if installed in a rack). These step pulses, are coupled with a direction signal to control motor velocity, acceleration, direction, and position. The SD drive uses the step pulses to switch motor phase currents in order to control the stepper motor's rotation and angular position. The motor converts electrical pulses into discrete mechanical motion (shaft rotation). An optional encoder mounted either on the motor or on the load provides positional feedback (encoder pulses) to the indexer. Figure 1-1 is a functional block diagram of the system's processes.

As a method of manual control, the drive internal oscillator can be used with the SLOW and FAST inputs to position the motor. *NOTE: The indexer is not aware of any extra motion produced by this method.*

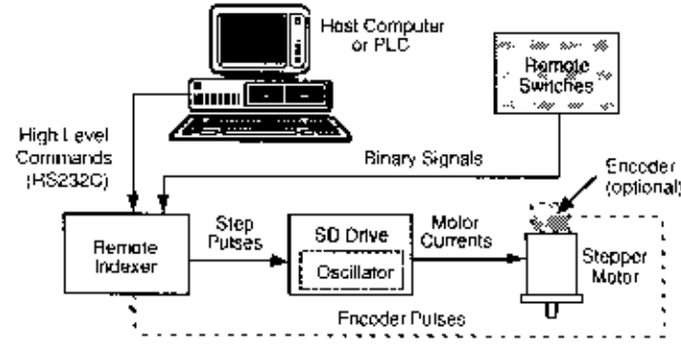


Figure 1-1. Typical SD Drive System Functional Block Diagram

For a detailed description of stepper motor construction and operation, refer to the Digiplan & Compumotor Motion Control Catalogue.

Chapter 2. GETTING STARTED

Chapter Objectives

The information in this chapter will enable you to do the following:

- Verify that each component of your system has been delivered safely
- Become familiar with system components and their interrelationships
- Establish the basic system configuration
- Carry out a pre-installation test to ensure that each component functions properly

What You Should Have

The SD Drive system is normally shipped with all components pre-wired and installed in the appropriate SC/SR rack system.

Upon receipt, you should inspect your SD Drive system shipment for obvious damage to its shipping container. Report any such damage to the shipping company as soon as possible. Digiplan cannot be held responsible for damage incurred in shipment. Carefully unpack and inspect your SD Drive System shipment. The items listed in Table 2-1 should be present and in good condition.

Ship Kit Table

Table 2-1 identifies ship kits corresponding with the six different SC/SR racks.

Description	Part No.	SC/SR10	SC/SR20	SC/SR30	SC/SR40	SC/SR50	SC/SR60
Possible drives: SD2 SD3 SD5	 SD2 SD3 SD5	1 (Total)	2 (Total)	3 (Total)	4 (Total)	5 (Total)	6 (Total)
Possible fr. panels: SD2 Drive SD3 Drive SD5 Drive	 FP6 FP7 FP32	1 (Total)	2 (Total)	3 (Total)	4 (Total)	5 (Total)	6 (Total)
Blank front panel	FP5	5	4	3	2	1	---
Transformers: TO116 TO119 TO120	 TO116 TO119 TO120	See Table 2-2					
Motor*		1	2	3	4	5	6
User guide	*1600.023.03*	1	1	1	1	1	1

Table 2-1. SC/SR System Ship Kits

Transformer Ship Kit

The following table shows the transformers that are typically supplied with systems involving one type of drive only and in typical applications where the axes are not drawing maximum VA's continuously.

For more demanding application requirements and cases where different SD drive types are used in the same rack, please consult an application engineer at Digiplan or your local distributor.

Transformer Type	Rack Type - Number of Drives (Drive Type)					
	SC/SR10	SC/SR20	SC/SR30	SC/SR40	SC/SR50	SC/SR60
T0116 (100VA)	1 (SD2) 1 (SD3)	2 (SD2)	—	—	—	—
T0119 (300VA)	* 1 (SD5)	2 (SD3) 2 (SD5)	3 (SD2) 3 (SD3) 3 (SD5)	4 (SD2) 4 (SD3)	5 (SD2)	6 (SD2)
T0120 (450VA)	—	—	—	4 (SD5)	5 (SD3)	6 (SD3)

* A T0116 may be used to power a single SD5 on low duty cycle applications.

Table 2-2. SC/SR System for Transformers

Pre-installation Testing

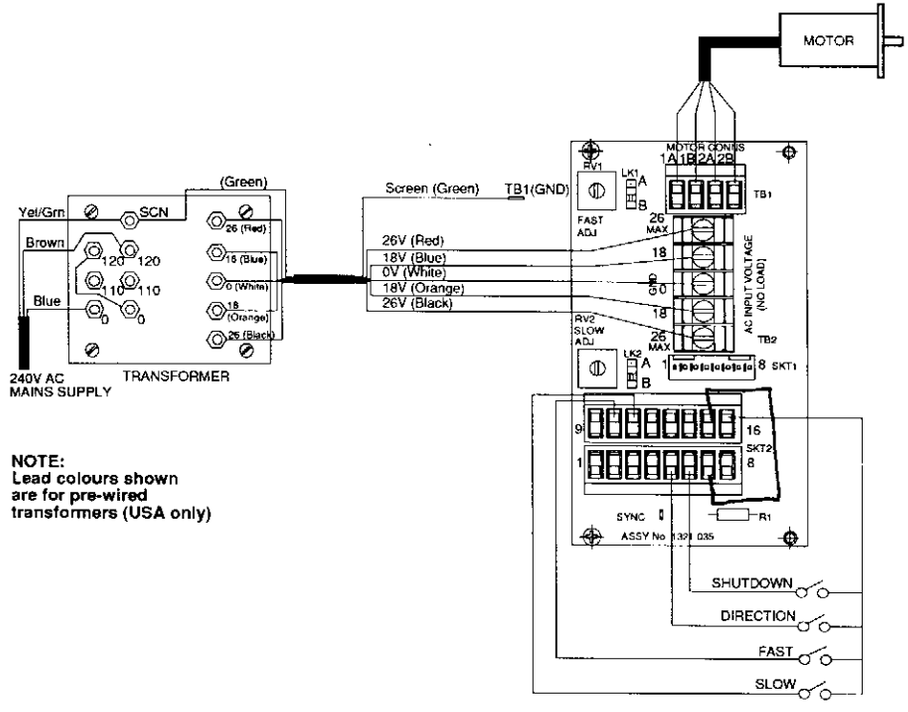
A simple pre-installation test may be carried out on systems using the SD or SDC Motherboard to verify that the received system is functioning correctly. This section details the test and describes basic system configurations to test each drive-motherboard-motor set. Final installation information is given in Chapter 3.

The possible test configurations are;

1. Connecting to the drive via an SD motherboard using the on-board oscillator.
2. Connecting to the drive via an SDC Motherboard using the on-board oscillator.
3. Testing using an indexer such as the MC20 Keypad Indexer and an SDC motherboard.

Test Configuration Using an SD Motherboard

Where interfacing to the drive is via a SD Motherboard, the system for pre-installation testing should be configured as shown in Figure 2-1.



NOTE:
Lead colours shown are for pre-wired transformers (USA only)

Figure 2-1. SD Motherboard Test Configuration

Internal clock out to clock in
Jump pin 7 to pin 15

Test Configuration Using an SDC Motherboard

Where the SDC Motherboard is used in the system to connect to the drive, the configuration shown in Figure 2-2 may be used for the pre-installation test.

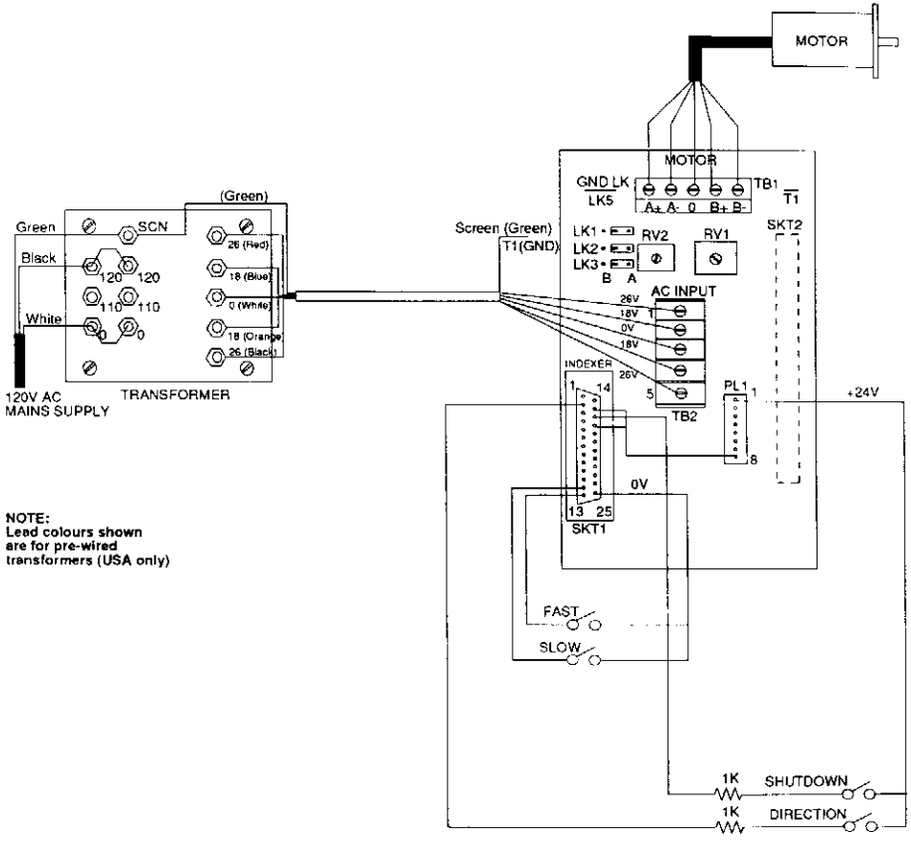


Figure 2-2. SDC Motherboard Test Configuration

Test Configuration Using the MC20 Indexer

If an indexer such as the Digiplan MC20 Keypad Indexer is included in the system, it may be used with the SDC Motherboard in the pre-installation test in the configuration shown in Figure 2-3. A separate procedure is described for this test.

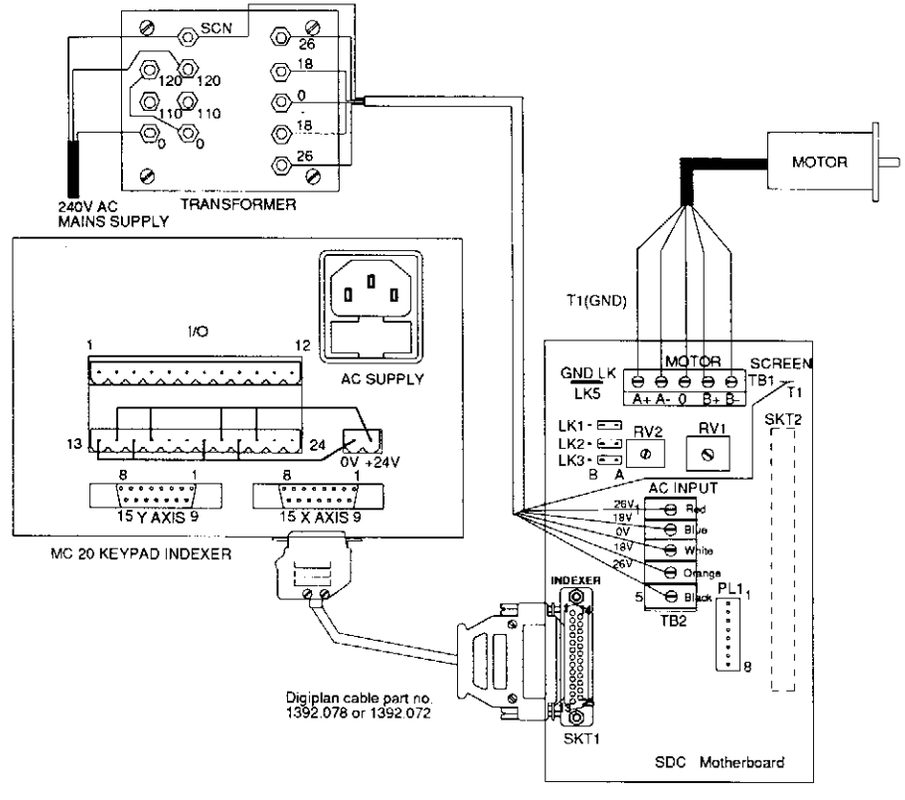


Figure 2-3. MC20 Indexer and SDC Motherboard Test Configuration

Powering Up the SD Drive

Before you power-up the drive, you should verify that the power and motor cables are properly connected . If everything is OK, the drive will be enabled (evident by *holding torque* on the motor) when you apply power.

If the motor does not have holding torque, remove power to the system and refer to Chapter 6, Maintenance and Troubleshooting.

Prior to proceeding with the pre-installation testing, remove power to the drive, remove the drive and move Lk4 to the Lk Pk position. Replace the drive and re-apply power. This will permit the shutdown function to be tested.

Functional Test Without Indexer

This procedure uses the built-in clock facility in the SD Drive to test the system where no indexer is available.

Step 1 Close the SHUTDOWN switch to energise the drive.

Step 2 Turn the SLOW potentiometer fully CCW and then press the SLOW button. The motor shaft should rotate slowly.

Step 3 Slowly turn the SLOW potentiometer CW and note that the speed of rotation increases.

Step 4 Release the SLOW button, close the DIRECTION button and then press the SLOW button keeping the DIRECTION button closed. The motor shaft should rotate in the opposite direction.

Step 5 Release both buttons. The shaft stops rotating.

Step 6 Turn the FAST potentiometer fully CCW then press the FAST button. The motor shaft should rotate faster than in Step 2.

Step 7 Turn the FAST potentiometer CW and note an increase in the shaft speed.

Step 8 Release the FAST button and open the SHUTDOWN switch.

If all of these steps have been completed satisfactorily the system is basically functioning correctly and may be properly installed (see Chapter 3).

Functional Test Using the MC20 Indexer

Use the following procedures to test the functionality of the system and to verify proper system connections where an indexer such as the MC20 Keypad Indexer is available.

Step 1 Set up the indexer to run in accordance with the installation procedures outlined in the indexer manual. Make sure the indexer resolution (steps/rev) matches the SD drive resolution setting. With drive Lk3 fitted the drive is in 200 steps/rev mode (Full Step). When drive Lk3 is not fitted the drive is in 400 Steps/rev mode (Half Step). See Figure 3-1.

Step 2 Apply power to the SD Drive and set the indexer to perform a move with the following parameters:

- Velocity = 4 revolutions per second (rps)
- Acceleration = 5 rps^2
- Distance = 800 steps

Executing this move should cause the motor to make an 800-step move (two revolutions).

If the motor does not move, refer to Chapter 6, Maintenance and Troubleshooting.

Chapter 3. INSTALLATION

Chapter Objectives

The information in this chapter will enable you to do the following:

- Mount all system components properly
- Connect all electrical system inputs and outputs properly
- Ensure that the complete system is installed properly
- Perform basic system operations

NOTE: You should complete all steps in Chapter 2, Getting Started, before proceeding with the steps in this chapter.

Complete System Configuration

In this section, you will go through complete set-up procedures for setting drive functions.

WARNING

NEVER adjust terminal connections or DIP switch settings when the power is on.

Setting Drive Functions

Drive functions are set by means of DIP switches and links. These are factory-set to provide optimum operation in most applications. You may, however, need to alter these settings to satisfy the particular operating requirements for your application.

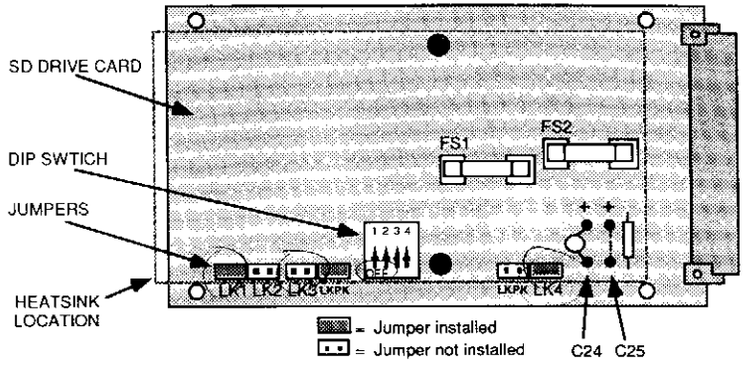
NOTE: To change DIP switch and some linksettings you must remove the drive from the rack.

CAUTION

Do not remove the drive modules while power is applied to the rack.

Drive DIP Switch Settings

A 4-position DIP switch is located on the SD Drive card (see Figure 3-1). This DIP switch allows you to program the output current to the motor. To access the DIP switch, remove the screws securing the front panel to the rack and pull the drive from the rack. *NOTE: When re-installing the drive, make sure the drive follows the guide rails in the rack.*



NOTE: Figure shows factory settings for DIP switch and Jumpers

Figure 3-1. SD Drive DIP Switch Link Locations & Acceleration Cap C25

Motor Selection

SD drives are suitable for use with high-performance hybrid or permanent magnet motors having 4, 6 or 8 leads; a 5-lead motor cannot be used with this type of drive. The phase inductance of the motor should ideally lie between 1mH and 10mH.

The best overall performance will generally be obtained when the unipolar current rating of the motor is between 1 and 1.5 times the current rating of the drive. Therefore the SD2 is best suited to motors in the 1.5-3A range, the SD3 to motors in the 2-4A range and the SD5 to motors in the 4-6A range. Select a motor with a current rating at the top of the corresponding range when the maximum high-speed torque is required; whilst there is less torque at low speeds, the reduced winding inductance helps to maintain the torque as speed is increased. The drives can be derated to match motors having a lower current rating, but the associated increase in motor inductance causes a corresponding reduction in high-speed torque.

Motors having 6 leads are best connected in series in order to utilise the whole winding, and in the series mode the current rating of the motor is 70% of the unipolar rating. Therefore try to choose a motor with a unipolar rating of about 3A for the SD2, 4A for the SD3 or 6A for the SD5. Greater flexibility is afforded with 8-lead motors since the windings may be connected in series or in parallel. The bipolar rating of the motor relates to parallel connection, but similar characteristics will be obtained from a higher-current motor connected in series. Motors with 4 leads are not suitable for unipolar drives and therefore have a bipolar rating only.

Motor Current Selection

Table 3-1 shows the settings of drive DIP switches 1-4 for the full range of current settings. The values shown are two-phase-on levels, and are nominal values in that they depend on motor inductance. *When selecting the current, be sure not to exceed the current rating of the motor.*

Nominal Current			DIP Switch Settings			
SD2	SD3	SD5	SW1	SW2	SW3	SW4
2.0A	3.0A	4.5	OFF	OFF	OFF	OFF
1.8A	2.7A	4.2	OFF	OFF	OFF	ON
1.6A	2.4A	3.9	OFF	OFF	ON	OFF
		3.7	OFF	OFF	ON	ON
		3.5	OFF	ON	OFF	OFF
1.4A	2.1A	3.4	OFF	ON	OFF	ON
		3.2	OFF	ON	ON	OFF
1.2A	1.8A	3.1	OFF	ON	ON	ON
1.0A	1.5A	3.0	ON	OFF	OFF	OFF
		2.9	ON	OFF	OFF	ON
		2.8	ON	OFF	ON	OFF
		2.7	ON	OFF	ON	ON
		2.6	ON	ON	OFF	OFF
		2.5	ON	ON	OFF	ON
		2.4	ON	ON	ON	OFF
		2.3	ON	ON	ON	ON

Table 3-1. Drive Current DIP Switch Settings

Drive Link Settings

The SD Drive is fitted with four links (see Figure 3-1 for link locations). The following paragraphs describe their functions and optional settings.

CAUTION

Remove power from the drive before removing or fitting any links to the drive module or motherboard.

Link LK1 **Leave this link fitted.**

Link LK2 **Do not fit this link.**

Link LK3

With this link installed, the drive will function in the full-step mode, producing 200 steps/rev. When this link is not installed, the drive will function in the half-step mode, producing 400 steps/rev. The half-step mode is preferred in most applications, the slight torque loss being offset by smoother operation at low speeds; consequently, the drive is shipped from the factory with this link not installed. If you desire full-step operation, remove the link from LKPk and place it in LK3 (see Figure 3-1). LKPk, which stands for *link park*, is simply a place to store unused links and serves no electrical purpose.

Link LK4

With this link installed, the drive will remain permanently energized and a Shutdown command signal will have no effect on the drive. When link LK4 is not installed, the Shutdown command will affect the drive. The SD drive is factory-configured with this link installed. When not installed, the link can be stored on LKPk, next to LK4 (see Figure 3-1).

Acceleration/ Deceleration Rate Adjustment

The Fast and Slow set speeds are selectable by control lines connected into the motherboard.

The acceleration and deceleration rates between the two set speeds are factory set to 60ms for accelerating from Slow speed to Fast speed, and 30ms for decelerating from Fast speed to Slow speed. These times may be increased by the addition of C25 on the drive module (see Figure 3-1 for location). If a capacitor value of 10µF is fitted the acceleration and deceleration times will increase to 120ms and 60ms respectively. A capacitor of minimum 16V rated voltage should be used. When fitting observe polarity.

It is also possible to obtain a greater increase in the acceleration and deceleration times by replacing C24 with a capacitor value greater than 10µF (see Figure 3-1). If C24 is removed a capacitor of minimum 10µF and 16V rated voltage must be fitted in its place.

SD Motherboard

Links 1 and 2 on the SD Motherboard (see Figure 3-2 for link locations)are fitted in position "b" to use the motherboard mounted preset controls RV1 (FAST ADJ) and RV2 (SLOW ADJ). When external speed controls are required, fit both links in position "a".

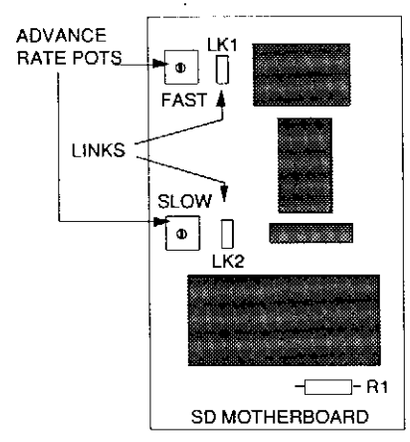


Figure 3-2. Location of Links, Advance Rate Pots and R1 (SD Motherboard)

Advance Rate Adjustment

You can use the advance rate potentiometers to manually adjust the rate from 40 to 1,000 steps/sec (**SLOW** pot) or from 400 to 10,000 steps/sec (**FAST** pot). Refer to Figure 3-2 for the location of the fast and slow advance rate pots.

Turn the pot CW to increase the rate, and CCW to decrease the rate.

NOTE: If you set the 'Slow' rate too high you can stall the motor. This function should be used only if the indexer does not need to track the motor's position.

Motor Current

As an alternative to using the switch on the drive, you can reduce the motor current by installing a resistor in the R1 location on the SD Motherboard (see Figure 3-2). The motor current may be set by this resistor according to Table 3-2. R1 may be used to reduce the current level of an SD2 drive to 0.2A. The values of current given correspond to the condition when all drive bit switches are in the 'OFF' position. The current level should not be reduced below the lowest figure given for each drive variant.

Nominal Current SD2	SD3	SD5	Resistor Value
2.0A	3.0A	4.5A	Open-circuit
1.8A	2.7A	4.0A	12KΩ
1.6A	2.4A	3.7A	5.6KΩ
1.4A	2.1A	3.1A	2.2KΩ
1.2A	1.8A	2.8A	1.5KΩ
1.0A	1.5A	2.4A	1.0KΩ
0.9A	------	------	680Ω
0.8A	------	------	560Ω
0.7A	------	------	470Ω
0.6A	------	------	330Ω
0.5A	------	------	220Ω
0.4A	------	------	150Ω
0.3A	------	------	82Ω
0.2A	------	------	Short-circuit

Table 3-2. SD Motherboard R1 Resistor Values for Setting Motor Current

SDC Motherboard

The SDC Motherboard is fitted with three links for selecting the use of the motherboard advance rate potentiometers or optional remote pots which you can connect via the 25-pin indexer connector (see Figure 3-3 for link locations). The factory default position for these links is position A.

Link LK1 Place link LK1 in position A to enable the advance rate pots on the motherboard. Place link LK1 in position B to disable the motherboard pots and divert the adjust common reference to pin 19 on the indexer connector.

Link LK2 Place link LK2 in position A to enable the slow advance rate pot. Place link LK2 in position B to disable the slow pot and divert the slow rate adjust signal to pin 6 on the indexer connector.

Link LK3 Place link LK3 in position A to enable the fast advance rate pot. Place link LK2 in position B to disable the fast pot and divert the fast rate adjust signal to pin 7 on the indexer connector.

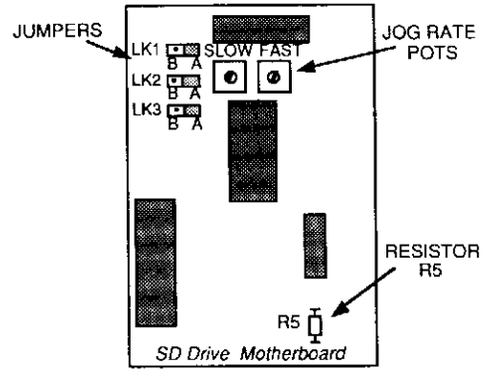


Figure 3-3. Location of R5, Links and Advance Rate Pots (SDC Motherboard)

Advance Rate Adjustment You can use the advance rate potentiometers to manually adjust the rate from 40 to 1,000 steps/sec (**SLOW** pot) or from 400 to 10,000 steps/sec (**FAST** pot). Refer to Figure 3-2 for the location of the fast and slow rate advance pots.

Turn the pot CW to increase the rate, and CCW to decrease the rate.

NOTE: If you set the rate too high you can stall the motor. This function should be used only if the indexer does not need to track the motor's position.

Refer to the System Connections section in this chapter for instructions to wire optional remote advance rate pots from the indexer connector.

Motor Current As an alternative to using the switch on the drive, you can reduce the motor current by installing a resistor in the R5 location on the back of the SDC Motherboard (see Figure 3-3). The values of current given correspond to the condition when all the drive bit switches are 'OFF'. This resistor may be used to reduce the SD2 drive motor current 0.2A. The current level should not be reduced below the lowest figures given for each drive type. Table 3-3 provides typical resistor values. *Remember that the actual current will depend on motor inductance.*

Nominal Current SD2	SD3	SD5	Resistor Value
2.0A	3.0A	4.5A	Open-circuit
1.8A	2.7A	4.0A	12KΩ
1.6A	2.4A	3.7A	5.6KΩ
1.4A	2.1A	3.1A	2.2KΩ
1.2A	1.8A	2.8A	1.5KΩ
1.0A	1.5A	2.4A	1.0KΩ
0.9A	------	------	680Ω
0.8A	------	------	560Ω
0.7A	------	------	470Ω
0.6A	------	------	330Ω
0.5A	------	------	220Ω
0.4A	------	------	150Ω
0.3A	------	------	82Ω
0.2A	------	------	Short-circuit

Table 3-3. SDC Motherboard R5 Resistor Values for Setting Current

Environmental Considerations

The SD Drive system should be operated in temperatures from 0°C to 50°C (32°F to 122°F) and at a relative humidity between 0 and 95% (non-condensing). Make sure the system is stored in temperatures within the range from -40°C to 85°C (-40°F to 185°F). Refer to the manufacturer's environmental specifications for the maximum motor case temperature when it is in operation.

Enclosure Considerations

You should install the SD Drive system in an enclosure to protect it against atmospheric contaminants such as oil, moisture, and dirt. Ideally, you should install the system in a rack cabinet. In the USA, the National Electrical Manufacturers Association (NEMA) has established standards that define the degree of protection that electrical enclosures provide. The enclosure should conform to NEMA Type 12 standards if the intended environment is industrial and contains airborne contaminants. Proper layout of components is required to ensure sufficient cooling of equipment within the enclosure.

System Mounting

You should give special attention to the environment and location in which you will operate your SD Drive system. Consider atmospheric contamination and temperature around the drive before you install and operate your SD Drive system.

Your SD Drive system is normally shipped with the drive(s) pre-installed in the standard 19"-long 5.2"-high rack.

Motor Mounting

The SD Drive system will operate most hybrid stepper motors. Motors should be mounted using flange bolts and centred by the pilot on the front face. Foot-mount configurations are a less desirable alternative because the torque of the motor is not evenly distributed around the motor case. Any radial load on the motor shaft is multiplied by a much longer lever arm when a foot mount is used rather than a face flange.

WARNING

Improper mounting can compromise system performance and jeopardize personal safety.

Transformer Mounting

The transformer models used with the SD Drive system (models TO116, TO119, and TO120) may be mounted in the cabinet or, if you are not using a cabinet, close to the rack system you are using. Ensure that the transformer is located where it does not have excessively long leads and does not interfere with the SD Drive system operation and electrical connections. Transformer dimensions and weights are provided in Chapter 6, Hardware Reference.

WARNING

Do not mount the transformer where it is likely to be touched by personnel. Touching the wiring studs while the transformer is energized can inflict a lethal electrical shock.

System Connections

If you have set all the SD Drive functions, you are now ready to perform the final wiring for your system. Pinouts on the drive's 32-way edge connector and on both of the types of motherboard usable are illustrated in Chapter 4, Hardware Reference.

Refer to Chapter 2, Getting Started, for instructions on the following system connections:

- Motor
- Indexer
- Transformer

WARNING

Ensure that AC power is disconnected before you perform any wiring. NEVER disconnect the motor with power applied to the drive.

Wiring Guidelines

Proper grounding of electrical equipment is essential to ensure the safety of personnel. You can reduce the effects of electrical noise due to electromagnetic interference (EMI) by grounding. All Digiplan equipment should be properly grounded. A good source of information on grounding requirements is the National Electrical Code published by the National Fire Protection Association of Boston, Massachusetts.

In general, all components and enclosures must be connected to earth ground to provide a low impedance path for ground fault or noise-induced currents. All earth ground connections must be continuous and permanent. Digiplan recommends using a central earth stud mounted on the rack end-plate or close to it. AC ground, the transformer shield, the rack 0V bus, and the enclosure metalwork should all be connected to this stud. In particular, you should connect the rack 0V bus with a 18AWG (1mm²) cable kept as short as possible.

Connecting via a Motherboard

The SD Drive system is normally shipped with the drive(s) pre-installed in the appropriate SR rack.

CAUTION

Ensure the AC power is disconnected before attempting to perform any system connections. Never disconnect the motor with power on; this will damage the drive and the motor connector contacts. Follow the steps described below to complete the basic configuration of your system.

Factory Settings

Rack-mount SD Drive functions are factory-set to provide optimum system performance and safe operation. You do not need to alter these settings to accommodate the preliminary system operation and testing discussed in this chapter. Normally, these factory settings, with the exception of motor current, will satisfy the complete system operating requirements. Chapter 3, Installation, discusses optional drive settings you can use for your particular application. The basic drive operating conditions are factory set as follows:

- Drive current is set at maximum (2A for SD2, 3A for SD3 and 4.5A for SD5)
- Drive resolution is set at 400 steps/rev

Motor Connections

If you purchased a Digiplan stepper motor with the SD Drive system, please refer to the Digiplan Motor Manual for connection details. Tables 3-4 and 3-5 show connection details for a range of proprietary stepper motors.

After you determine the motor's wiring configuration, connect the motor leads to connector TB1 on the motherboard.

CAUTION

Be sure to properly connect the motor to the SD Drive motherboard. Incorrect connections could damage the drive or the motor.

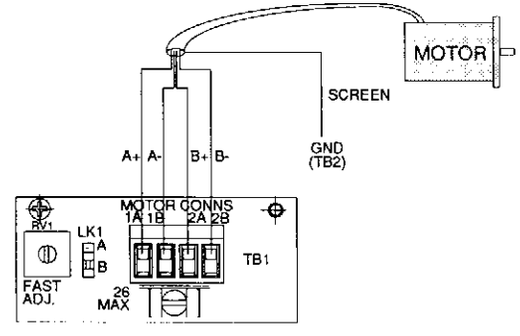


Figure 3-4. SD Motherboard Motor Connections

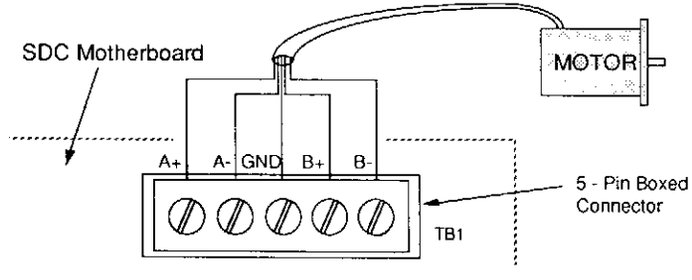


Figure 3-5. SDC Motherboard Motor Connections

N.C. - no connection.

MAKE	TYPE	A+ 1A	A– 1B	B– 2A	B+ (SDC) 2B (SD)	NOTES
Evershed & Vignoles	6-lead	Red	Green	Blue	Yellow	Brown & Black N.C.
	8-lead	Red	Green	Blue	Yellow	Link Grey & Pink, link White & Violet
	T.box	1	3	4	2	Link 5 & 6, link 7 & 8
Sigma	6-lead	Black	Orange	Red	Yellow	White/Blk/Org, White/Red/Yel N.C.
	8-lead	Black	Orange	Red	Yellow	Link Wh/Blk & Wh/Org Link Wh/Red & Wh/Yel
	T.box	1	3	2	4	Link 5 & 6,link 7 & 8
Astrosyn, Rapidsyn, Slo-syn	6-lead	Red	Red/Wh	Grn	Grn/Wh	White & Black N.C.
	T.box (x6)	1	3	4	5	2 & 6 N.C.
Slo-syn	8-lead	Red	Red/Wh	Grn	Grn/Wh	Link Black & White, link Org & Blk/Wh
	T.box (x8)	1	3	5	4	Link 2 & 6, link 7 & 8
Stebon	8-lead	Red	Yel	Pink	Blk	Link Blue & violet, link White & Grey
	T.box	1	2	3	4	Link 5 & 6, link 7 & 8
G.E.C.	T.box	1	2	3	4	Link 5 & 6, link 7 & 8
M.A.E.	6-lead	Grn/Wh	Grn	Red	Red/Wh	White & Black N.C.
	8-lead	Black	Orange	Red	Yellow	Link Wh/Blk & Wh/Org, Link Wh/Red & Wh/Yel
	T.box	6	5	8	7	Link 1 & 3, link 2 & 4
Zebotronics	T.box	1	4	5	8	Link 2 & 3, link 6 & 7
Oriental	6-lead	Black	Green	Red	Blue	Yellow & White N.C.
Sonceboz	8-lead	Green	Grn/Wh	Red	Red/Wh	Link Org & Blk/Wh, link Black & White
Japan Servo	6-lead	Red	Blue	Green	Yellow	2 x White N.C.
Escap	8-lead	Brown	Org/Wh	Red	Yel/Wh	Link Brn/Wh & Org, Link Red/Wh & Yellow.
Bodine	8-lead	Brown	Orange	Yellow	Red	Link Wh/Brn & Wh/Org, link Wh/Yel & Wh/Red.
	T.box	1	3	4	2	Link 5 & 7,link 6 & 8
Digiplan/Compumotor RM Motor	8-lead	Black	Orange	Red	Yellow	LinkWh/Blk & Wh/Org. Link Wh/Red & Wh/Yel
Digiplan/Compumotor QM Motor	8-lead	Red	Black	White	Green	Link Yel & Blue Link Org & Brown

Table 3-4. Motor Connection Data - Windings in Series

For 6-lead motors, connections shown are for one half-winding.
N.C. - no connection.

MAKE	TYPE	A+ 1A	A– 1B	B– 2A	B+ (SDC) 2B (SD)	NOTES
Evershed & Vignoles	6-lead	Red	Brown	Blue	Black	Grn & Yellow N.C.
	8-lead	Rd & Pink	Grn & Grey	Blue & Violet	Yel & White	
	T.box	1 & 6	3 & 5	4 & 8	2 & 7	
Sigma	6-lead	Black	Wh/Blk/ Orange	Red	Wh/Red/ Yellow	Or & Yellow N.C.
	8-lead	Black & Wh/Or	Or & Wh/Blk	Red/ Wh/Yel	Yel & Wh/Red	
	T.box	1 & 5	3 & 6	2 & 7	4 & 8	
Astrosyn, Rapidsyn, Slo-syn	6-lead	Red	Black	Green	White	Red/Wh & Grn/Wh N.C.
	T.box(x6)	1	6	4	2	3 & 5 N.C.
Slo-syn	8-lead	Red & White	Blk & Red/Wh	Grn & Blk/Wh	Org & Grn/Wh	
	T.box(x8)	1 & 2	3 & 6	4 & 7	5 & 8	
Stebon	8-lead	Rd & Blue	Yel & Violet	Wh & Pink	Black & Grey	
	T.box	1 & 6	2 & 5	3 & 8	4 & 7	
G.E.C.	T.box	1 & 6	2 & 5	3 & 8	4 & 7	
M.A.E.	6-lead	Grn/Wh	White	Red	Black	Grn & Red N.C
	8-lead	Black & Wh/Or	Or & Wh/Blk	Red & Wh/Yel	Yel & Wh/Red	
	T.box	3 & 6	1 & 5	4 & 8	2 & 7	
Zebotronics	T.box	1 & 2	3 & 4	5 & 6	7 & 8	
Oriental	6-lead	Black	Yellow	Red	White	Grn & Blue N.C.
Sonceboz	8-lead	Grn & Blk/Wh	Or & Grn/Wh	Red & White	Blk & Red/Wh	
Japan Servo	6-lead	Red	White*	Green	White*	
Escap	8-lead	Brn & Orange	Brn/Wh & Org/Wh	Red & Yellow	Red/Wh & Yel/Wh	
Bodine	8-lead	Brn & Wh/Or	Wh/Brn & Orange	Yel & Wh/Red	Wh/Yel & Red	
	T.box	1 & 7	3 & 5	4 & 6	2 & 8	
Digiplan/Compumotor RM Motor	8-lead	Black & Wh/Or	Orange & Wh/Black	Red & Wh/Yellow	Yellow & Wh/Red	
Digiplan/Compumotor QM Motor	8-lead	Red & Blue	Blk & Yellow	Wh & Brn	Green & Org.	

* Use correct White for each phase.

Table 3-5. Motor Connection Data - Windings in Parallel

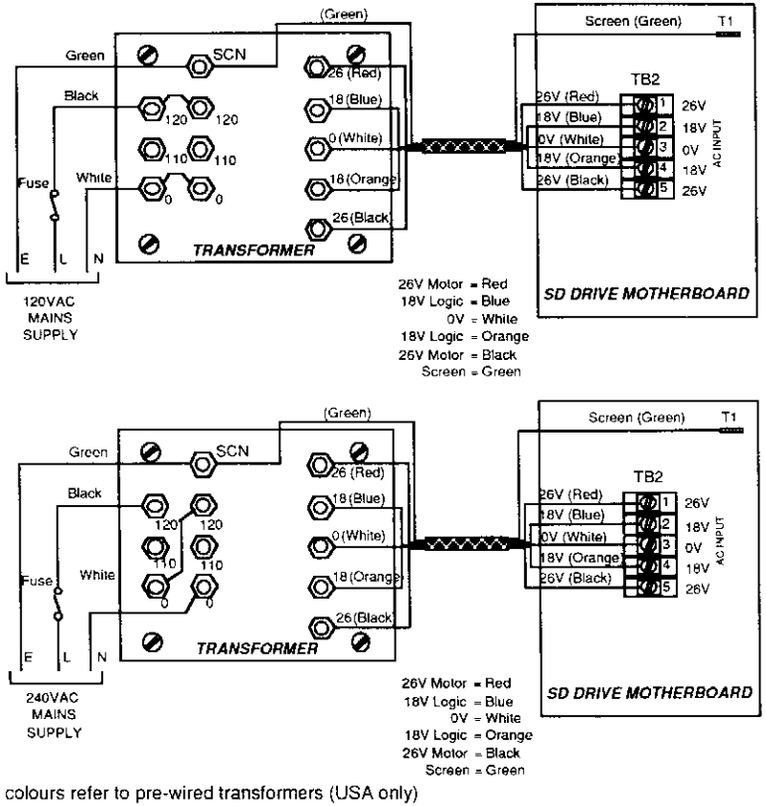
Transformer Connections

Refer to Chapter 4, Hardware Reference, to select the proper wiring arrangement on the transformer and check that the transformer is wired to operate with the correct mains voltage input.

As illustrated in Figure 3-6, the transformer leads are connected to the five barrier strip terminals (connector TB2 on both motherboard types) and the fast-on connector (T1) on the back of the SDC Motherboard.

WARNING

Do not connect the transformer to the motherboard while power is applied to the transformer. Do not touch the wiring studs on the transformer after it is plugged into an AC outlet. This can cause serious personal injury.



Lead colours refer to pre-wired transformers (USA only)

Figure 3-6. Typical Transformer Connections for 120V and 240V Mains Supplies

Indexer Connections - SD Motherboard

Refer to Chapter 4, Hardware Reference for details of connections between the Indexer and the SD Motherboard. Table 3-6 lists the pin functions.

Pin	Function
1	EXTERNAL REFERENCE INPUT
2	+24v DC OUT
3	FAULT OUTPUT
4	$\overline{\text{ZERO PHASE}}$ OUTPUT
5	DIRECTION INPUT
6	$\overline{\text{ENERGISE}}$ INPUT
7	$\overline{\text{CLOCK}}$ INPUT
8	0v
9	SIGNAL 0v
10	$\overline{\text{FAST}}$ INPUT
11	$\overline{\text{SLOW}}$ INPUT
12	FAST RATE ADJUST
13	SLOW RATE ADJUST
14	RATE COMMON
15	$\overline{\text{INTERNAL CLOCK}}$ OUTPUT
16	0v

Table 3-6. SD Motherboard Indexer Connector (SKT2) Pinouts

Indexer Connections - SDC Motherboard

Figure 3-7 shows the 25 way connector for connecting the Indexer to the SDC Motherboard. A standard cable Part No. 1392.072 or 1392.078 is available for connecting the Digiplan MC20 Keypad Indexer.

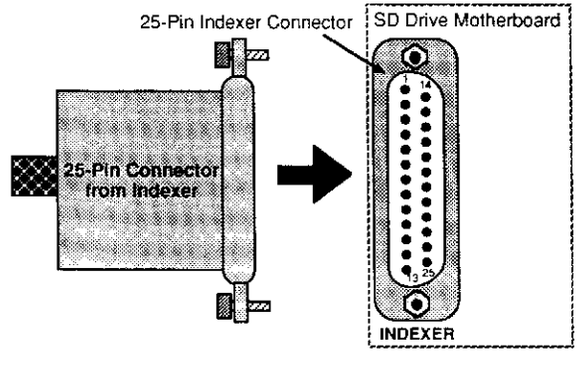


Figure 3-7. SDC Motherboard Indexer Connections

Table 3-7 provides the pinouts for the 25-pin connector on the SDC Motherboard.

Pin	Function
1	STEP +
2	DIRECTION +
6	SLOW RATE ADJUST
7	FAST RATE ADJUST
9	FAULT +
12	$\overline{\text{SLOW}}$ INPUT
13	$\overline{\text{FAST}}$ INPUT
14	STEP -
15	DIRECTION -
16	SHUTDOWN +
17	SHUTDOWN -
19	RATE ADJ COMMON
21	FAULT -
25	0v

Table 3-7. SDC Motherboard Indexer Connector (SKT1) Pinouts

Auxiliary Indexer Connections

The PL1 (SDC Motherboard) and SKT1 (SD Motherboard) connectors provide optional connections for the drive control signals (see Figure 3-8).

These inputs are for using non-TTL Digiplan indexers, clock cards (MC1, BC7, RC9, etc.), or an indexer that has output characteristics that differ from TTL indexers.

If you are <u>not</u> using a Digiplan indexer with standard Digiplan cables, it may be easier for you to use connector PL1. The electrical specifications for this connector are provided in Chapter 4, Hardware Reference. The inputs on PL1/SKT1 are not compatible with Digiplan or Compumotor TTL indexers.

NOTE: Caution must be used since these inputs are <u>not</u> optically isolated.

Link cables are available from Digiplan (200mm cable: p/n 200MM JUMPER, or 400mm cable: p/n 400MM JUMPER). Refer to Figure 3-8 for the PL1 auxiliary indexer connector location and pinouts.

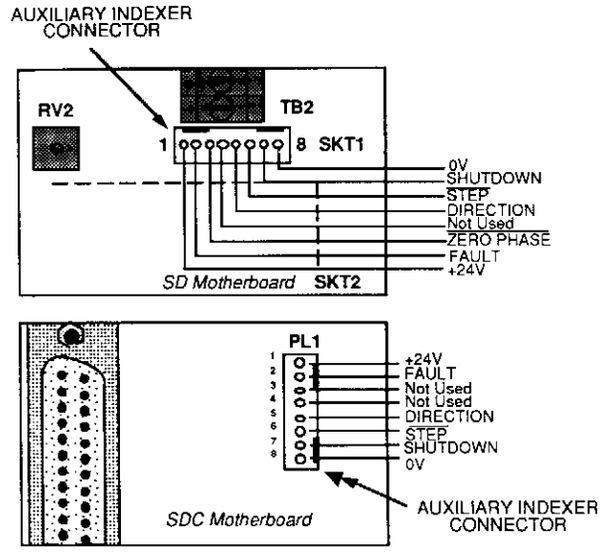


Figure 3-8. Motherboard Auxiliary Indexer Connector

+24 Volts (Pin 1)

This terminal may be used as an output to provide +24V from the SD Drive to external control circuitry. Current drawn must be limited to a total of 250mA.

Fault (Pin 2)

This is an output signal which goes high in the event of an overload fault. It is driven by an open-collector transistor and should be pulled up by an external resistor when the signal is required. The resistor should be returned to a voltage no higher than +25V, and should not allow more than 15mA to flow when the output is low.

When a fault occurs, the drive will de-energise until the shutdown signal is cycled or the power is cycled after the fault has cleared.

You can establish a visual fault verification by installing an LED as illustrated in Figure 3-9. Here the LED will be lit unless there is a fault.

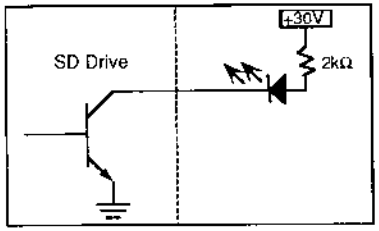


Figure 3-9. Fault Output Example

Zero Phase (Pin 4)

This is an output signal that goes low when the drive translator is in its primary state. This occurs every 8 motor steps in the half-step mode. The drive always powers up in the zero-phase state. Ths signal is used in conjunction with an auto-homing circuit. Electrical parameters are the same as those of the Fault output.

Direction (Pin 5)

Taking this input terminal low (connecting it to the 0V terminal) will reverse the direction of motor rotation. The direction should only be changed when the motor is stationary or running within the start/stop speed range. The input is not TTL compatible.

Step (Pin 6)

A low-going transition on this input terminal causes the motor to advance one step. The input should remain low for not less than 10µs. The maximum step pulse frequency is 20kHz in the half-step mode. The input is not TTL compatible.

CAUTION

Do not stop the clock while it is running above the start/stop speed; this will cause the motor to de-synchronise.

Shutdown (Pin 7)

This input terminal enables the motor to be Shut down (*de-energized*) so that it may be rotated slowly by hand without switching the system off. You must connect this input terminal to the 0V terminal in order to energize the motor. *NOTE: If link LK4 is installed, the shutdown input has no effect and the drive remains energised at all times except in the event of a fault.*

The input is not TTL compatible.

0V (Pin 8)

Use this terminal as the common return point for the indexer signals.

Optional Advance Rate Pot and Switch Connections

If you set links LK1, LK2, and LK3 on the SDC Drive motherboard to position B, the **ADJUST COMMON**, **FAST ADJUST**, and **SLOW ADJUST** signals are diverted to the 25-pin indexer connector. Pins 6 and 7 are the slow and fast adjust pins, and pin 19 is the adjust common. Using these pins, you can wire remote jog potentiometers (pots) as illustrated in Figure 3-10.

Using the **SLOW**, **FAST**, and **0V** signals from the 25-pin connector, you can wire remote slow/fast jog switches (see Figure 3-10). When you close the switch from the slow input (pin 12) or the fast input (pin 13) to 0V (pin 25), the motor runs at the rate set with the corresponding pot. The slow range is 40 to 1,000 steps/sec. The fast range is 400 to 10,000 steps/sec.

Using the 8-pin PL1 connector, you can also wire a remote direction switch using the **DIRECTION** (pin 5) and **0V** (pin 8) signals (see Figure 3-10). When the direction switch is grounded to 0V, the motor moves in the opposite direction.

NOTE: The jog switches should be used only if the indexer does not need to track the motor's position.

Figure 3-10 also shows the corresponding external connections on the SD motherboard. Note that links LK1 and LK2 should be transferred to position 'a' to isolate the board-mounted rate adjust controls when external pots are used.

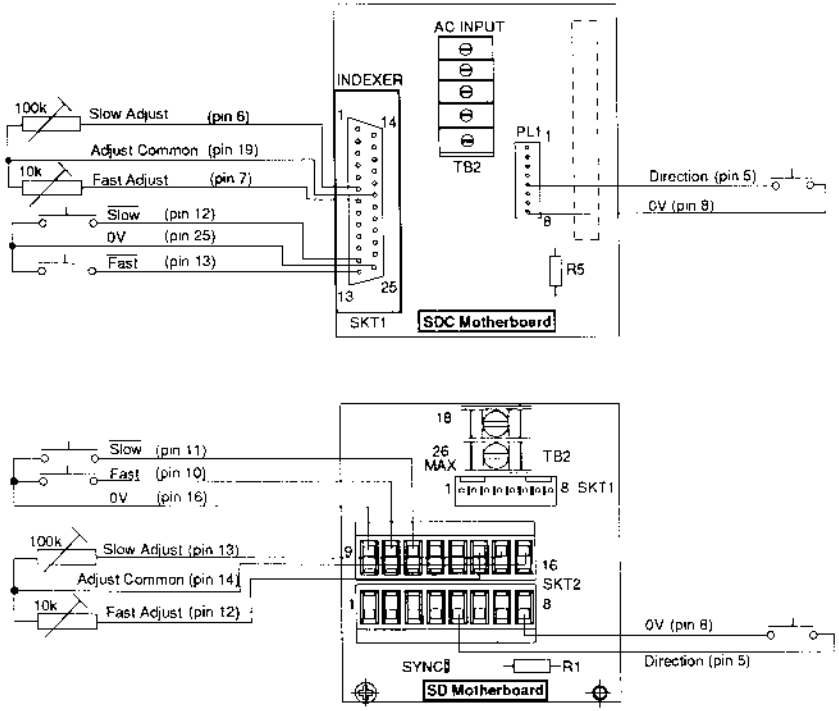


Figure 3-10. Optional Remote Advance Pot and Switch Connections

Chapter 4. HARDWARE REFERENCE

Chapter Objectives

This chapter is designed to function as a quick-reference tool for the following information:

- System specifications (dimensions & performance)
- Default DIP switch and link settings
- I/O connections and specifications

Environmental Specifications

Digiplan recommends you operate and store your SD Drive system under the following conditions:

- Operating Temperature: 0° to 50°C (32° to 122°F)
- Relative Humidity: 0% to 95% (non-condensing)
- Maximum Heatsink Temperature: 85°C (185°F)
- Storage Temperature: -40° to 85°C (-40° to 185°F)
- Maximum Motor Case Temperature: 125°C (255°F)

SD Drive Specifications

Parameter	Value
Amplifiers	
Type	Bipolar Chopper
Motor resolution	200 or 400 steps/rev (User-selectable)
Protection	
Open circuit	
Short circuit	Phase-to-phase and across phases
Over-temperature	If heatsink exceeds 85°C (185°F)
Nominal output current (two-phase-on)	2A/phase (SD2), 3A/phase (SD3), 4.5A/phase (SD5) - DIP switch adjustable
Maximum stepping rate	10kHz @ 200 steps /rev 20kHz @ 400 steps /rev
Nominal chopping frequency	15kHz
Command Interface	
SD drive module	
Input impedance	Built-in pull-up resistors (4k7) to +12V
Input logic level	Low (logic 0) 0 to +2V or short-circuit High (logic 1) +10V to +12V or open-circuit
Output circuits	Open-collector NPN transistors
Output logic levels	Low (transistor switched to 0V) +1V max. @ 15mA max. High (transistor off) +25V max.
SD drive mounted in an SC rack	Step input is high going pulse, 10µS min. width Maximum pulse rate is 20kHz
Input	Inputs are fully optically isolated and require a TTL-type signal to operate. >3.5VDC high, <0.8VDC low. User-supplied step and direction signals must be capable of providing up to 20mA.
Power	
Drive supply voltage	18-0-18 to 26-0-26VAC, or 24 to 36VDC
Logic supply voltage	18-0-18VAC or +24VDC at 350mA max.
Drive supply current	
18-0-18VAC for +24VDC	1.5A (SD2), 2.2A (SD3), Not recommended for use (SD5)
26-0-26VAC for +36VDC	1.5A (SD2), 2.2A (SD3), 4.5A (SD5)
Fuses	
FS1 (Logic Supply)	1A
FS2 (Motor Supply)	3.15A (SD2), 4A (SD3), 6.3A (SD5)
Internal Oscillator	
Speed range	
Fast	400 - 10,000 steps/sec (ramped)
Slow	40 - 1,000 steps/sec (not ramped)
Preset acceleration time	60 ms
Preset deceleration time	30 ms
Motors	
Type	2-Phase hybrid or permanent magnet (normally 1.8°)
Number of leads	4, 6, or 8 (5 lead not suitable)
Inductance range	1mH-10mH
Typical current range	SD2: 1.5—3A* SD3: 2—4A SD5: 4—6A

* For SD2, lower current can be accommodated by leaving all DIP switches OFF and changing the value of resistor R5 on the SDC motherboard or R1 on the SD motherboard.

Table 4-1. SD Drive Specifications

Factory Default Settings

Table 4-2 below provides the SD Drive factory default settings. If the factory settings are not appropriate for your application, refer to Chapter 3, Installation, for instructions on adjusting the appropriate drive and motherboard DIP switches and links.

Feature	Default Setting	Function Selected
SDC Motherboard Jumpers		
LK1	Position A	Enables use of onboard rate pot
LK2	Position A	Enables use of onboard slow rate pot
LK3	Position A	Enables use of onboard fast rate pot
SD Motherboard Jumpers		
LK1	Position B	Enables use of onboard fast rate pot
LK2	Position B	Enables use of onboard slow rate pot
Drive Jumpers		
LK1	Installed	**DO NOT CHANGE**
LK2	Not installed	**DO NOT CHANGE**
LK3	Not installed	Selects resolution of 400 steps/rev
LK4	Installed	Motor is energized at all times
Drive DIP Switch	**SW1 SW2 SW3 SW4** OFF OFF OFF OFF	Maximum current

Table 4-2. SD Drive Factory Default Settings

SD Drive Direct Connections

You will need to make connections directly to the drive edge connector if you are not using either of the standard motherboards. The edge connector pin functions are detailed below.

Pinouts		
Pin	Row a	Row c
2	Motor Phase B-	Motor Phase B-
4	Motor Phase B+	Motor Phase B+
6	Motor Phase A-	Motor Phase A-
8	Motor Phase A+	Motor Phase A+
10	+24VDC	+24VDC
12	Logic Supply 1	Motor Supply 1
14	Logic Supply 2	Motor Supply 2
16	0V	0V
18	0V	0V
20	$\overline{\text{Fast}}$	Fault
22	$\overline{\text{Slow}}$	$\overline{\text{Zero Phase}}$
24	Rate Adjust Com.	Slow Rate Adjust
26	Fast Rate Adj.	Direction
28	$\overline{\text{Internal Clock Out}}$	$\overline{\text{Clock In}}$
30	*Not Connected*	$\overline{\text{Energise}}$
32	External Ref.	Signal 0V

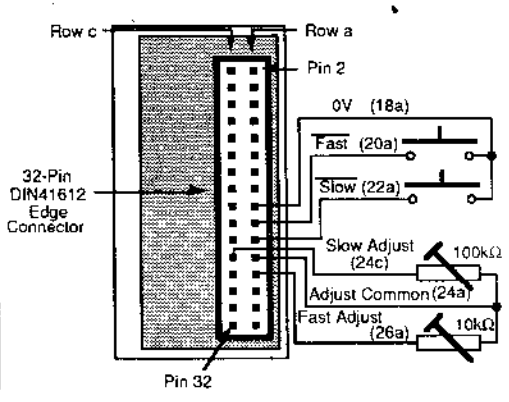


Figure 4-1. Connecting Directly to the Drive

Drive Signal Descriptions

The signals at the 32 way drive edge connector are as follows:-

Motor Phases Connect one phase of the motor to A+ and A-, and the other phase to B+ and B- (connect corresponding pins in row a and row c in parallel).

+24VDC Use the +24VDC output (pin 10 in either row) to power an external controller. The maximum current that you can draw is limited to 250mA.

Logic Supply Inputs 1 & 2 When the drive is AC powered, these two inputs (pins 12a and 14a) are connected to the centre-tapped secondary on an isolation transformer rated at 18-0-18 volts rms. The centre tap is connected to 0V (pins 16 and 18). As an alternative, you can use a 24V DC supply with +24V connected to both 12a and 14a.

Motor Supply Inputs 1 & 2 For operation at a motor supply of 24V DC, these inputs (pins 12c and 14c) must be driven from the same isolated transformer secondary as the logic supply inputs. If operation with a motor supply of 36V is required, a single secondary winding tapped 26-18-0-18-26 should be used. Pins 12c and 14c are connected to the 26V rms tappings and pins 12a and 14a are connected to the 18V rms tappings. Alternatively, a DC motor supply voltage of between 24V and 36V DC may be used. The logic supply voltage should always be 24V when operating from DC.

The SD5 is only recommended for 36V operation.

Fast Input Connect this input (pin 20a) to 0V (pin 16 or 18, either row) to run the internal oscillator at the fast rate of 400 - 10,000 steps/sec (see Figure 4-1).

Fault Output This output (pin 20c) goes high (open circuit) if the drive fault circuit operates as a result of an overload or short-circuit. The fault circuit may be reset by temporarily removing power or by taking the Energize input high. The pin should be connected through external circuitry to a voltage not exceeding 30V, such that when low, no more than 15mA will be passed into the pin.

Slow Input Connect this input (pin 22a) to 0V (pin 16 or 18, either row) to run the internal oscillator at the slow rate of 40 - 1,000 steps/sec (see Figure 4-1).

Zero Phase Output This output (pin 22c) is low during the *zero phase* state of the drive translator. This is the primary state of the translator when power is applied. The zero phase signal is used in conjunction with an auto datum circuit. The pin should be connected through external circuitry to a voltage not exceeding 30V, such that when low, no more than 15mA will be passed into the pin.

Rate Adjust Inputs The speed of the internal oscillator can be controlled by connecting external potentiometers between the appropriate inputs (see Figure 4-1). The normal values are 10kΩ for the fast control pot and 100kΩ for the slow control pot. Use higher values to reduce the minimum speed in each range.

Direction Input Connect this input (pin 26c) to 0V (pin 16 or 18, either row) to reverse the direction of motor rotation. This input should not be changed when the step input is low, or while the motor is running above its start/stop speed.

Internal Clock Output This is the output of the internal oscillator, and it can be connected the the CLOCK input (pin 28c). The output (pin 28a) consists of low-going pulses approximately 25µS wide.

Clock Input (Step Input) The motor shaft will advance one step following a low-going pulse in this input (pin 28c). The step occurs on the rising edge of the pulse. This input should remain low for at least 10µS, and may be driven from the internal oscillator (connected to pin 28a) or an external controller.

This signal is alternatively referred to as "Step Input".

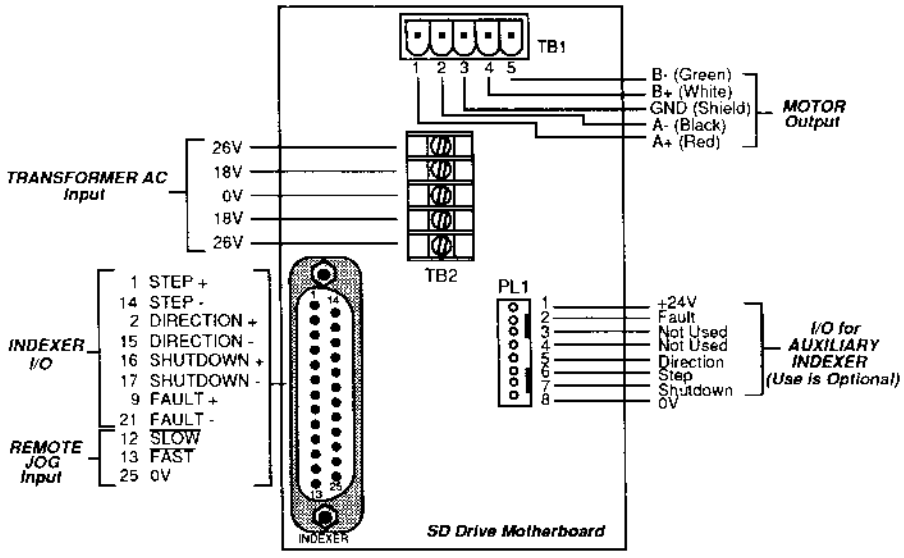
Energize Input Connect this input (pin 30c) to 0V (pin 16 or 18, either row) to energise the motor. When you remove this input from 0V, the motor is de-energized (***shut down***) and the shaft rotates freely. Link LK4 on the drive card may be installed as an alternative to making an external connection to 0V. ***Do not shut down the drive while it is running or damage may result***

External Reference Input As an alternative to using the drive DIP switch, you can program the motor current by connecting an external resistor between this input (pin 32a) and signal 0V (pin 32c). Refer to the Changing Components section in Chapter 3 to determine the appropriate resistor value for the desired current.

Signal 0V Use this pin, number 32c, as the return connection if you install a current programming resistor between signal 0V and the external reference input (pin 32a). ***Do not confuse this pin with the power 0V pins, 16a/c 18a/c; it should not be used as a power or control signal 0V.***

SDC Motherboard Connections

This section describes the pinouts and connectors of the SDC Motherboard.



NOTE: If motherboard jumpers LK1, LK2 & LK3 are set to position B, then pin 6 = Slow Ajust, pin 7 = Fast Ajust, and pin 19 = Adjust Common

Figure 4-2. SDC Motherboard Inputs and Outputs

I/O Specifications

Tables 4-3 and 4-4 below identify the I/O specifications for the INDEXER and AUXILIARY INDEXER connectors.

Pin	Name	Type	I/O	Min. on State Current	Max. Current	On State Voltage	Max. Voltage	Unipolar Signal Level
1	Step +	OPTO	I	15mA	30mA	3.5V min.	5V	Low <0.8V High >3.5V
14	Step -	OPTO	I	15mA	30mA	3.5V min.	5V	0V
2	Direction +	OPTO	I	15mA	30mA	3.5V min.	5V	Low <0.8V High >3.5V
15	Direction -	OPTO	I	15mA	30mA	3.5V min.	5V	0V
16	Shutdown +	OPTO	I	7.5mA	20mA	3.5V min.	7V	Low <0.8V High >3.5V
17	Shutdown -	OPTO	I	7.5mA	20mA	3.5V min.	7V	0V
9	Fault +	OOC	O	-------	5mA	0.8V max.	12V	Open collector 12V max.
21	Fault -	OOC	O	-------	5mA	0V max.	0V	0V
6	Slow Adjust *	VAR	I	-------	20mA	-------	12V	-------
7	Fast Adjust *	VAR	I	-------	20mA	-------	12V	-------
19	Adjust Common	REF	O	-------	20mA	-------	12V	-------
12	$\overline{\text{Slow}}$	LOG	I	-------	2mA	0.8V max.	12V	Low <0.8V High Open Circuit
13	$\overline{\text{Fast}}$	LOG	I	-------	2mA	0.8V max.	12V	Low <0.8V High Open Circuit
25	0V	GND	I/O					

All other pins not used

* These pins only enabled if SDC motherboard links LK1, LK2, LK3 are set to position B

+/– Pairs with same name indicate the go and return connections for a particular signal

Type: OPTO - Opto isolated outputs for high noise immunity
OOC - Open collector output opto isolated from drive
VAR - Variable
REF - DC reference
LOG - Logical active low input
GND - Ground connected to drive 0V

I/O I - Input
O - Output

Signal Levels - These are the voltages that should be applied to the '+' signal inputs with the '–' signal inputs held at 0V. However, for maximum noise immunity it is recommended that the signals are driven as a differential pair. The FAULT- should be connected to an external 0V and the FAULT+ used as an open collector output.

Table 4-3. Indexer 25-Way Connector I/O Specifications

Pin	Name	Type	Input/Output	Current	Voltage
1	+24V	----------	Output	250mA max	24VDC
2	Fault	OC*	Output	15mA max	12VDC
3	*Not Used*	----------	----------	----------	----------
4	*Not Used*	----------	----------	----------	----------
5	Direction	** ACTIVE LOW	Input	3mA	Low <0.8VDC
6	Step		Input	3mA	High >8V or Open Circuit
7	Shutdown		Input	3mA	(Max. 12V)
8	0V	GND	----------	----------	0VDC

* Open collector output. Not optically isolated.
** Non optically isolated control input. Requires a ground to activate.

Table 4-4. Auxiliary Indexer Connector (PL1) I/O Specifications

Signal Descriptions - SDC Motherboard

Indexer Inputs

Indexer inputs (compatible with most Digiplan and Compumotor indexers) are transmitted via the Indexer connector on the SDC Motherboard. These inputs are optically isolated within the SD Drive and are intended to be driven differentially from 5V logic levels. Figure 4-3 represents the input circuits.

STEP+ & STEP-

A pulse on these inputs (i.e. pin 1 positive with respect to pin 14) causes the motor to step on a high-to-low transition. The pulse should remain high for at least 10µS. Consult your indexer user guide for instructions on how to change the output pulse width.

DIRECTION+ & DIRECTION-

These inputs (pins 2 and 15) control the direction of the motor shaft rotation. Changing the level of these inputs changes the direction in which the shaft moves.

SHUTDOWN+ & SHUTDOWN-

These differential inputs (pins 16 and 17) are used to energize and de-energize (*shut down*) the motor. To remotely shutdown the drive, you must first remove the energize link (LK4) on the drive. When the shutdown+ input is taken high and shutdown- is low, the drive is shut down and the motor shaft may be rotated ***slowly*** by hand. *NOTE: Back-driving the motor may stress the drive and could cause failure.* Taking the shutdown+ input high whilst shutdown- is low resets a fault condition, and the drive is re-energized when the input returns low.

Remote Advance Rate Inputs

If you set links LK1, LK2, and LK3 on the SD Drive motherboard to position B, the **Adjust Common**, **Fast Adjust**, and **Slow Adjust** signals are diverted to the 25-pin indexer connector (see Figure 4-2 for pinouts). Using these pins, you can wire remote jog potentiometers (pots) as demonstrated in Chapter 3.

As demonstrated in Chapter 3, you can also use the **Slow**, **Fast**, and **0V** signals from the 25-pin connector to wire remote slow/fast switches (see pinouts in Figure 4-2). When you close the switch on the slow input (pin 12) or the fast input (pin 13) to the 0V input (pin 25), the motor runs at the rate set with the corresponding pot. The slow range is 40 to 1,000 steps/sec. The fast range is 400 to 10,000 steps/sec. *NOTE: This function should be used only if the indexer does not need to track the motor's position.*

Auxiliary Indexer I/O

PL1 on the back of the SDC Motherboard is an 8-pin ramp connector providing connections for the four drive control signals (see Figure 4-2).

If you are not using a Digiplan or Compumotor indexer with standard cables, it may be easier for you to use the ramp connector (PL1). Refer to Table 5-4 for electrical specifications. **The inputs on PL1 are compatible with Digiplan rack-mounting indexer cards and indexers with open collector outputs only.**

NOTE: Caution must be used, since these inputs are not optically isolated and are therefore more noise-sensitive than the inputs on the 25-pin indexer connector (SKT1).

Interfacing Circuits

Figure 4-3 shows methods of connecting signals to the SDC Motherboard via SKT 1. The equivalent devices in alternative logic families to those quoted are not necessarily compatible. Methods other than those shown may be used but they should comply with the requirements shown in Table 4-3.

OPTICALLY ISOLATED INPUTS

These circuits are designed for maximum noise immunity and especially where long leads are necessary and interference fields exist, the ideal input arrangement is a differential line driver with twisted pair cabling to the inputs. Cable length should always be kept as short as possible.

Input Circuit B could be used as an alternative to the line driver circuit but poorer noise immunity would result.

Input Circuit C would operate satisfactorily where the cable length is short and interference fields are minimal.

INTERFACING TO PL1

PL1 allows signal connections to the drive by-passing the opto-isolators. Figure 4-4 shows a method of coupling TTL signals to the drive and indicates the circuit arrangements at the PL1 interface. Note that the signals at PL1 are themselves not TTL compatible.

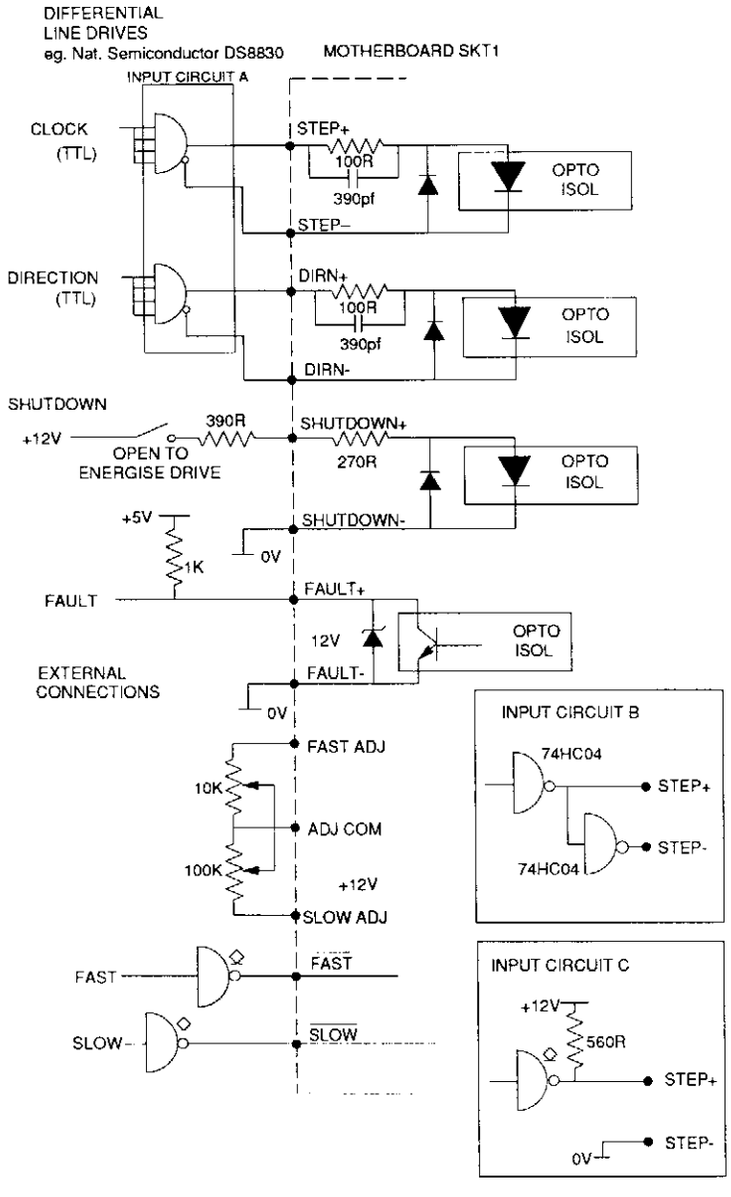


Figure 4-3. SDC Motherboard SKT 1 Interfacing Circuits

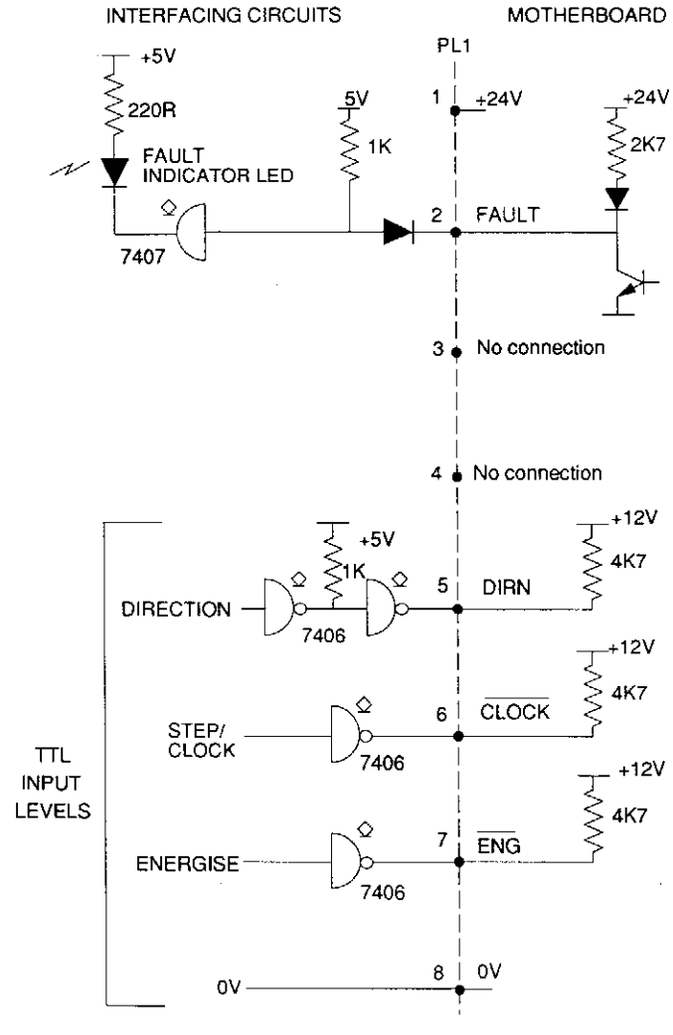


Figure 4-4. Interfacing to SDC Motherboard PL1

SD Motherboard Connections

Description

The use of an SD Motherboard simplifies the installation of the drive since all external connections may be made without the need for soldering. Opto-isolation of the main control signals is NOT provided with this motherboard but it incorporates preset controls for setting the speed of the internal oscillator without the need for external components. Links 1 and 2 on the motherboard are are fitted in position "b" to use the preset controls. When external speed controls are required for the on-board oscillator, fit the links in position "a".

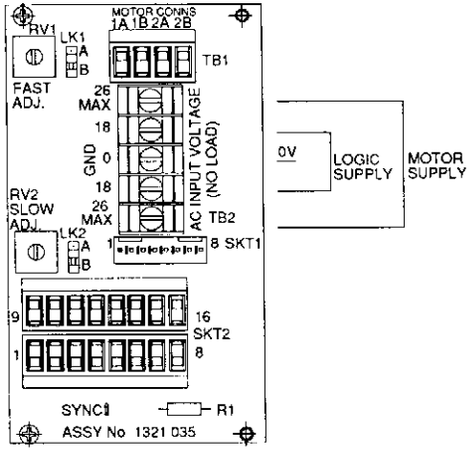


Figure 4-5. SD Motherboard Component Layout

Signal Descriptions - SD Motherboard

The control signals which appear on two 8-way terminal connectors on the SD Motherboard are:

1. External Reference Input (VREF EXT)

The motor current may be programmed by means of an external resistor connected between this input and Signal 0V (terminal 9). Alternatively the resistor may be fitted in position R1 on the motherboard. Suitable resistor values are given in the section on current setting (Table 3-3).

2. +24VDC Out

This output is used to supply up to 250mA to an external control module such as an indexer card.

3. Fault Output

This is an open collector output which goes high (open-circuit) if the drive fault circuit operates as a result of an overload or short-circuit.

4. Zero Phase Output

This is an open collector output which is low during the "zero phase" state of the translator, this being the primary state in which the translator is set when power is applied. Otherwise this output goes high (open circuit).

**** 5. Direction Input***

Connect to 0V to reverse the direction of motor rotation. This input should not be changed whilst the motor is running above its start/stop speed.

**** 6. Energise Input***

The motor will be energised with this input connected to 0V. When the input is released, the power switches are turned off and the motor shaft is free to rotate. Link 4 may be fitted as an alternative to making an external connection to 0V. Note that the drive should not be de-energised when the motor is running at speed.

**** 7. Clock Input***

The motor will step following a low-going transition on this input, the step occurring on the rising edge of the pulse. The input should remain low for at least 10µS. It may be driven from an external oscillator card, a processor interface unit or the internal oscillator in the drive.

8. & 16. 0V

Use this terminal as a return for control signals and the +24V supply.

9. Signal 0V

Use this terminal as the return connection for a current programming resistor (see terminal 1).

**** 10. Fast Input***

Connect to 0V to run the internal oscillator at the fast rate.

**** 11. Slow Input***

Connect to 0V to run the internal oscillator at the slow rate.

12. Fast Rate Adjust

An external potentiometer may be connected between this terminal and "Rate Common" (terminal 14) to control the fast speed of the internal oscillator. Alternatively the fast rate may be set by RV1 on the motherboard. To use an external control, transfer link 1 on the motherboard from "b" to "a". A suitable value for the external resistor is 10K.

13. Slow Rate Adjust

This is used in the same way as terminal 12 but for the slow speed, and a suitable resistor value is 100K. Transfer link 2 on the motherboard from "b" to "a" when using an external control in place of RV2 on the motherboard.

14. Rate Common

Common return connection for external speed controls.

* These signal inputs should be pulled low (i.e. to a voltage less than 0.8V) with circuitry capable of sinking 5mA. At other times the input should be open circuit or pulled to a voltage greater than +8V. The input has an internal pull-up resistor to +12V.

15. Internal Clock Output

This is the output of the internal oscillator which will normally be connected to the clock input of the drive (terminal 7). The output consists of low-going pulses approximately 25µS wide.

Transformer Wiring

Depending on your application, the SD Drive system is equipped with one of the following transformer models. The transformer used in your system depends on your application.

- Model TO116 - 100VA
- Model TO119 - 300VA
- Model TO120 - 450VA

Input power to and output power from the transformer are AC. The drive receives AC power from the transformer via TB2 on the motherboard. If your application requires different supply voltages, use Table 5-6 to select the appropriate primary wiring configuration.

CAUTION

Always wire the transformer first, then check the secondary output voltages on open-circuit BEFORE you connect the transformer to the SD Drive motherboard. ***Note: Be sure to connect the AC ground (GND) to SCN (Earth Ground).***

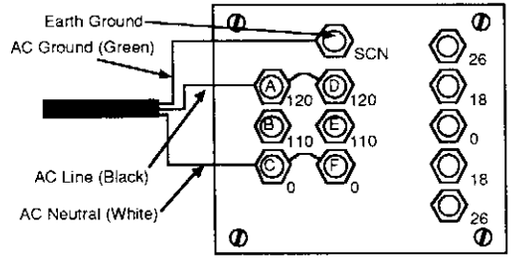


Figure 4-6. 120VAC Supply Transformer Wiring

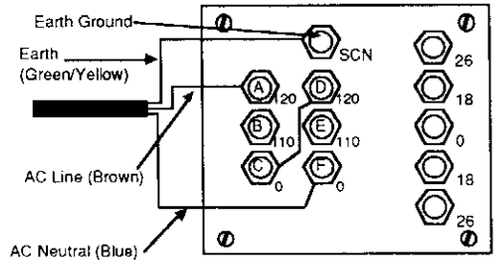


Figure 4-7. 240VAC Supply Transformer Wiring

Input Voltage	Connect AC Line to:	Connect AC Neutral to:	Connect Studs:
110	B	C	B&E; C&F
120	A	C	A&D; C&F
220	B	F	C&E
230	A	F	C&E
240	A	F	C&D

Table 4-5. Transformer Primary Connections

Dimensional Drawings

SR/SC Rack

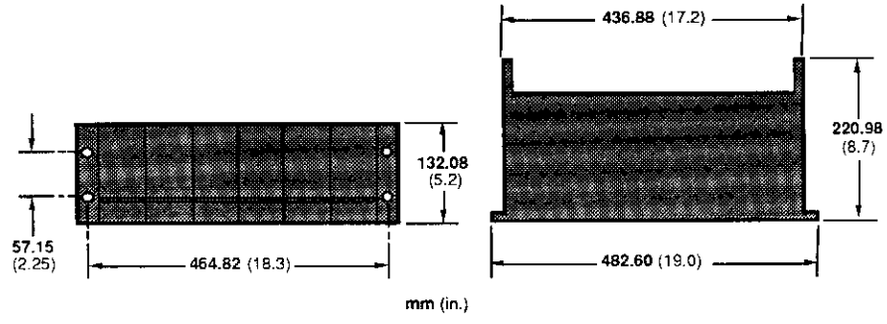
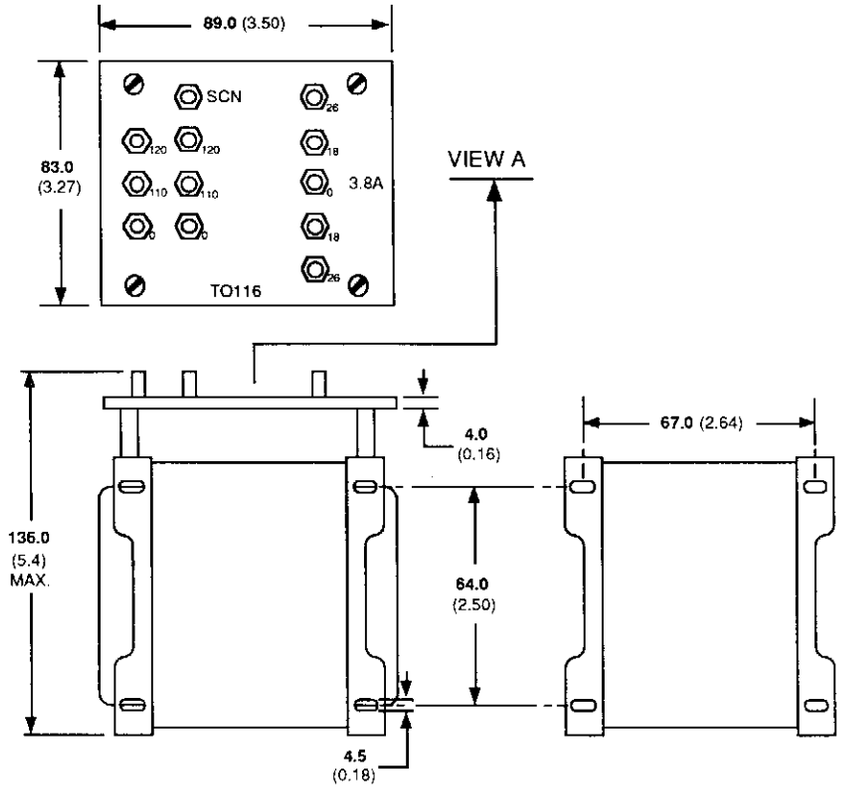


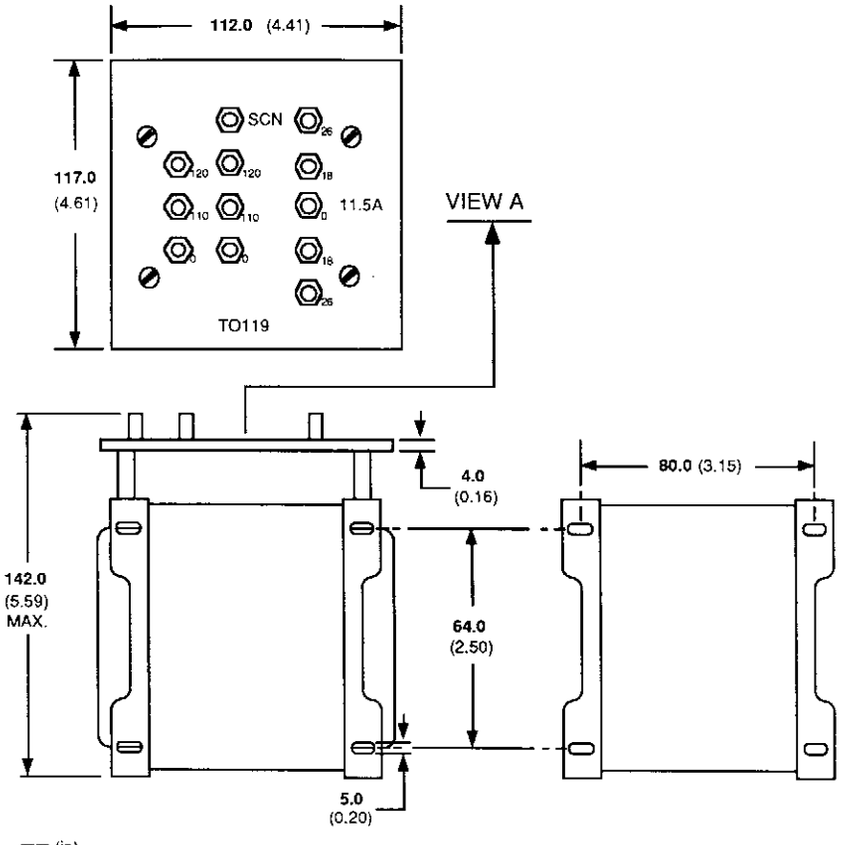
Figure 4-8. SR Rack Dimensions

Transformers



mm (in) Approximate weight = 3Kg (6.6 lbs)

Figure 4-9. Transformer Model TO116 Dimensions (100VA)



mm (in)

Approximate weight = 5.3 Kg (11.6 lbs)

Figure 4-10. Transformer Model TO119 Dimensions (300VA)

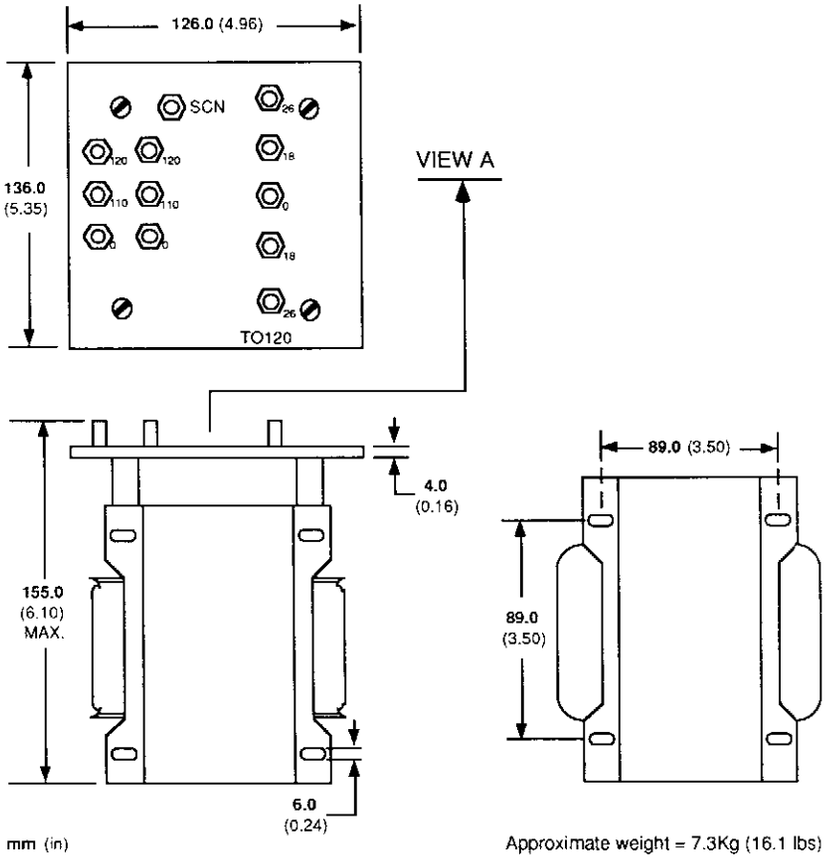


Figure 4-11. Transformer Model TO120 Dimensions (450VA)

Chapter 5. MAINTENANCE & TROUBLESHOOTING

Chapter Objectives

The information in this chapter will enable you to do the following:

- Maintain the system's components to ensure smooth, efficient operation
- Isolate and resolve system hardware and software problems

Maintenance

Routine maintenance is not necessary, but occasional checking of the following points is recommended.

Motor

You should inspect the motor to ensure that no bolts or couplings have become loose during operation. This will prevent minor defects from developing into more serious problems.

The ball bearings used in most stepper motors are permanently lubricated and do not require any maintenance.

You should inspect the motor cable or leads periodically for signs of wear. You should not apply excessive tensile force to the cable or bend it beyond a one-inch radius of curvature during normal operation. Tighten all cable connectors.

Drive

Check that the drive heatsink is free of particles and has a free flow of air over its entire surface. Enclosures must be connected to earth ground through a grounding electrode conductor to provide a low-impedance path for ground-fault or noise-induced currents. Check the security of the ground connections.

Troubleshooting

This section discusses methods to identify and resolve problems that may occur with your SD Drive System.

Problem Isolation

When your system does not function properly (or as you expect it to operate), the first thing that you must do is identify and isolate the problem.

Isolate each system component and ensure that each one functions properly when it is run independently. You may have to remove system components and re-install them to detect the problem.

WARNING

Make sure to remove power before testing any SD system components.

Use the following information to help in identifying the difficulty. If the problem persists, call one of the numbers at the front of this User Guide for engineering assistance.

Motor Fails to Move

Test the motor to see if it has holding torque. If there is no holding torque, here are some probable causes:

- There is no AC power.
- Current selection DIP switches are not set properly (see the motor current selection table in Chapter 3, Installation). *NOTE: If you have changed the current with resistor R5 make sure the current matches the motor's requirements*
- There are bad connections or bad cables in the power supply circuit. Disconnect the power connector, then use a meter to monitor continuity between the power connector and the transformer and between the transformer and the rack.
- There are bad connections or bad cables in the motor circuit. Disconnect the power to the drive and remove the motor connector into the motherboard. Using a meter, check the continuity in the motor circuit between pins 1 and 2 of the motor connector. Repeat for pins 3 and 4.
- The drive may not be connected properly to the motherboard. Make sure the drive is securely plugged into the DIN connector on the inside of the motherboard.
- The shutdown input may be active.
- The drive fuses may be blown. Disconnect AC power from the drive, remove the drive from the rack, and inspect the line fuses FS1 and FS2, on the SD Drive card. **If either of the fuses are blown, return the system for repair.**

If the unit has holding torque and the motor shaft still fails to move, here are some probable causes:

- The limit switches have been tripped or are faulty. Make sure that your limit switches are OFF or that the limits are disabled
- The load is jammed. You should *hear* the drive attempting to move the motor. Remove AC power from the driver and verify that you can move the load manually away from the point of the jam.
- Indexer parameters are incorrectly set up. If certain parameters are out of range or are missing, the motor will not move when you issue the GO or START command.

The following are additional troubleshooting techniques:

- Check the motor for damage. Also check the motor leads/cable to see if they are damaged or shorted. These conditions may cause the drive to fault out.
- Check the resistance of the motor and cables to make sure that shorts do not exist between phases or to earth GND. The resistance across each motor phase should be consistently low, and there should be no connection between motor phases and between each phase and earth ground.

Motor Stalls

A motor stall during acceleration may be caused by one or more of the following factors:

- The torque requirements may be excessive
- The acceleration ramp may be too steep - lower acceleration may be required
- The load inertia and rotor inertia may be grossly mismatched.

If the motor stalls during the constant velocity portion of a move, the shaft and/or coupler may be damaged or binding due to improper coupling or excessive motor load.

A stall may occur if the DIP switch setting for the motor current selection is incorrect. The motor may not be receiving enough current to drive the load.

A stall may also be detected in closed loop mode if the encoder resolution is not set properly, or if the encoder (where fitted) input channels (A and B) are reversed.

Motor Fails to Run at High Speeds

If the motor fails to run at high speeds, it is possible that the motor may not be producing enough torque to move the load at these velocities. Check the torque/speed curves in the *Digiplan Motion Control Catalogue* and make sure you are trying to run the motor within the system capabilities.

Motor is Jerky or Weak

Check that there are no mechanical problems at the load causing variable loading condition. Disconnect the motor from the load and run it without a load connected. Check the DIP switches (or programming resistor value) for proper current settings.

Motor Overheats

If the motor exceeds its maximum motor case temperature rating, failure will eventually result. Check your DIP Switch settings (or programming resistor value) to ensure that the current setting is correct for the motor you are using. Refer to Chapter 3, Installation, for proper current settings.

Motor Shaft Develops Signs of Wear

The motor shaft may wear prematurely if there is foreign material rubbing against the shaft, or if the load is not coupled properly. Check couplings for tightness.

Reducing Electrical Noise

For information on identifying and suppressing electrical noise, refer to the Technical Data section of the *Digiplan Motion Control Catalogue*.

Returning the System

If you must return your SD Drive/System to effect repairs or upgrades, use the following steps:

1. Get the serial number and the model number of the defective unit, and a purchase order number to cover repair costs in the event the unit is determined by the manufacturers to be out of warranty.

2. Before you return the unit, have someone from your organisation with a technical understanding of the equipment and its application include answers to as many of the following questions as possible:

- What is the extent of the failure/reason for return?
- How long did it operate?
- Did any other items fail at the same time?
- What was happening when the unit failed (i.e., installing the unit, cycling power, starting other equipment, etc)?
- How was the product configured (in detail)?
- What, if any, cables were modified and how?
- With what equipment is the unit interfaced?
- What was the application?

- What was the system environment (temperature, enclosure, spacing, unit orientation, contaminants, etc.)?
- What upgrades, if any, are required (hardware, software, user guide)?

3. In the UK, call Digiplan for a GRA (Goods Returned Authorisation) number. Returned products cannot be accepted without a GRA number. The phone number for Digiplan Repair Department is 0202 690911. For Customer Service/Applications Department phone 0202 699000.

Ship the unit to:
Parker Hannifin plc
Digiplan Division,
21, Balena Close,
Poole,
Dorset,
England.
BH17 7DX

4. In the USA, call Parker Compumotor for a Return Material Authorization (RMA) number. Returned products cannot be accepted without an RMA number. The phone number for Parker Compumotor Applications Department is (800) 358-9070.

Ship the unit to:
Parker Hannifin Corporation
Digiplan Division
5500 Business Park Drive
Rohnert Park, CA 94928
Attn: RMA # xxxxxxx

5. Elsewhere: Contact the distributor who supplied the equipment

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