



HIGH PERFORMANCE MOTORS & DRIVES

110 Fordham Road
Wilmington, MA 01887
(978) 988-9800
Fax (978) 988-9940

Part# MA6445-HW
List Price \$30 U.S.
January, 1999
Rev 2

MA6445

Microstepping Indexer / Drive

Installation & Hardware Reference Manual

This document is copyrighted by Pacific Scientific Company.
It is supplied to the user with the understanding that it will not
be reproduced, duplicated, or disclosed in whole or in part
without the express written permission of Pacific Scientific
Company.

WARRANTY AND LIMITATION OF LIABILITY

Includes software provided by Pacific Scientific

Pacific Scientific warrants its motors and controllers ("Product(s)") to the original purchaser (the "Customer"), and in the case of original equipment manufacturers or distributors, to their original consumer (the "Customer") to be free from defects in material and workmanship and to be made in accordance with Customer's specifications which have been accepted in writing by Pacific Scientific. In no event, however, shall Pacific Scientific be liable or have any responsibility under such warranty if the Products have been improperly stored, installed, used or maintained, or if customer has permitted any unauthorized modifications, adjustments, and/or repairs to such Products. Pacific Scientific's obligation hereunder is limited solely to repairing or replacing (at its option), at its factory any Products, or parts thereof, which prove to Pacific Scientific's satisfaction to be defective as a result of defective materials or workmanship, in accordance with Pacific Scientific's stated warranty, provided, however, that written notice of claimed defects shall have been given to Pacific Scientific within two (2) years after the date of the product date code that is affixed to the product, and within thirty (30) days from the date any such defect is first discovered. The products or parts claimed to be defective must be returned to Pacific Scientific, transportation prepaid by Customer, with written specifications of the claimed defect. Evidence acceptable to Pacific Scientific must be furnished that the claimed defects were not caused by misuse, abuse, or neglect by anyone other than Pacific Scientific.

Pacific Scientific also warrants that each of the Pacific Scientific Motion Control Software Programs ("Program(s)") will, when delivered, conform to the specifications therefore set forth in Pacific Scientific's specifications manual. Customer, however, acknowledges that these Programs are of such complexity and that the Programs are used in such diverse equipment and operating environments that defects unknown to Pacific Scientific may be discovered only after the Programs have been used by Customer. Customer agrees that as Pacific Scientific's sole liability, and as Customer's sole remedy, Pacific Scientific will correct documented failures of the Programs to conform to Pacific Scientific's specifications manual. **PACIFIC SCIENTIFIC DOES NOT SEPARATELY WARRANT THE RESULTS OF ANY SUCH CORRECTION OR WARRANT THAT ANY OR ALL FAILURES OR ERRORS WILL BE CORRECTED OR WARRANT THAT THE FUNCTIONS CONTAINED IN PACIFIC SCIENTIFIC'S PROGRAMS WILL MEET CUSTOMER'S REQUIREMENTS OR WILL OPERATE IN THE COMBINATIONS SELECTED BY CUSTOMER.** This warranty for Programs is contingent upon proper use of the Programs and shall not apply to defects or failure due to: (i) accident, neglect, or misuse; (ii) failure of Customer's equipment; (iii) the use of software or hardware not provided by Pacific Scientific; (iv) unusual stress caused by Customer's equipment; or (v) any party other than Pacific Scientific who modifies, adjusts, repairs, adds to, deletes from or services the Programs. This warranty for Programs is valid for a period of ninety (90) days from the date Pacific Scientific first delivers the Programs to Customer.

THE FOREGOING WARRANTIES ARE IN LIEU OF ALL OTHER WARRANTIES (EXCEPT AS TO TITLE), WHETHER EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR OF FITNESS FOR ANY PARTICULAR PURPOSE, AND ARE IN LIEU OF ALL OTHER OBLIGATIONS OR LIABILITIES ON THE PART OF PACIFIC SCIENTIFIC. PACIFIC SCIENTIFIC'S MAXIMUM LIABILITY WITH RESPECT TO THESE WARRANTIES, ARISING FROM ANY CAUSE WHATSOEVER, INCLUDING WITHOUT LIMITATION, BREACH OF CONTRACT, NEGLIGENCE, STRICT LIABILITY, TORT, WARRANTY, PATENT OR COPYRIGHT INFRINGEMENT, SHALL NOT EXCEED THE PRICE SPECIFIED OF THE PRODUCTS OR PROGRAMS GIVING RISE TO THE CLAIM, AND IN NO EVENT SHALL PACIFIC SCIENTIFIC BE LIABLE UNDER THESE WARRANTIES OR OTHERWISE, EVEN IF PACIFIC SCIENTIFIC HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES, FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, INCLUDING WITHOUT LIMITATION, DAMAGE OR LOSS RESULTING FROM INABILITY TO USE THE PRODUCTS OR PROGRAMS, INCREASED OPERATING COSTS RESULTING FROM A LOSS OF THE PRODUCTS OR PROGRAMS, LOSS OF ANTICIPATED PROFITS, OR OTHER SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER SIMILAR OR DISSIMILAR, OF ANY NATURE ARISING OR RESULTING FROM THE PURCHASE, INSTALLATION, REMOVAL, REPAIR, OPERATION, USE OR BREAKDOWN OF THE PRODUCTS OR PROGRAMS, OR ANY OTHER CAUSE WHATSOEVER, INCLUDING NEGLIGENCE.

The foregoing shall also apply to Products, Programs, or parts for the same which have been repaired or replaced pursuant to such warranty, and within the period of time, in accordance with Pacific Scientific's date of warranty.

No person, including any agent, distributor, or representative of Pacific Scientific, is authorized to make any representation or warranty on behalf of Pacific Scientific concerning any Products or Programs manufactured by Pacific Scientific, except to refer purchasers to this warranty.

Table of Contents

.....

1 Overview of the 6445 Microstep Indexer/Drive	1-1
1.1 6445 Definition	1-1
1.2 System Diagram.	1-4
1.3 How to Use This Manual	1-6
1.4 Warranty	1-6
2 Installing the 6445 Microstep Indexer/Drive	2-1
2.1 Unpacking and Inspecting the 6445	2-1
2.2 Selecting System Components.	2-2
2.3 6445 Safety	2-4
2.4 Mounting the 6445 in your Installation	2-5
2.5 Connecting the Eight Input/Output Cables	2-7
2.5.1 J1 120\240 Vac Power Connection	2-10
2.5.2 J3 Motor Connection	2-11
2.5.3 J6 66 Vdc Output Connection	2-18
2.5.4 J7 Serial Port Connection	2-20
2.5.5 J8 and J9 Discrete Input/Output Connection	2-26
2.5.6 J11 Encoder/Step and Direction Input Connection	2-33
2.5.7 J10 Step and Direction Output Connection	2-38
3 Powering Up the 6445 Microstep Indexer/Drive	3-1
3.1 Setting Up Switch S1	3-1
3.2 Setting Up Serial Addresses Using Switch S2	3-6
3.3 AC Switch Settings	3-9
3.4 Testing the Installation.	3-10

4 Troubleshooting	4-1
4.1 POWER LED Not On - 6445 Does Not Power Up	4-2
4.2 FAULT LED On - 6445 Disable Fault	4-5
4.3 PROCESSOR FAULT LED On	4-6
4.4 LEDs Do Not Respond - Communications Interface Fault	4-7
Appendix A - Specifications	A-1
Appendix B - Order Number and Ordering Information	B-1
Appendix C - Series/Parallel Connections	C-1
Index	

1 Overview of the 6445 Microstep Indexer/Drive

- In this chapter** This chapter introduces the 6445 Microstep Indexer/Drive. Topics covered are:
- 6445 definition
 - Selecting system components
 - System diagram
 - How to use this manual
 - Warranty information

1.1 6445 Definition

- Overview** The Pacific Scientific® 6445 Microstep Indexer/Drive combines a high-performance, bipolar chopper drive with a Pacific Scientific StepperBASIC™ programmable indexer for stepper motor motion control.
- The output current of the 6445 is dip switch selectable from 0.625A rms (0.88A peak in microstep mode) to 5A rms (7.1 A peak in microstep mode).
- The Pacific Scientific 6445 can be powered from 120 or 240 Vac (60/50 Hz). This input is switch selectable for either 120 or 240 Vac. An internal PWM switching power supply provides up to 300 W ± 10% of power to the stepper drive.

Drive features

Bipolar chopper drive - patented 4-phase PWM (pulse width modulation) chopping electronically controls the motor winding currents at 20 KHz frequency. This combines the best of recirculating and non-recirculating current regulation producing high back EMF rejection with low chopping ripple current. Benefits include: reduced heat dissipation, low electric noise and improved current control during motor braking.

Internal power supply - AC off line operation is dip switch selectable for either 120 or 240 Vac input. The main motor supply consists of a PWM switching supply.

Shunt regulator circuitry -protects the drive by disabling the drive if the DC bus voltage exceeds 84 volts (at external connector J6). This feature protects the circuitry from excessive voltage that may be generated under certain motor deceleration conditions.

Short circuit protection circuitry - disables the drive if a short circuit occurs on the motor outputs. The drive must be power cycled to clear fault.

Power supply features

66 Vdc output - three pin pluggable connector (J6) provided to supply 66 Vdc to power an additional drive. The total power available for both the internal and external drives is 66 Vdc @ 4.6 Amps or 300W \pm 10%.

Indexer features

The indexer circuitry provides programmable motion control and allows flexible interfacing to the application.

Pacific Scientific StepperBASIC - programming language with over 100 instructions, combines the ease of the programming language BASIC with sophisticated motion control features.

Serial port RS-232 or RS-422/485 communications
-interfacing the user computer or terminal for programming and/or computer control. RS-422/485 control allows multiple 6445 units to be controlled from a single computer or terminal.

**Indexer
features
(cont'd)**

12 outputs - user programmable outputs to external devices. One output is program-selectable to indicate motor moving.

16 inputs - user programmable inputs from external devices. Six inputs can be pre-defined for limit, start, stop, and jog functions.

Encoder inputs - for position verification, or for electronic gearing. Alternatively, these inputs can be redefined for external step and direction control.

Step and direction outputs - outputs step and direction signals for control of another drive.

Memory - indexer memory capacity is 12K bytes (battery-backed RAM).

**User-defined
functions**

using DIP
switch S1

Motor current - sets the motor phase current to 5.0, 4.375, 3.75, 3.125, 2.5, 1.875, 1.25, or 0.625 A rms.

Step size - sets the amount of shaft rotation per step. The settings are full, half, 1/5, 1/10, 1/25, 1/50, 1/125, and 1/250 steps per (micro)step. This corresponds to 200, 400, 1000, 2000, 5000, 10,000, 25,000, and 50,000 (micro) steps per revolution with a standard 1.8° motor.

Digital Electronic Damping control - enables this patented feature which eliminates loss of torque and possible motor stalling conditions when operating at mid-range speeds. This instability is a phenomenon of the electronic, magnetic and mechanical characteristics of a stepping motor system. The compensation circuit damps mid-range oscillations by advancing or delaying switching of the output current relative to the incoming pulse train.

Idle current reduction (ICR) - enables or disables idle current reduction which reduces motor winding current by 50% of its rated value during motor dwell periods. ICR begins 0.1 second after the last input step pulse occurs.

Note: *The current will return to 100% at the next step pulse.*

using AC
Switch SW1



Off line 120/240 Vac - switch selects AC input.

Warning!

Applying 240 (230) Vac with AC Switch in 120 (115) Vac position will permanently damage the drive.

Typical applications

Typical applications for the 6445 microstep indexer/drive include:

- X-Y tables and slides
- Packaging machinery
- Feed to length
- Labeling machines

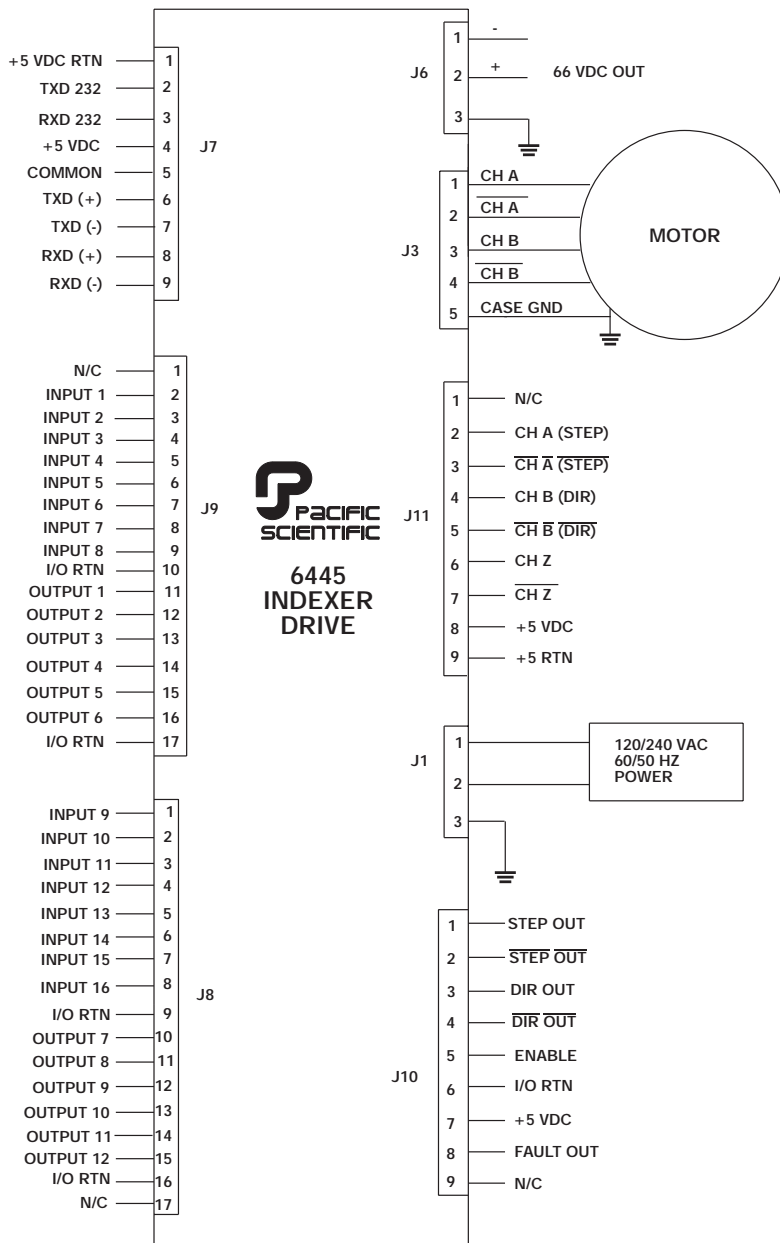
1.2 System Diagram

The following diagram shows an installation of the drive in a typical system. Your installation may vary from this configuration. Typical components used with the 6445 include:

- Motor
- Computer or terminal
- External switches

Selection and installation guidelines for these components are described in Chapter 2, "Installing the 6445 Microstep Indexer/Drive."

System Diagram



1.3 How to Use this Manual

This manual contains information and procedures to install, set up, test with simple commands, and troubleshoot the 6445. Refer to the StepperBASIC Programming Manual for programming instructions and reference.

1.4 Warranty

The Pacific Scientific 6445 drives have a **two year warranty** against defects in material and assembly. Products that have been modified by the customer, physically mishandled, or otherwise abused through miswiring, incorrect switch settings, and so on, are exempt from the warranty plan.

2 Installing the 6445 Microstep Indexer/Drive

In this Chapter This Chapter explains how to install the 6445 Microstep Indexer/Drive. Topics covered are:

- Unpacking and inspecting the 6445
- Selecting a motor
- 6445 safety
- Mounting the 6445 in your installation
- Connecting input/output cabling
- Selecting switch functions

2.1 Unpacking and Inspecting the 6445

Unpacking procedure

1. Remove the 6445 from the shipping carton. Make sure all packing materials are removed from the unit.
2. Check the items against the packing list. A label located on the side of the unit identifies the unit by model number, serial number, and date code.

Inspection procedure Inspect the unit for any physical damage that may have been sustained during shipment.

If you find damage, either concealed or obvious, contact your buyer to make a claim with the shipper. Do this as soon as possible after receipt of the unit.

Storing the unit Store the 6445 in a clean, dry place. The storage temperature must be between -40 degrees C and 70 degrees C. To prevent damage during storage, replace the unit in the original shipping carton.

2.2 Selecting System Components

Introduction Match your 6445 unit to your other components.

Selecting a motor

The 6445 is designed for use with Pacific Scientific's line of hybrid stepper motors. The drive works with either the standard line or the enhanced high performance line of stepper motors. Use the system Torque/Speed curves for the 6445 shown in the Pacific Scientific "Motion Control Solutions" Catalog to select the right motor for your application.

To use a motor not included in the system selections, observe the following rules:

- The motor winding current rating must be equal or greater than the drive's output current:
 - 5.0 Amps RMS (7.1 Amps peak)
- The electrical and magnetic losses of the motor must not exceed the motor power dissipation rating. This is of special concern at high speed and with low inductance motors. The motor case temperature should not exceed 100 degrees C.

If you need help in selecting a motor, contact your local Pacific Scientific distributor for sizing and motor compatibility assistance.

Serial communications interfaces

The 6445 requires a serial communication link in order to develop StepperBASIC software (using PacCom). A serial interface may be used under software control to interface the 6445 with other user-supplied equipment such as:

- Operator displays
- Host computers
- Programmable controllers (PLC)

The 6445 uses serial communication interfaces supported by the RS-232 and RS-485 hardware specifications.

Single- and Multi-unit control

For controlling a single 6445, use RS-232 communications and install cable as described in section 2.5.4.1 "J7 Serial Port - RS-232 Connection."

For controlling multiple 6445s, use RS-422 or RS-485 communications, which permit a single PC to host from 1 to 31 6445s (each requiring a unique switch selectable address). For detailed information on setup refer to section 2.5.4.2 "Serial Port - RS-422 or RS-485 Connection."

Digital I/O

Enable input - One dedicated input to enable the controller. Connecting this input to I/O Return enables the 6445.

Fault output - An open collector (NPN) dedicated output showing controller fault status. This output turns off to indicate a fault. Maximum current sinking capability is 100 mA and maximum off voltage is 16 volts.

General inputs - 16 inputs to support logic type interfaces. The input circuitry is intended to be operated with open collector type circuitry. These inputs can be polled under software control. Six of the 16 inputs can be pre-defined for specific functions: LIMIT +/-, START/STOP, and JOG +/-.

General outputs - 12 open collector discrete outputs under software control. Each output can sink a maximum of 100 mA. Maximum off voltage is 16 volts. One of the 12 outputs can be pre-defined for MOTOR MOVING status.

Encoder I/O - The external encoder I/O port permits interfacing to quadrature type encoder signals for applications such as electronic gearing. This input can also be configured by software as a step and direction input.

Note: *Factory default is for quadrature encoder inputs.*

Step/Dir Out - The Step/Dir output permits controlling external devices so they can follow step and direction from the 6445. This output signal is present as long as the 6445 is enabled and executing any motion profile.

2.3 6445 Safety


Your responsibility

As the user or person applying this unit, you are responsible for determining the suitability of this product for any application you intend. In no event will Pacific Scientific Company be responsible or liable for indirect or consequential damage resulting from the use of this product.



Safety guidelines

To avoid possible personal injury whenever you are working with the 6445:

- DO NOT power up the unit without the cover on and the chassis tied to earth ground.
Note: *This is normally done by connecting the motor's case ground to J3-5 of the 6445 and connecting J1-3 of the 6445 to earth ground. These pins are marked by a  symbol on the silkscreen and are shown on the diagram on page 2-8.*
- DO NOT operate the unit without the motor case tied to earth ground.
- Always remove power before making or removing connections from the unit.
- Before removing the cover of the unit, shut off power and allow the unit to sit for 5 minutes to discharge the bus capacitors.
- Be careful of the motor terminals when disconnected from the motor. With the motor disconnected and power applied to the drive, the motor terminals have high voltage present.
- DO NOT use the enable input as a safety shutdown. Always remove power to the drive for a safety shutdown.

WARNING

The circuits in the 6445 are a potential source of severe electrical shock. Follow the safety guidelines to avoid shock.

2.4 Mounting the 6445 in Your Installation

Cabinet selection

Select a standard 8-inch (205 mm) deep or greater NEMA (National Electrical Manufacturers Association) enclosure appropriate for industrial applications.



CAUTION

The internal cabinet temperature should not exceed 50°C (60°C with derating). If the cabinet is ventilated by filtered or conditioned air make sure to prevent the accumulation of dust and dirt on the unit's electronic components. The air should also be free of corrosive or electrically conductive contaminants.

Mounting guidelines

Select a cabinet position that meets these guidelines:

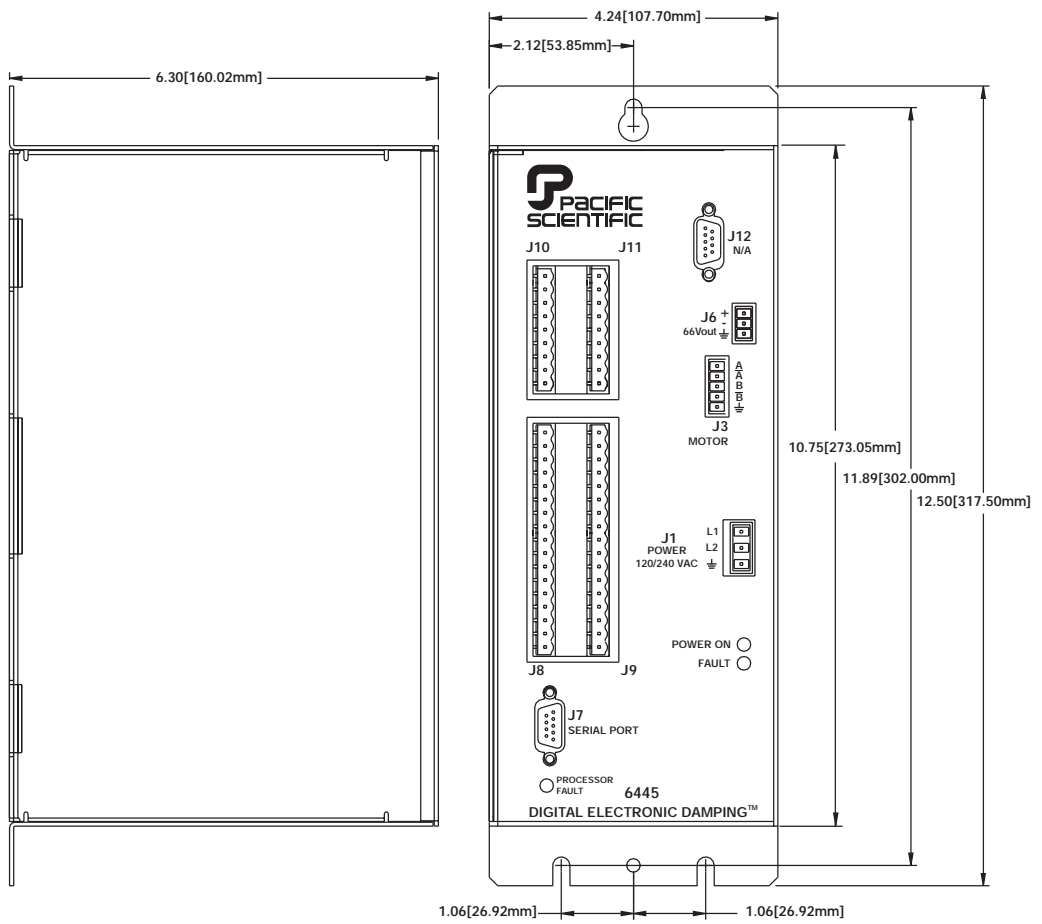
- Flat, solid surface capable of supporting the approximate 6.0 lbs. (2.7 kg) weight of the unit.
 - Free of excessive vibration or shock.
 - Minimum unobstructed space of four inches (10 cm) at the fan input on the unit bottom and the exhaust on the unit top.
 - Operating temperature of:
0 to 50 degrees C at full rated current
-

Mounting procedure

Bolt the unit to the cabinet using the three slots (refer to the dimensions figure) using a #10 (M5 metric equivalent) bolt.

Mounting dimensions

Prepare the cabinet for the 6445 using the dimensions in inches or millimeters as shown in the following figure.



Power dissipation for cabinet

The 6445 dissipates power causing cabinet heating. Power dissipation is determined by a number of factors, such as output current, motor winding impedance, input step rates, and idle current reduction. The 6445 is factory preset for 5 amps/phase current and idle current reduction enabled.

For an estimate of the power dissipation for use in calculating cabinet cooling requirements, use the values shown:

For an RMS current of (amps):	Use a value of (watts):
5.0	50
2.5	20

2.5 Connecting the Eight Input/Output Cables

Introduction

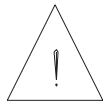
The eight input/output connectors are:

- J1-120 or 240 Vac power
- J3-Motor
- J6-External 66 Vdc output
- J7-RS-232/RS-485 serial port
- J8-Discrete inputs and outputs
- J9-Discrete inputs and outputs
- J11-Encoder/Step and direction inputs
- J10-Step and direction outputs, fault output, and enable input

Note: *These inputs and outputs are shown on the next page.*

Wiring is application specific

Wiring sizes, wiring practices, and grounding/shielding techniques described in the following section represent common wiring practices and should prove satisfactory in the majority of applications.



CAUTION

Non-standard applications, local electrical codes, special operating conditions, and system configuration wiring needs take precedence over the information included here. Therefore, you may need to wire the drive differently than described here.

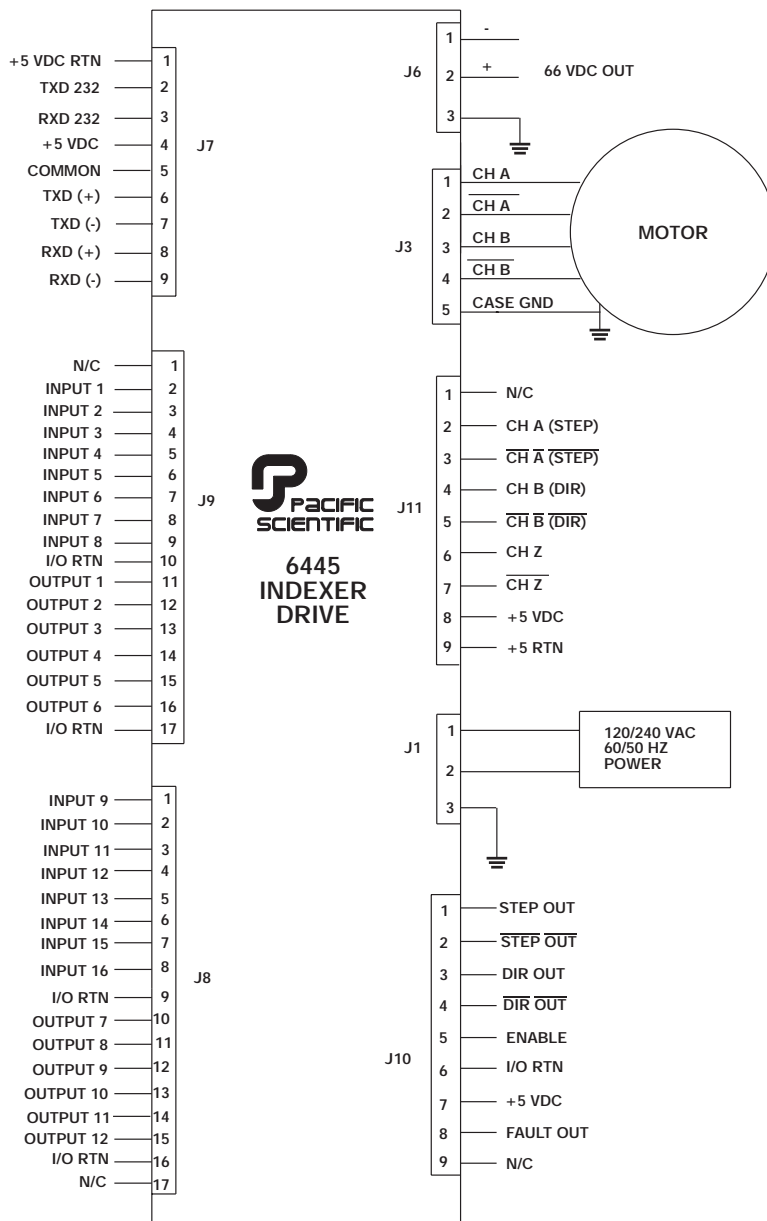
Noise pickup reduction

Use shielded and twisted cabling for the signal and power cables. This precaution reduces electrical noise.

Shock hazard reduction

Refer to section 2.3 for safety information that must be followed to reduce shock hazard.

Connection diagram



2.5.1 J1 120/240 Vac Power Connection

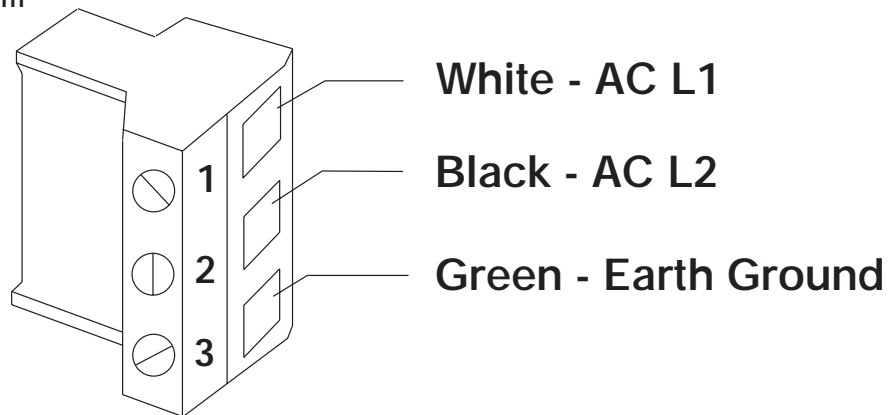
Introduction The J1 120/240 Vac power cable connects power to the 6445.

Mating Connector The J1 120/240 Vac power connector mates to a PCD 3-pin screw cable connector. The mating connector is type ELFP03210.

Note: *Connector kits are available as an accessory.*

Cable requirements Use 16-to 14-gauge shielded wire for the cabling.

Cabling diagram



Procedure

1. Strip the wires 0.27 inch (7 mm).
2. Attach the wires to the connector as indicated in the diagram.

Note: *Make sure the screws on the PCD connector are tightened down firmly on the wiring.*



CAUTION

Do not pre-tin (solder) the tips of the cables going into the PCD connector. This can result in a loose connection.

WARNING

The chassis ground must be tied to earth ground. Failure to do this leaves the potential for severe hazard. Make sure the ground is connected via the ground stud on the front of the 6445.



3. Plug the mating connector firmly into the 6445.

2.5.2 J3 Motor Connection

Introduction

The J3 motor cable connects the drive to the motor windings. Motor cables are available from Pacific Scientific, or you can make your own.

Note: *Refer to Appendix C, "Series/Parallel Connections" for additional information.*

Mating connector

The J3 motor connector is a PCD 5-pin screw mating connector. The mating connector is type PCD ELVP05100.

Note: *Connector kits are available as an accessory.*

Making your own cable

If you need to build the cable, refer to the appropriate subsection as follows:

To build the cable for motor type:	Refer to Section:
4-lead	2.5.2.1
8-lead series	2.5.2.2
8-lead parallel	2.5.2.3

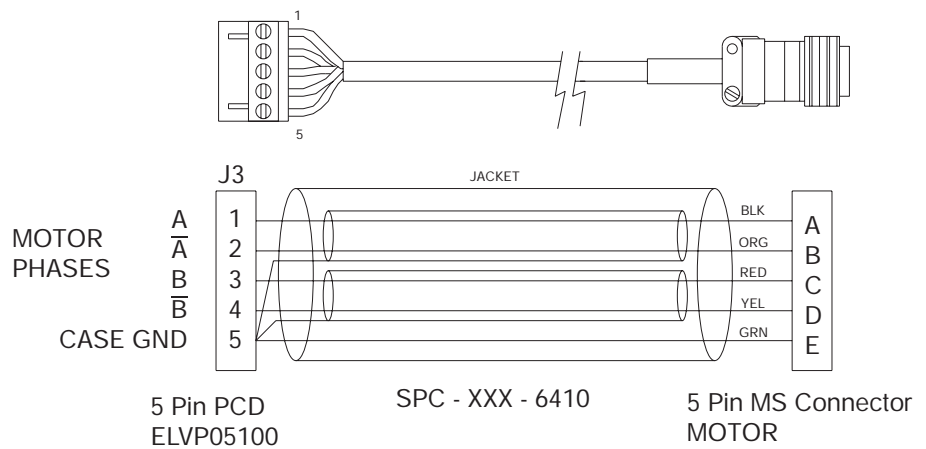
Pacific Scientific cable

If the motor cable is purchased from Pacific Scientific, install as follows. The Pacific Scientific order number is SPC-xxx-6410, where "xxx" is the length in one-foot increments up to 50 feet. For example, SPC-050-6410 is a cable 50 feet long.

Pacific Scientific cabling installation

If you are using Pacific Scientific motor cable with the mating connectors already attached, install as follows:

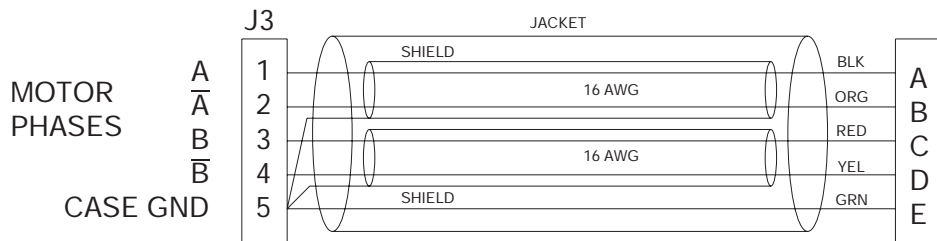
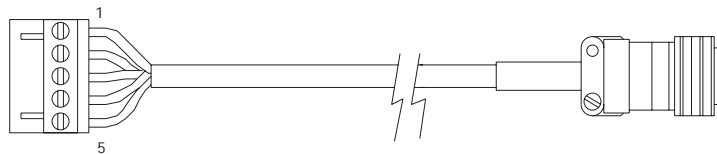
Pacific Scientific cable diagram



Note: This cable is for use with Pacific Scientific **E** and **H** series stepper motors.

Pacific Scientific cable diagram

Note: This cable is for use with Pacific Scientific **K** and **N** series stepper motors.



5 Pin PCD
ELVP05100

SPC - XXX - 6410 - KN

5 Pin MS Connector
MS31 06A1 4S-5S
MOTOR

Procedure

1. Remove power from the 6445.

WARNING

Always remove power before making or removing connections to the unit. The motor terminals have high voltage present when the 6445 is On.



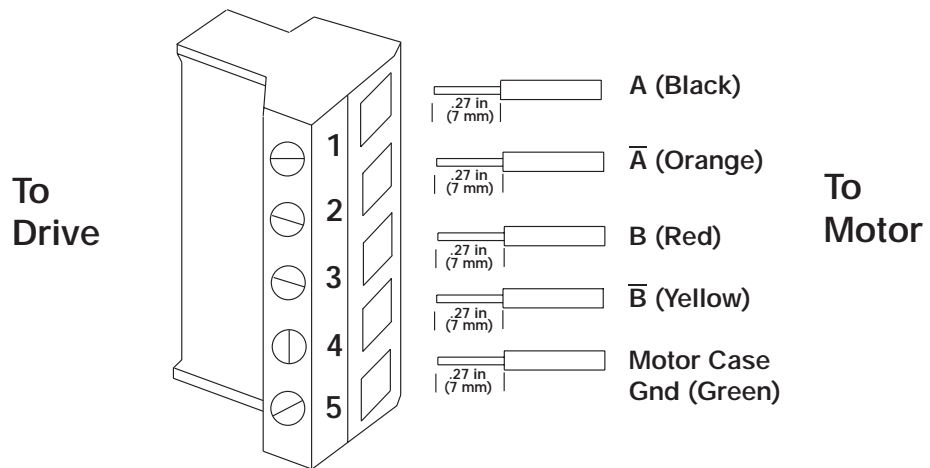
2. Plug the mating connector firmly into the 6445.
3. Plug the other mating connector into the motor and screw down the retaining collar.
4. Reconnect power to the 6445.

2.5.2.1 4-Lead Motor

Introduction For the 4-lead standard systems motor with MS connector, build and install the cable using guidelines that follow.

Cable requirements Use 18- to 16-gauge stranded wire for the cabling. Obtain cable with each winding pair (refer to diagram) twisted at about 3 to 4 turns per inch (1 to 1.5 turns per centimeter). Make sure the cable contains a lead for grounding. As an option, the cable may be shielded to reduce radiated noise. If a shield is used, connect as shown for pre-built cables.

Cabling diagram The colors referenced in the diagram follow the Pacific Scientific stepper motor color code.



Procedure

1. Strip the wires to 0.27 inch (7 mm).
2. Attach the wires to the connector as indicated in the diagram.

Note: *Make sure the screws on the PCD connector are tightened down firmly to the wiring.*

**CAUTION**

Do not pre-tin (solder) the tips of the cables going into the PCD connector. This can result in a loose connection.

3. Remove power from the 6445.

WARNING

Always remove power before making or removing connections to the unit. The motor terminals have high voltage present when the 6445 is On.



4. Plug the mating connector firmly into the 6445.
5. Connect the cable shield to 6445 ground, if applicable.
6. Plug the other mating connector into the motor.
7. Switch On the 6445.

2.5.2.2 8-Lead Motor, Series Connected

Introduction

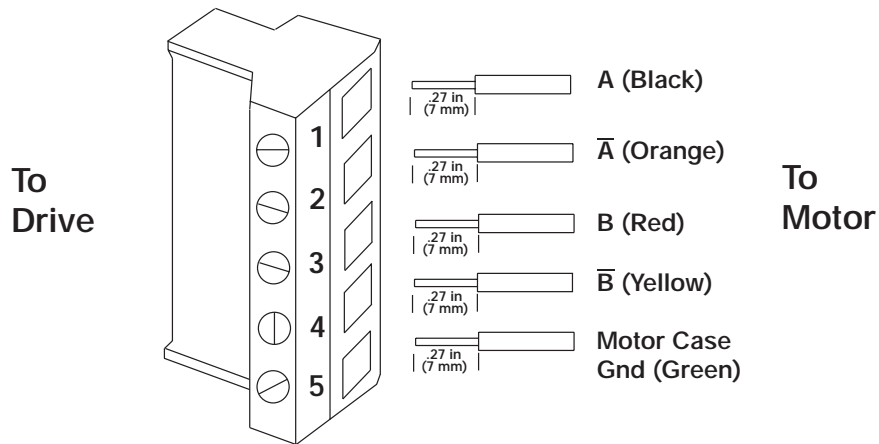
For an 8-lead motor to be wired in series, build and install the cable using guidelines that follow.

Cable requirements

Use 18- to 16- gauge stranded wire for the cabling. Obtain cable with each winding pair (see diagram) twisted at about 3 to 4 turns per inch (1 to 1.5 turns per centimeter). Make sure the cable contains a lead for grounding. As an option, the cable may be shielded to reduce radiated noise.

Cabling diagram

The colors referenced in the diagram follow the Pacific Scientific stepper motor color code.



In addition, make the following connections at the motor:



Procedure

1. Strip the wires to 0.27 inch (7 mm).
2. Referring to the diagram, attach the wires to the connector. Connect the white-striped leads with wire nuts as shown.

Note: Make sure the screws on the PCD connector are tightened down firmly on the wiring.



CAUTION

Do not pre-tin (solder) the tips of the cables going into the PCD connector. This can result in a loose connection.

3. Remove power from the 6445.



WARNING

Always remove power before making or removing connections to the unit. The motor terminals have high voltage present when the 6445 is On.

**Procedure
(cont'd)**

4. Plug the mating connector firmly into the 6445.
5. Connect the cable shield to 6445 ground, if applicable.
6. Plug the other mating connector into the motor.
7. Switch On the 6445.

2.5.2.3 8-Lead Motor, Parallel Connected

Introduction

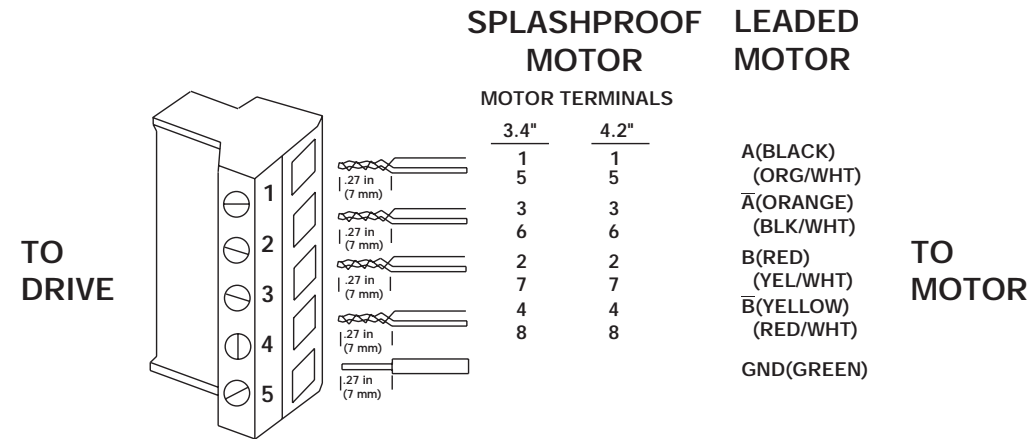
For an 8-lead motor to be wired in parallel, build and install the cable using guidelines that follow.

Cable requirements

Use 18- to 16- gauge stranded wire for the cabling. Obtain cable with each winding pair (see diagram) twisted at about 3 to 4 turns per inch (1 to 1.5 turns per centimeter). Make sure the cable contains a lead for grounding. As an option, the cable may be shielded to reduce radiated noise.

Cabling diagram

The colors referenced in the diagram follow the Pacific Scientific stepper motor color code.



Procedure

1. Strip the wires so that the twisted ends will be the length shown.
2. Referring to the diagram, twist the striped and solid lead ends and attach the wires to the connector.

Note: *Make sure the screws on the PCD connector are tightened down firmly on the wiring.*

**CAUTION**

Do not pre-tin (solder) the tips of the cables going into the PCD connector. This can result in a loose connection.

3. Remove power from the 6445.

WARNING

Always remove power before making or removing connections to the unit. The motor terminals have high voltage present when the 6445 is On.



4. Plug the mating connector firmly into the 6445.
5. Connect the cable shield to 6445 ground, if applicable.
6. Switch On the 6445.

2.5.3 J6 External 66 Vdc Output Connector

Introduction

The J6 external 66 Vdc output allows the 6445 to power additional drives.

Mating connector

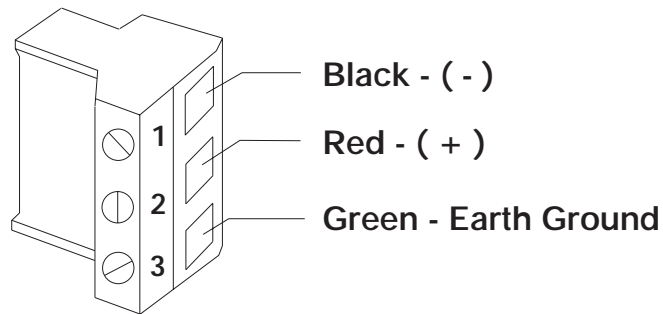
The J6 connector is a PCD 3-pin screw mating connector. The mating connector is type PCD ELVP05100.

Note: *Connector kits are available as an accessory.*

Cable requirements

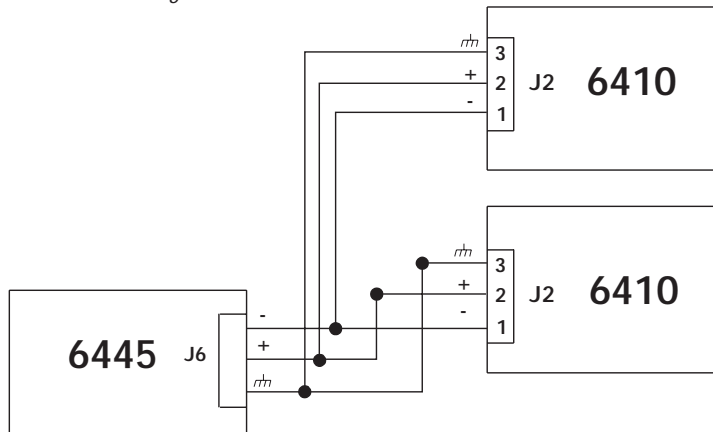
Use 18-to 16-gauge shielded wire for the cabling.

Cabling diagram



Connection diagram

Note: The total power available for both the internal and external drives is 66 Vdc @ 4.6 A or approximately 300 W $\pm 10\%$. If the two drives are running simultaneously and require more than 4.6 A, the voltage will drop. The power supply has a low voltage protection circuit that will fault the drive if the voltage is < 55 Vdc.



Note: If the 6445 is powering additional 6410s with J6, a total of 1000 μ f (maximum) 100 Vdc aluminum electrolytic capacitor, rated for 2A ripple current or greater @ 10 KHz and 105°C, must be installed (as close to the 6410 as possible). **DO NOT** exceed 1000 μ f total on J6 external connector.

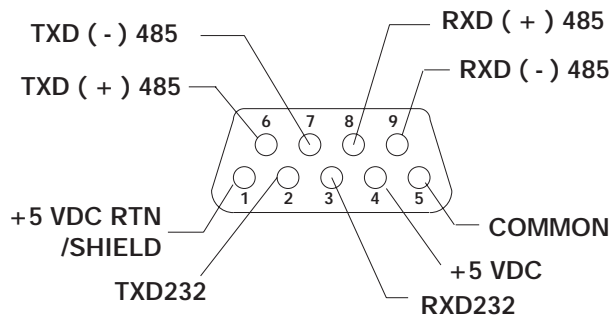
2.5.4 J7 Serial I/O Connections

- Introduction** The serial port transmits and receives RS-232 or RS485-multidrop serial communication for the user interface of your unit. You can configure to control single or multiple 6445s.
- Single- and multi-unit control**
- For controlling a single 6445, use RS-232 communications. DIP switch S2 must be set to Address 31 for RS-232 Communications as described in Section 3.2.
 - For controlling multiple 6445s, RS-422 or RS-485 communications permits a single PC to host from 1 to 31 6445s (each requiring a unique address ranging from 0 to 30, set using DIP switch S2 as described in Section 3.2).
 - The 6445 utilizes 9600 baud communications with one start bit/one stop bit and eight bit word length in either RS-232 or multidrop format.
 - For controlling a single 6445 from a T10 terminal, use RS-232 communications and install cabling as described in section 2.5.4.3, "J7 Serial Port - T10 Connection".

Serial input/output table - J7

Input/Output	Pin Number	Explanation
+5VReturn/ Shield	J7-1	Common/shield - serial port interface.
Txd 232	J7-2	RS-232 transmitter output (from 6445).
Rxd 232	J7-3	RS-232 receiver input (to 6445).
+5 V dc	J7-4	5 Vdc output Note: The total 5 Vdc current from pins J7-4, J11-8 and J10-7 must be less than 450 mA.
+5 V Common	J7-5	Common - serial port interface.
Txd (+) 485	J3-6	RS-485 transmitter output (from 6445).
Txd (-) 485	J7-7	
Rxd (+) 485	J7-8	RS-485 transmitter input (to 6445)
Rxd (-) 485	J7-9	

Cabling diagram



Mating connector

The J7 serial port mating connector is an ITT Cannon DE-9P 9-pin plug-in female D connector.

Note: Connector kits are available as an accessory.

Cable requirements

Use 22-gauge wire for the cabling. Obtain cable with each I/O pair (refer to the diagram) twisted at about 3 to 4 turns per inch (1 to 1.5 turns per centimeter). As an option, the cable may be shielded to reduce noise pickup.



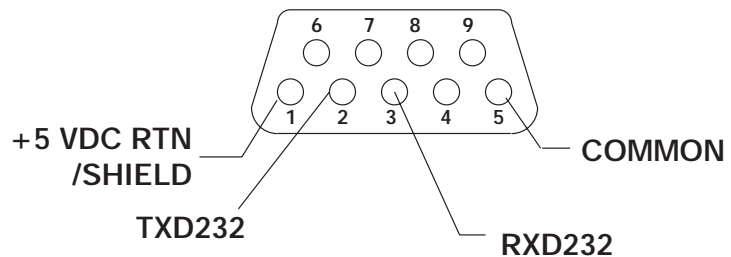
CAUTION

To avoid ground loops, connect ground shield to indexer ground (J7-1) only.

2.5.4.1 J7 Serial Port - RS-232 Connection

Introduction This section shows how to connect your PC's RS-232 port to the 6445.

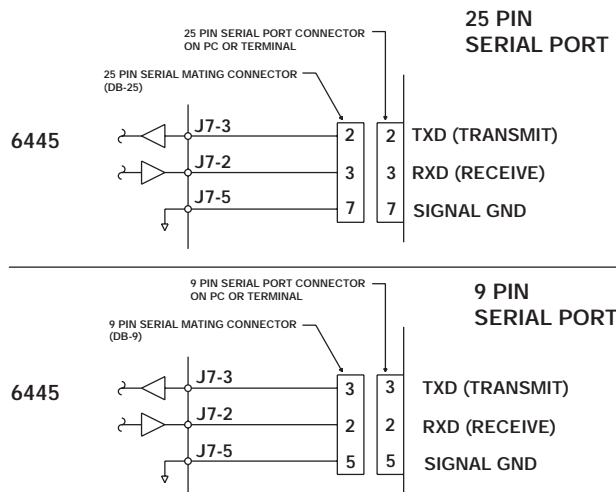
J7 Connections



Build the cable to connect to your computer or terminal by referring to the documentation for the device. Standard RS-232 pinouts for IBM compatible personal computers are shown as follows.

Note: *Pinouts vary among computer manufacturers. Check the hardware reference manual for your machine before wiring the serial port.*

RS-232 Connection



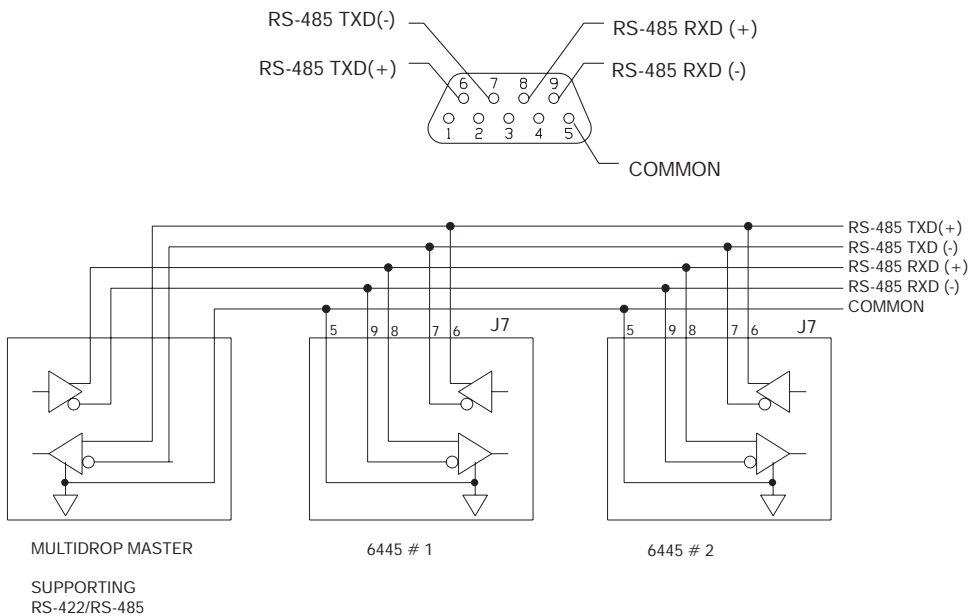
2.5.4.2 J7 Serial Port - RS-422 or RS-485 Connection

Introduction This section describes how to connect your 6445 to devices supporting RS-422/RS-485 communications.

RS-485/RS-422 Connections Up to 31 6445s can be connected in parallel to a multidrop master. The 6445s must each have a unique address, set using DIP switch S2 as described in Section 3.2.

RS-485/RS-422 connections to J7 are shown below. A multidrop interconnection diagram, showing multiple axes connected to a single host is also included.

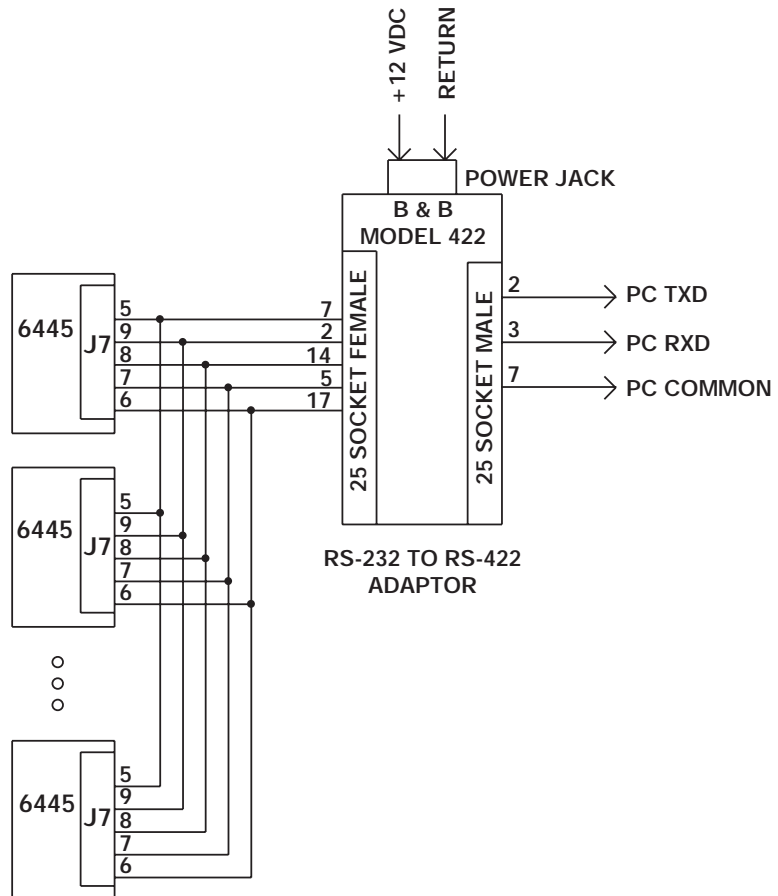
Diagram



**RS-232/RS-485
Converter
installation**

It is often convenient to use an RS-232 to RS-485/RS-422 converter so that an RS-232 port, available on all PCs, can be used to connect multiple axes. The figure below shows a typical installation, using the B & B Model 422 RS-232 to RS-422 adaptor. RS-232 to RS-485/RS-422 adapters are available from many sources.

**RS-485/RS-422
pin out diagram**

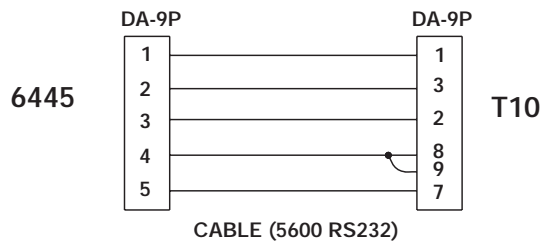


2.5.4.3 J7 Serial Port - T10 Connection

Introduction This section shows how to connect your 6445 to Pacific Scientific's T10 Terminal.

Note: *The T10 terminal requires a DA-9P 9-pin plug-in male D connector.*

Connection diagram Connections between the 6445 and the T10 terminal are shown below:



Parameter Setup

Set up the T10 terminal as follows:

1. Enter the setup mode by pressing the "." key while power is applied to the T10 (wait until the two letter prompt appears). Refer to the terminal manual for more information.
2. Enter the following values:

VW = 4	default	LE = 0	Local Echo OFF
TM = 0	character mode	EN = 1	Line Terminator (CR)
TD = 0	turnaround delay	KC = 2	Key Click
BR = 2	baud rate (9600)	KR = 1	Key Repeat
DF = 4	8 bits, no parity	CU = 2	Cursor
HS = 0	default (DTR asserted)		

Note: *The 6445 is always configured for 9600 baud, 8 bit, no parity data formats.*

2.5.5 J8 and J9 Discrete Input/Output Connection

Introduction

Connectors J8 and J9 contain all the programmable inputs and outputs for the 6445:

- The 16 inputs are for external discrete switch-type devices. Inputs are used with functions and variables from the program. Six of the 16 inputs can be used for dedicated functions. The 6445 discrete input circuit is shown at the end of this section, in addition to several drive circuits.
- The 12 outputs are programmable for sending out signals. Output 12 can be dedicated to indicate when the motor is moving. These outputs are driven by open collector NPN transistors and can sink up to 100 mA. Several load configurations are shown at the end of this section.

For information on using the inputs and outputs, refer to the specific variable in the StepperBASIC Programming Manual.

Output table

The following table lists the discrete outputs on connectors J8 and J9.

Output Signal	Pin Number	Explanation
OUT 1	J9-11	Outputs are controlled by the user's program. To turn On an output, set the variable OUTn to 0; to turn it Off, set to 1. For example, if you set OUT6 to 0 in your program, output 6 is active (low), displayed as OUT6 = 0. If you program the predefined variable PREDEF.OUT = 1, output 12 (J8-15) will be active (low) whenever the motor is moving.
OUT 2	J9-12	
OUT 3	J9-13	
OUT 4	J9-14	
OUT 5	J9-15	
OUT 6	J9-16	
OUT 7	J8-10	
OUT 8	J8-11	
OUT 9	J8-12	
OUT 10	J8-13	
OUT 11	J8-14	
OUT 12	J8-15	

Input table

The following table lists the discrete inputs on connectors J8 and J9.

Input Signal	Pin Number	Explanation
INP1	J9-2	Inputs 1 to 9 are general purpose inputs. For example, if INP6 is connected to I/O Return (J9-7), then $INP6 = 0$. You can use inputs to signal events, display messages, go to other programming lines, and so on.
INP2	J9-3	
INP3	J9-4	
INP4	J9-5	
INP5	J9-6	
INP6	J9-7	
INP7	J9-8	
INP8	J9-9	
INP9	J8-1	
INP10	J8-2	Note: <i>Inputs 10 to 15 can be programmed for specific functions. If these inputs are not pre-defined, they act as general purpose inputs. The factory default settings for these inputs are pre-defined, but they can be used as general purpose inputs by setting $PREDEF.INPn$ equal to 0. Functionality of the pre-defined inputs is given below.</i>
INP11	J8-3	
INP12	J8-4	
INP13	J8-5	
INP14	J8-6	
INP15	J8-7	
INP16	J8-8	

Functionality of the pre-defined inputs is given below.

Input or Output Signal	Pin Number	Explanation
Input 10 (Limit +, cw) Input 11 (Limit -, ccw)	J8-2 J8-3	These inputs limit rotation direction. To set: Limit+ (clockwise), program PREDEF.INP10 = 1 Limit -(counter-clockwise), program PREDEF.INP11 = 1
Input 12 (Start)	J8-4	This input starts motor motion using the GO statement, or starts the program using the RUN command. Activate this input by programming PREDEF. INP12 = 1. Change the value of RMT.START for other options.
Input 13 (Stop)	J8-5	This input stops program execution. Any motion in progress is stopped immediately. Activate this input by programming PREDEF.INP13 = 1. Note: <i>DO NOT use Input 13 for an emergency stop to prevent personal injury. Use a hard-wired switch connected to the power source for an emergency stop.</i>
Input 14 (Jog+, cw) Input 15 (Jog-, ccw)	J8-6 J8-7	These inputs control rotation direction and speed. This function is useful for testing because it only requires an enable signal for automatic motor running; a program is not needed. To set: Jog +, program PREDEF.INP14 = 1 Jog -, program PREDEF.INP15 = 1 Note: <i>Jog inputs will not initiate jogging if a program is running.</i>
Input 16 (Mechanical home switch)	J8-8	This input determines the location of mechanical home. Activate this input by programming SEEK.HOME after connecting a mechanical home switch to the input.

**Functionality
table (cont'd)**

Input or Output Signal	Pin Number	Explanation
No connect	J9-1, J8-17	These pins are not used.
I/O Return	J9-10, J9-17, J8-9, J8-16	These pins provide the ground for the input and output signals.

**Mating
connector**

The J8 and J9 discrete I/O cables are for a PCD 17-pin screw mating connector. The connectors are type ELFP17110.

Note: *Connector kits are available as an accessory.*

**Cable
requirements**

Use 22- to 14-gauge wire for the cabling.



CAUTION

To avoid ground loops, connect ground shield to user interface only.

Procedure

Connect discrete devices to the 6445 as follows:

1. Refer to the table and connector figure for the desired connections to your discrete devices. Select an I/O RTN for the return to ground for each device. For connection to input or output differential drivers, refer to the following sections.
2. Strip the wires to 0.27 inch (7 mm).
3. Attach the wires to the connector as indicated in the cabling diagram.

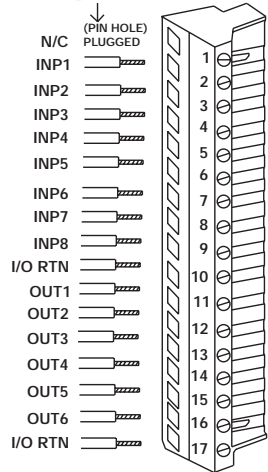
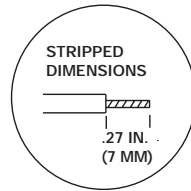
Note: *Make sure the screws on the PCD connector are tightened down firmly on the wiring.*



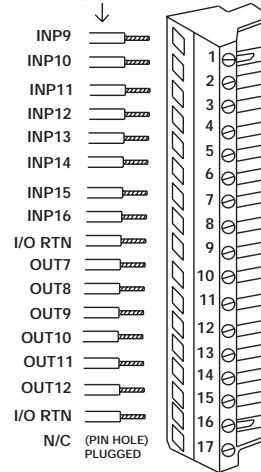
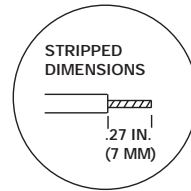
CAUTION

Do not pre-tin (solder) the tips of the cables going into the PCD connector. This can result in a loose connection.

4. Plug the connector firmly into the 6445.

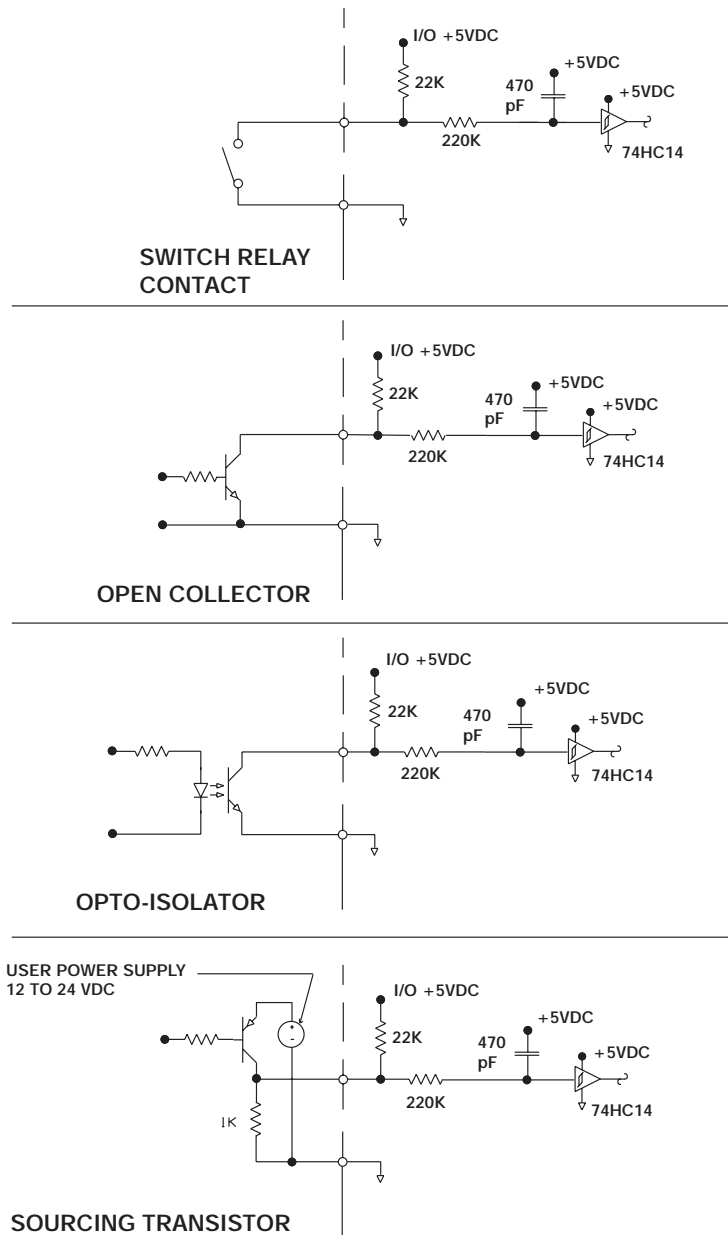


J9 DISCRETE I/O

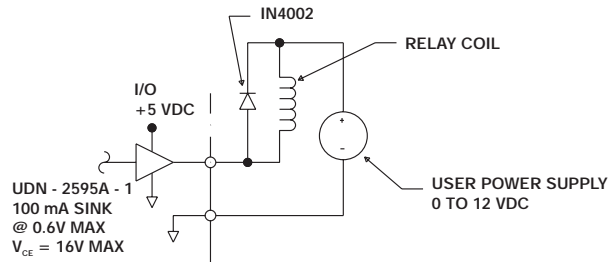


J8 DISCRETE I/O

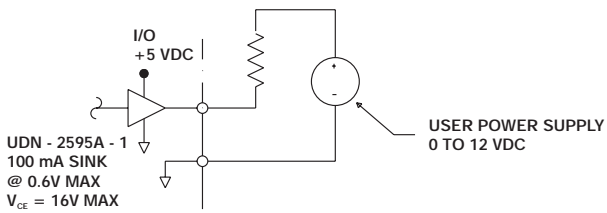
Driving the discrete inputs



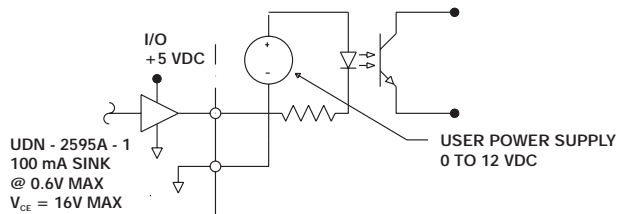
Output differential wiring



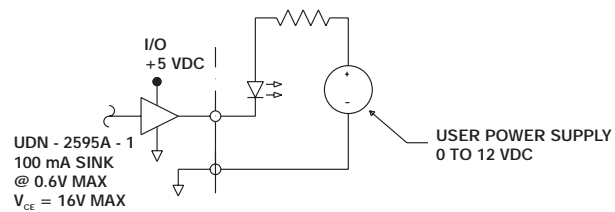
RELAY LOAD



RESISTIVE LOAD



OPTO-ISOLATOR LOAD



LED INDICATOR LOAD

2.5.6 J11 Encoder/Step and Direction Input Connection

Introduction Connector J11 accepts encoder quadrature inputs for A, \bar{A} , B, \bar{B} , Z and \bar{Z} which can be used for electronic gearing, encoder position verification, and stall detection.

Alternatively, a program variable can be set to switch the encoder inputs to external step and direction inputs. These converted inputs are DIR, \bar{DIR} , STEP, and \bar{STEP} .

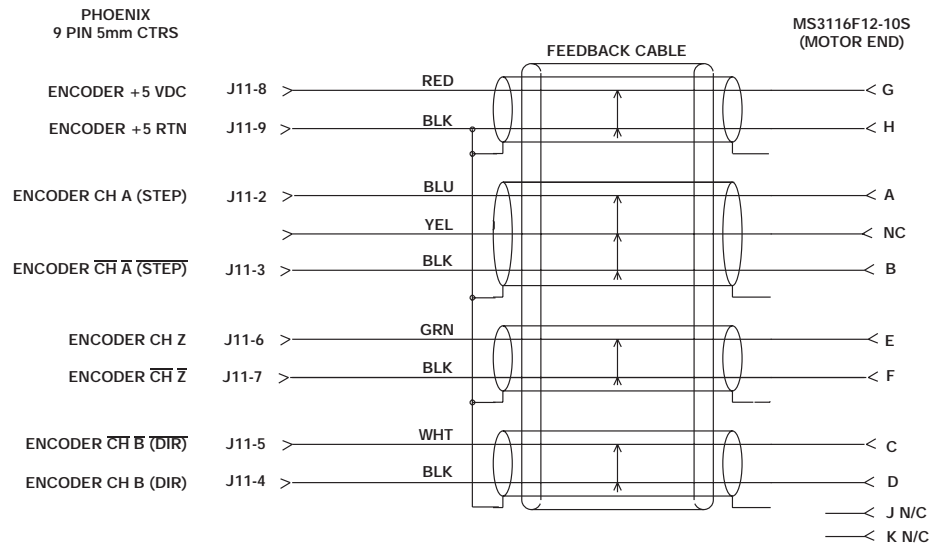
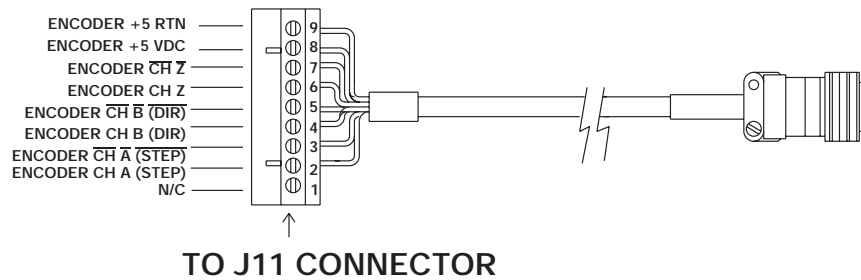
Encoder requirement The encoder must provide quadrature differential, line driver outputs. The receiver IC is an SM75175.

Input table The following table lists the inputs on connector J11:

Input	Pin Number	Explanation
No connect	J11-1	This pin is not used.
Channel A and \bar{A}	J11-2 and J11-3	For the A and \bar{A} quadrature encoder inputs.
Channel B and \bar{B}	J11-4 and J11-5	For the B and \bar{B} quadrature encoder inputs.
Channel Z and \bar{Z}	J11-6 and J11-7	For the Z and \bar{Z} quadrature inputs.
+ 5 V dc	J11-8	To provide power for the encoder. The maximum allowable load on this pin must be an amount that, when added to the load on pins J7-4 and J10-7, totals to less than 450 mA.
+5 V return	J11-9	To provide 5 volt ground. Note: <i>If using external power, you must connect the power supply ground here.</i>
Step and \bar{step}	J11-2 and J11-3	Alternative input used with STEP.DIR.INPUT = 1 to input step signals for external control.
Direction and $\bar{direction}$	J11-4 and J11-5	Alternative input used with STEP.DIR.INPUT = 1 to input direction signals for external control.

Pacific Scientific cable diagram

If the encoder cable is purchased from Pacific Scientific, install as follows. The Pacific Scientific order number is SEC-xxx, where "xxx" is the length in one-foot increments. For example, SEC-050 is a cable 50 feet long. This cable connects the 6445 to the encoders on Pacific Scientific series E and H system stepper motors.



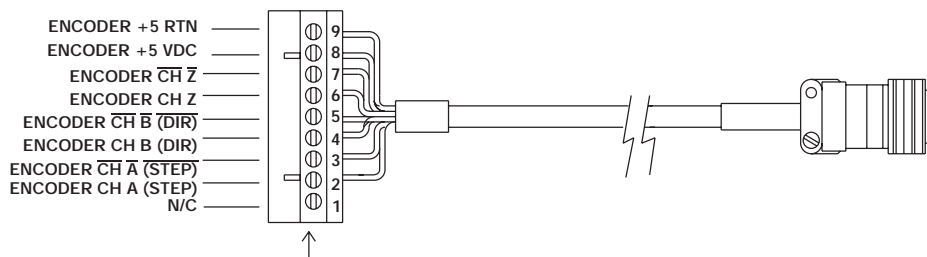
SEC - XXX

NOTE:

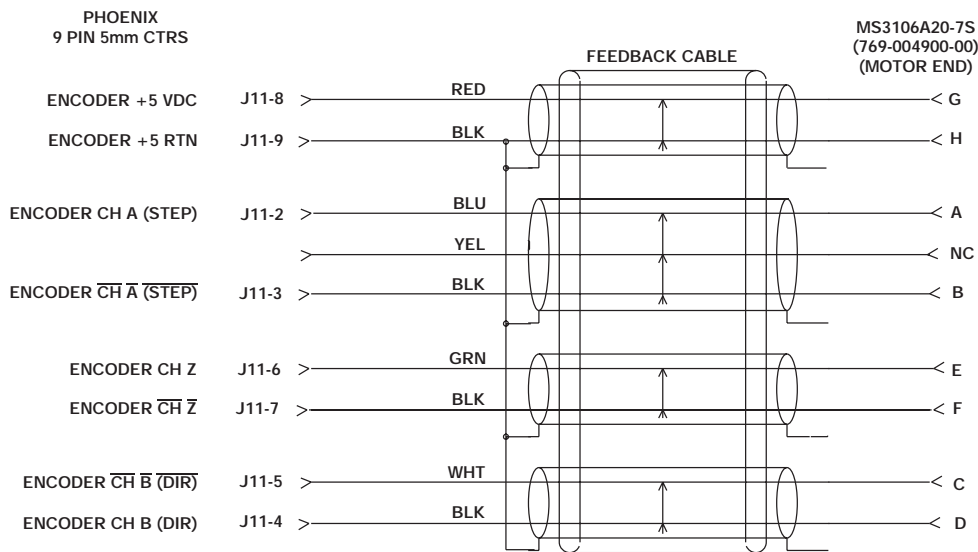
1. INDIVIDUALLY INSULATE SHIELD DRAIN AT MOTOR END.
2. INDIVIDUALLY INSULATE UNUSE WIRE AT BOTH ENDS.

Pacific Scientific cable diagram

This cable connects the 6445 to the encoders on Pacific Scientific K and N series system stepper motors.



TO J11 CONNECTOR



SEC - XXX - KN

NOTE:

1. INDIVIDUALLY INSULATE SHIELD DRAIN AT MOTOR END.
2. INDIVIDUALLY INSULATE UNUSE WIRE AT BOTH ENDS.

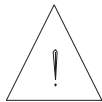
Mating connector

The J11 external I/O cables are for a PCD 9-pin screw mating connector. The connector is type ELFP09110.

Note: *Connector kits are available as an accessory.*

Cable requirements

Use 22- to 14-gauge wire for the cabling.



CAUTION

To avoid ground loops, connect ground shield to user interface only.

Procedure

Connect the encoder or step and direction inputs to the 6445 as follows:

1. Refer to the table and connector figure for the desired input connections. Connect the +5 RTN if using the +5 V dc for the encoder.
2. Strip the wires to 0.27 inch (7 mm).
3. Attach the wires to the connector as indicated in the cabling diagram.

Note: *Make sure the screws on the PCD connector are tightened down firmly on the wiring.*

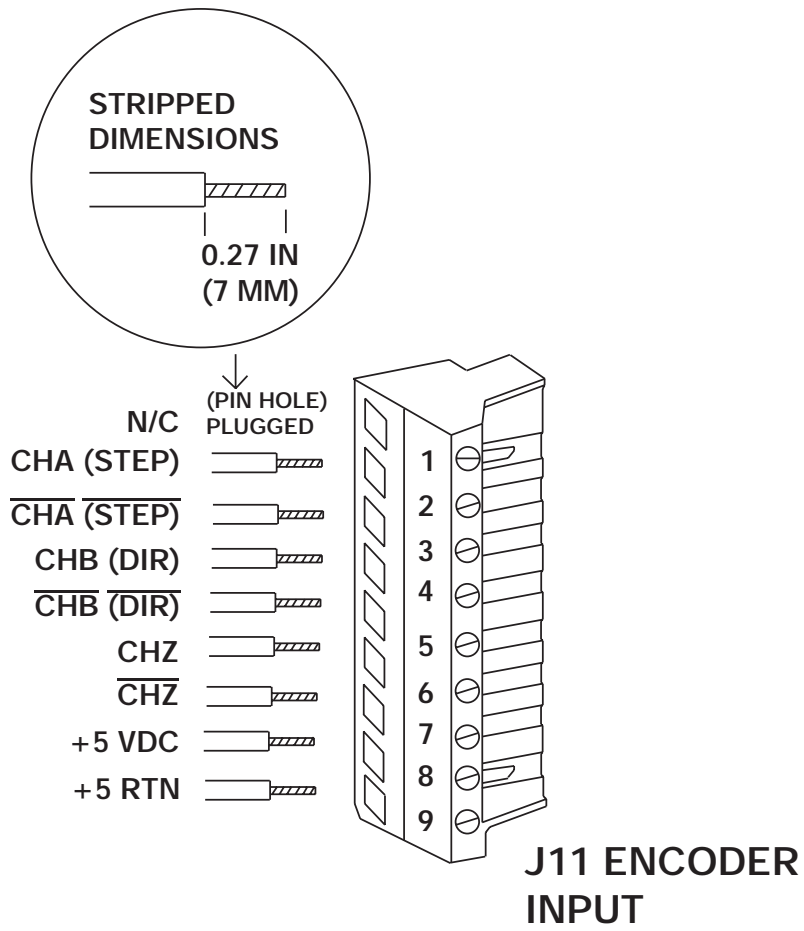


CAUTION

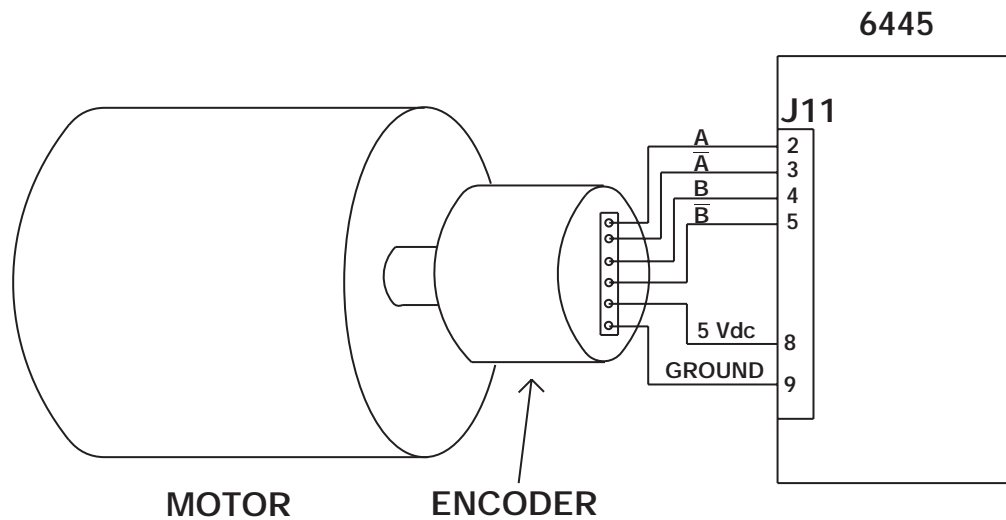
Do not pre-tin (solder) the tips of the cables going into the PCD connector. This can result in a loose connection.

4. Plug the connector firmly into the 6445.

Cabling
diagram



Typical encoder connection



2.5.7 J10 Step and Direction Output Connection

Introduction

Connector J10 outputs step and direction pulses so that external devices can follow step and direction from the 6445. Using these outputs you may control up to two 6445 or 6410 drives. The enable input and the fault outputs for the 6445 are also located on J10.

Note: *The Step and Direction outputs are active if the controller is enabled and motion is being commanded.*

Output table

The following table lists the outputs on connector J10:

Output	Pin Number	Explanation
<u>Step out and step out</u>	J10-1 and J10-2	Outputs step signals for controlling external devices. Sinks up to 24 mA.
<u>Direction out and direction out</u>	J10-3 and J10-4	Outputs direction signals for controlling external devices. Sinks up to 24 mA.
Enable	J10-5	Input to enable the 6445 for operation. Connect this input to the I/O Return to enable the 6445.
I/O return	J10-6	Provides ground for the enable input and 5 V output.
+5 V dc	J10-7	Provides power for an external device. The maximum allowable load on this pin must be an amount that, when added to the load on pins J7-4 and J11-8, totals to less than 450 mA.
Fault out	J10-8	This open collector NPN transistor output is ON (low) if no fault and OFF (high) if fault.
No connect	J10-9	This pin is not used.

Mating connector

The J10 discrete output cables are for a Phoenix 9-pin screw mating connector. The connector, supplied with the unit, is type MSTB 1.5/9-ST 9-pin. The Phoenix order number is 17-54-58-8.

Cable requirements

Use 22- to 14-gauge wire for the cabling. Obtain cable for output pairs (refer to table) twisted at about 3 to 4 turns per inch (1 to 1.5 turns per centimeter). As an option, the cable may be shielded to reduce noise pickup.

**CAUTION**

To avoid ground loops, connect ground shield to user interface only.

Procedure

Connect the step and direction outputs to the 6445 as follows:

1. Refer to the table and connector figure for the desired input connections. Use the I/O RTN with the enable and if using the +5 V dc for a device.
2. Strip the wires to 0.27 inch (7 mm).
3. Attach the wires to the connector as indicated in the cabling diagram.

Note: Make sure the screws on the Phoenix connector are tightened down firmly on the wiring.

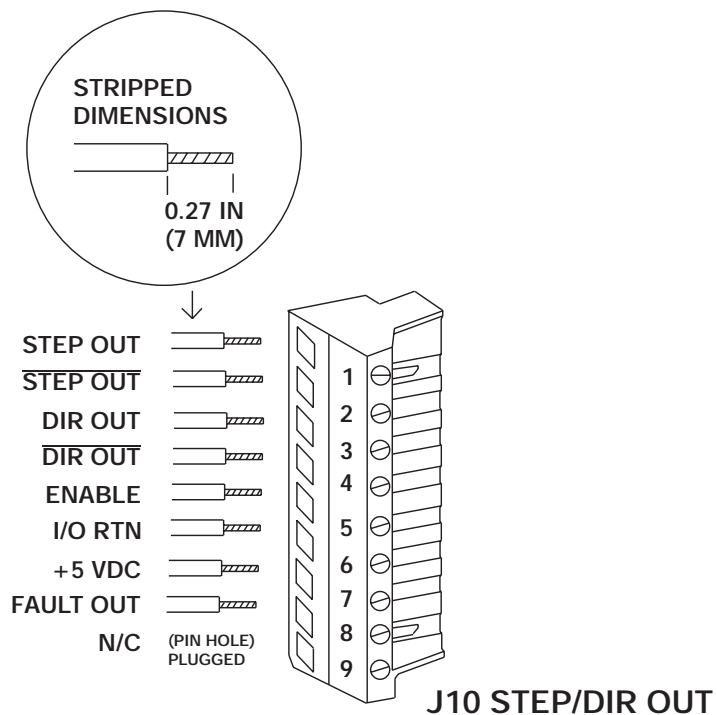


CAUTION

Do not pre-tin (solder) the tips of the cables going into the Phoenix connector. This can result in a loose connection.

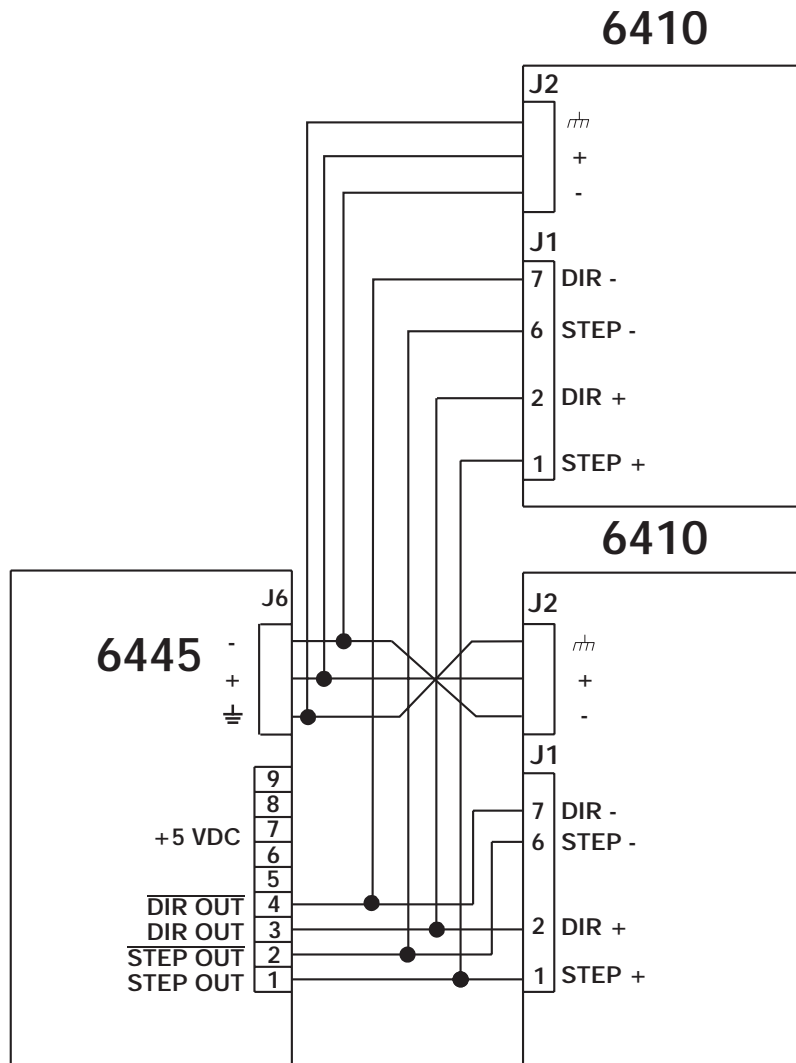
4. Plug the connector firmly into the 6445.

Cabling diagram



Step and direction inputs for other drives

Pin outputs for other units are shown as follows:



NOTE: THE 6445 STEP/DIR OUTPUTS CAN DRIVE TWO 6410 STEP/DIR INPUTS MAXIMUM

3 Powering Up the 6445 Microstep Indexer/Drive

In this chapter This chapter explains how to power up the 6445 after installation. Topics are:

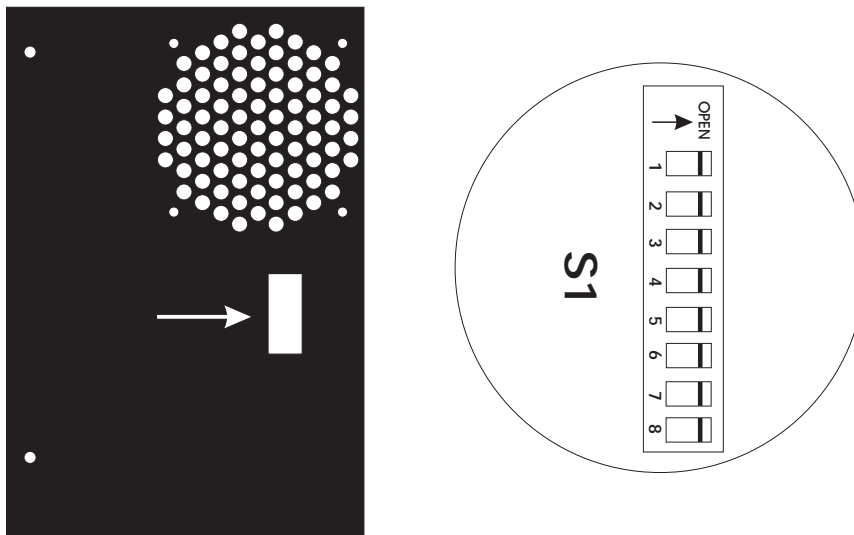
- Setting up functions using switch S1
- Setting up serial address using switch S2
- AC switch (SW1) settings
- Testing the installation

This section is intended to familiarize the user with the hardware adjustments and settings required to power up and operate the 6445 indexer/drive.

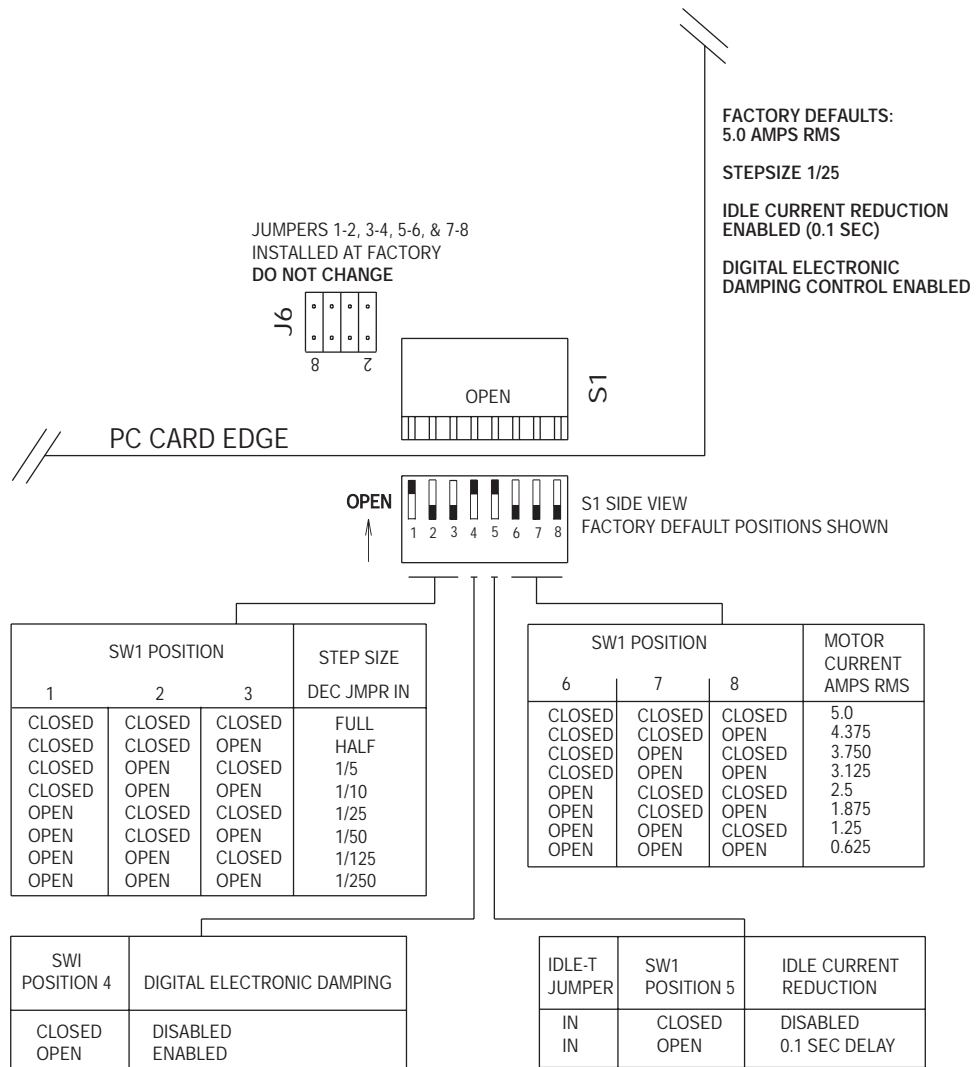
3.1 Setting Switch S1

Introduction DIP Switch S1 sets step size, digital electronic damping control, idle current reduction, and motor current settings.

Location S1 is accessed through the top cover of the 6445 as shown:



Default settings The 6445 leaves the factory with the following settings:



3.1.1 Step Size

Definition

The step size sets the amount of rotation per input step. Eight step sizes are available using DIP switch S1 positions 1-3 as shown. For all Pacific Scientific stepper motors and all 1.8° step motors, step size can be converted to steps per rotation using the following table:

Full	200
Half	400
1/5	1,000
1/10	2,000
1/25	5,000
1/50	10,000
1/125	25,000
1/250	50,000

Benefits

Selecting a microstep size of 1/4 or smaller results in:

- higher resolution
- smoother low speed operation
- ability to operate in low-speed resonance regions

Note: *Step sizes 1/10, 1/50 and 1/250 are not available in StepperBASIC. Setting DIP switch S1 to these positions will allow the unit to function properly, however speed and distance traveled will be inconsistent due to incompatible settings.*

3.1.2 Digital Electronic Damping Control

Definition Mid-speed instability and the resulting loss of torque occurs in any step motor/drive system due to the motor back EMF modulating the motor winding currents at certain speeds. Mid-speed instability can be explained as a region of potential instability that occurs as a result of the electronic, magnetic, and mechanical characteristics of any stepping motor system. The circuitry used to control this phenomenon does so by advancing or delaying the switching of the output current with respect to the incoming pulse train. This should be taken into account if the user is attempting to employ pulse placement techniques.

Enable the digital electronic damping function by placing DIP switch S1 position 4 in the open position as shown. This is the default position and should be used for most applications if your application is affected by loss of torque at mid-range speeds. If pulse placement techniques are being used, disable the digital electronic damping function by placing DIP switch S1 position 4 in the open position.

Benefit This feature controls torque loss at mid-range speeds. When enabled, the motor maintains torque at mid-range operation, provided the torque load does not exceed motor torque ratings.

3.1.3 Idle Current Reduction

Definition The Idle Current Reduction (ICR) function reduces the phase current at times when no motion is commanded. Motor current is reduced when no step commands are received for a given time. This time is set at the factory to be 0.1 seconds. Current to both motor windings is reduced by one-half.

The ICR function can be enabled/disabled using DIP switch S1 position 5. ICR is disabled when DIP Switch S1 position 5 is in the closed position and enabled with a delay of 0.1 second (current is reduced by 50% when no step command is received for 0.1 second) when the switch is open.

Note: *When ICR is active, both the holding torque generated by the motor and the motor stiffness around the holding position are reduced by approximately 50%.*

Benefits

The ICR function:

- Reduces motor and drive heating during stand-by operation
- Reduces 6445 power dissipation

3.1.4 Setting Motor Current

Motor current can be set using DIP Switch S1 positions 6, 7, and 8 as shown. Current should be compatible with motor current ratings.

3.2 Setting Up the Serial Address Using Switch S2

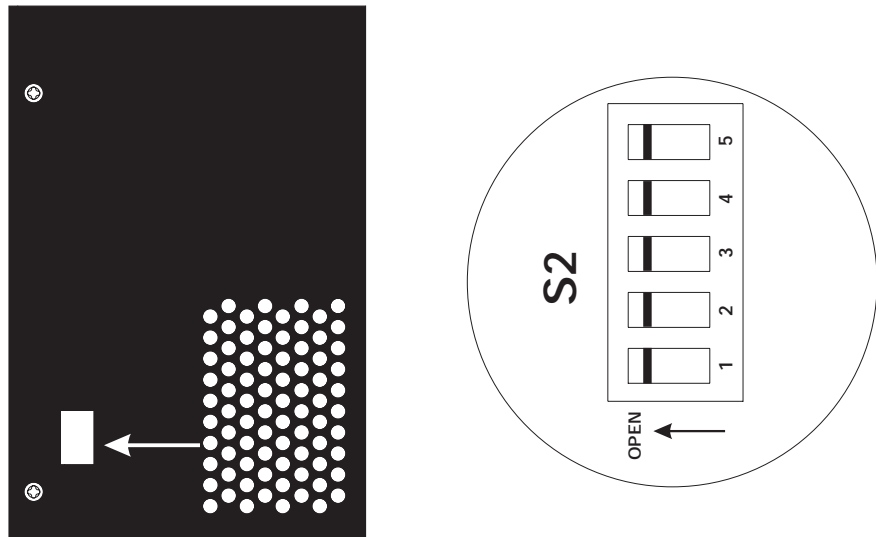
Definition

This switch:

- determines if you are using RS-232 or RS-422/RS-485 communications.
- sets the address required for each 6445 on the RS-422 or RS-485 bus.

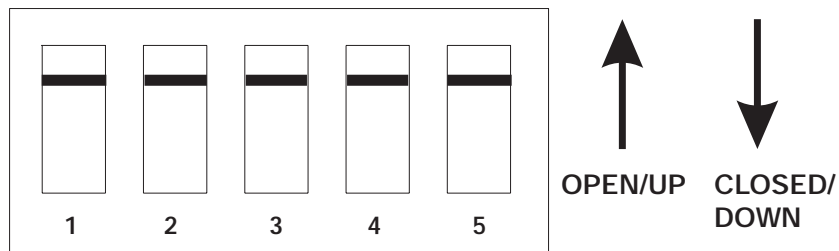
Location

S2 is accessed through the bottom cover of the 6445 as shown:



Procedure

The following diagram shows switch S2.



The switches are:

- ON in the closed/down position
- OFF in the open/up position

1. Remove power from the 6445.
2. Refer to the table to set the 6445 to the appropriate address.

Note: *Addresses 0 to 30 are for RS-422/485 operation. Address 31 is for RS-232 operation.*

1. *Each 6445 sub-system connected to the multidrop master must have a unique serial address. Addresses 0 to 30 are for RS-422/RS-485 operation.*
2. *RS-232 requires that all switches are in the up position (address 31).*

Address	1	2	3	4	5	Address	1	2	3	4	5
0	On	On	On	On	On	16	On	On	On	On	Off
1	Off	On	On	On	On	17	Off	On	On	On	Off
2	On	Off	On	On	On	18	On	Off	On	On	Off
3	Off	Off	On	On	On	19	Off	Off	On	On	Off
4	On	On	Off	On	On	20	On	On	Off	On	Off
5	Off	On	Off	On	On	21	Off	On	Off	On	Off
6	On	Off	Off	On	On	22	On	Off	Off	On	Off
7	Off	Off	Off	On	On	23	Off	Off	Off	On	Off
8	On	On	On	Off	On	24	On	On	On	Off	Off
9	Off	On	On	Off	On	25	Off	On	On	Off	Off
10	On	Off	On	Off	On	26	On	Off	On	Off	Off
11	Off	Off	On	Off	On	27	Off	Off	On	Off	Off
12	On	On	Off	Off	On	28	On	On	Off	Off	Off
13	Off	On	Off	Off	On	29	Off	On	Off	Off	Off
14	On	Off	Off	Off	On	30	On	Off	Off	Off	Off
15	Off	Off	Off	Off	On	31*	Off	Off	Off	Off	Off

* For RS-232 operation (factory default)

4. Reconnect power to the 6445.
5. Repeat steps 1 through 4 for other 6445 units on the bus. Make sure to give the other units unique addresses.

3.3 AC Switch Settings

Introduction

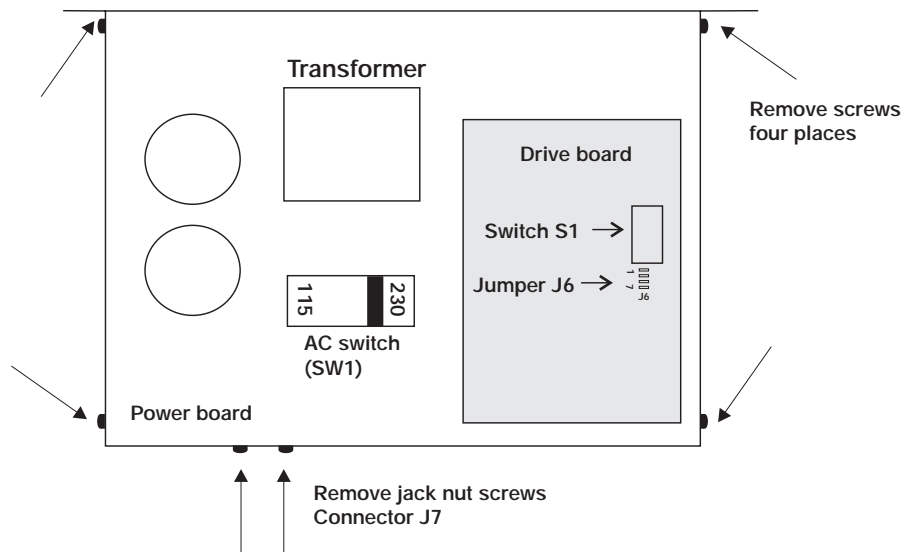
The AC Switch (SW1) on the power board allows the user to select 120 **OR** 240 Vac.



Warning!

Connecting 240 (230) Vac with switch in 120 (115) Vac position will permanently damage the drive.

Location of AC Switch



Note: *The AC Switch is preset at the factory in the 230 Vac position.*

Accessing AC Switch

The AC switch settings are accessible by opening the cover. First, **make certain the power connections have been removed.** Rest the unit on its side as shown. Unscrew four screws and two jack screws as shown in diagram to remove cover.

Cautiously remove cover, being careful not to put a strain on the ribbon cable or power supply cable. Select appropriate setting. Replace cover and mounting screws. **DO NOT** over tighten mounting screws. (5.0 in-lbs max).

3.4 Testing the Installation

Background Perform the following test procedure to verify that the 6445 is installed properly, and that it was not damaged internally during shipment.

Configuration The installation test power-up procedure requires a motor and computer or terminal to test the basic functionality of the 6445. A computer or terminal is required for complete testing.

Procedure First, connect the computer or terminal by referring to Chapter 1 in the Programming Manual, "Setting up for Programming" (use the "Terminal Emulator" Mode for this test). Test your installation as follows:

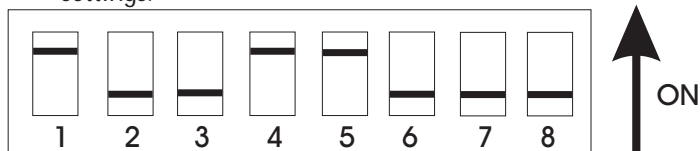
WARNING

Perform this initial power-up with the motor shaft disconnected from the load. Improper wiring or undiscovered shipping damage could result in undesired motor motion. Be prepared to remove power if excessive motion occurs.



Connections test

1. Check over all wiring and mounting and verify correct installation. Especially check the 120/240 Vac connections, the motor connections, and the grounding.
2. With the power Off, verify that the switch S1 settings are set as follows. The 6445 leaves the factory with these settings.



These settings enable the digital electronic damping, enable idle current reduction, set the step size to 1/25 step, and set 5 A rms motor current.

Signals test

1. Enable the 6445 (connect input pin 5 to pin 6 on J10).
2. Verify that the motor has holding torque by attempting to rotate the motor shaft. The energized motor shaft is either immovable or very resistant to rotation when the 6445 is enabled.
3. Jog the motor (connect input pin 7 to pin 9 on J8). The motor moves at the default jog speed.
4. Remove the jog input.
5. From the terminal or computer, type GO.VEL <enter> . This moves the motor at the default run speed.
6. Type DIR = 1 <enter>. This changes the default direction (if DIR = 0 was the initial setting).
Repeat Step 5. The motor should run in the reverse direction.
7. Continue exercising the unit, testing it in your application.

Getting help

If you need further help with your installation, contact Pacific Scientific at 978-988-9800 from 8 a.m. to 5 p.m. Eastern Standard Time, or contact your Pacific Scientific distributor.

4 Troubleshooting

Introduction The LEDs located on the front panel indicate unit status and are useful for troubleshooting. A table of the LEDs referencing the appropriate section for troubleshooting is located below.

Fault output The fault output is located on pin 8 of the J10 connector. This output is active when the unit is enabled and no fault condition is present.

LED Indicators

When this LED is On...	It signifies ...	Troubleshoot using section ...
POWER ON	Connection to 120/240 Vac power is within operational levels	4.1
FAULT	Either an external or internal short or internal power supply problem	4.2
PROCESSOR FAULT	Indexer circuitry determines drive is faulted.	4.3

Note: *If the LEDs are not affected by commands over the serial link, there may be a communications problem. See Section 4.4.*

4.1 POWER ON LED Not On - 6445 Does Not Power Up

Procedure Follow this procedure if the 6445 POWER ON LED will not light when power is applied:

SYMPTOM	CORRECTIVE ACTION
POWER ON LED is Off when power is applied.	Check 66 Vdc Out @ J6-1, J6-2. If voltage is within operational range, then it is an internal failure. If not, then check AC input is applied and within operational range.
	240 Vac applied and switch in 120 Vac position. Return to factory for service.
	Fuse F1 is blown. Replace fuse and retry.
	Internal failure. Return to factory for service.

Fuse replacement

If an open fuse is suspected, replace the fuse as follows. Usually a fuse failure indicates a problem requiring factory repair.

1. Remove power and wait five minutes to allow the charge on the capacitors to dissipate.

WARNING

Do not operate the unit with the cover removed. Contact with energized components causes severe shock or burn.

2. Remove the 4 phillips-head screws located on the sides of the 6445.
3. Using a nutdriver, remove the 2 jacknut screws on J7.
4. Remove the cover.

CAUTION

Be careful not to put a strain on the ribbon cable when removing the cover.

5. Check the fuse F1 located by the J1 120/240 Vac connector. Replace open fuse with a 5 A, 250 Vac SLO-BLO fuse.
6. Replace the cover.



4.2 FAULT LED On - 6445 Disable Fault

Procedure Follow this procedure if the 6445 FAULT LED lights during operation:

SYMPTOM	POSSIBLE CAUSE	ACTION
Motor does not turn, LEDs ON (green and/or red)	120/240 Vac switch in 240 position, input from 120 Vac	Turn power off, correct switch position.
	AC Input line low	Increase Input AC to spec.
	Dead short or overload across external 66 Vdc output connector (J6).	Remove short or reduce load.
	Over temperature	Check ambient temperature or internal fan malfunction/blockage.
	Bad load connection	Check load connection. Check J6 Vdc output with a voltmeter and ensure output voltage is 66V \pm 3V. 1. If output voltage > 70 Vdc and < 78 Vdc add a load and ensure Vdc is \approx 66Vdc. 2. If output voltage > 78 Vdc, return 6445 to factory for service.
Internal failure.	Return to factory for service.	

Table (cont'd)

SYMPTOM	POSSIBLE CAUSE	ACTION
Motor does not turn, LEDs OFF	Check AC input	Use proper input.
	240 Vac applied and switch in 120 Vac position.	Return to factory for service.
Motor runs for a while and stops, both LEDs come on	Over temperature.	Reduce load. Check for excessive ambient temperature. Check for internal fan malfunction/blockage.
Motor turns on and off on its own (although no such commands are given) and red LED keeps flashing	120 Vac applied and switch in 240 Vac position	Correct switch position.
	Over load.	Reduce load.
	AC input line low.	Check input AC line voltage for low line.
Red LED turns ON when motor tries to accelerate, motor does not turn	Load is too high, AND/OR Accel/decel are too high, AND/OR Run speed is too high.	Reduce the load, accel/decel and/or run speed.

Red LED Flashing, but NO FAULT

Note: *If the power supply is on the verge of an under-voltage fault, you will notice the following during normal operation.*

SYMPTOM	POSSIBLE CAUSE
Motor runs fine, red LED flashes	Load is too high, AND/OR Accel/decel are too high, AND/OR Run speed is too high.

Although no action is required, the above symptoms may be eliminated by reducing the load, accel/decel and/or run speed.

4.3 PROCESSOR FAULT LED On

Procedure Follow this procedure if the 6445 PROCESSOR FAULT LED lights during operation:

SYMPTOM	POSSIBLE CAUSE	CORRECTIVE ACTION
Drive faults when enabled.	Motor output overcurrent.	Disconnect the AC power. Disconnect motor cable and cycle the J1 120/240 Vac 60/50 Hz power Off and On. If the PROCESSOR FAULT LED is OFF, check motor cable and motor for shorts across the windings or between the windings and the motor case.
Drive faults while decelerating.	Drive internal bus over voltage.	Measure drive internal bus voltage at J6-1 and J6-2 (66 Vdc Out) with a storage oscilloscope during deceleration. If regeneration causes the bus voltage to exceed 84 V, verify the system load inertia to insure that the 66 Vdc out limit is never exceeded.
PROCESSOR FAULT LED on when power is applied.	Indexer external +5V logic supply out of tolerance	Measure the +5 V Logic Supply at J7-4 to J7-1 and J10-7 to J10-6 within +5V ($\pm 5\%$). Note: <i>The total 5 Vdc current from pins J7-4, J11-8 and J10-7 must be less than 450 mA.</i>
	Indexer processor watchdog timer failed.	Internal Failure. Return to factory for service.

4.4 Communications Interface Fault

Procedure Follow this procedure if the terminal does not communicate with the indexer/drive:

SYMPTOM	CORRECTIVE ACTION
6445 will not respond to commands over serial link	Verify that baud rate and COM port are set correctly in PacCom.
	Check that terminal transmit and receive lines from computer go to receive and transmit lines on the 6445. (See Section 2.5.4)
	Verify that serial cable is functioning properly. 1. Disconnect serial cable. 2. Short pins 2 & 3 (See Section 2.5.4) 3. Type a character on keyboard. 4. Verify that character entered echoes back to screen.
	Verify that serial cable is connected to J7. Note: <i>J12 is not used on the 6445.</i>
	Internal Failure. Return to factory for service.
6445 will not respond during RS-422/ RS-485 operation	Verify that each unit has a unique serial address using switch S2. (See Section 3.2)

**6445
defective**

If you cannot correct the problem, return the indexer/drive to Pacific Scientific for replacement.

**Return
procedure**

1. Call Pacific Scientific at (815) 226-3100 from 8:00 a.m. to 5:00 p.m. Eastern Standard Time to get a Returned Materials Authorization Number (RMA#).

Note: *Do not attempt to return the drive, motor or any other equipment without a valid RMA#. Returns received without a valid RMA# are not accepted and are returned to the sender.*

2. Pack the drive in its original shipping carton. Pacific Scientific is not responsible or liable for damage resulting from improper packaging or shipment.
3. Ship the 6445 to:

Pacific Scientific

110 Fordham Road

Wilmington, MA 01887

Attn: Repair Department, RMA# _____

Note: *Do not ship Pacific Scientific motors to the above address. The correct address for motor returns is:*

Pacific Scientific

4301 Kishwaukee Street

Rockford, IL 61105

Attn: Motor Repair Department, RMA# _____

Shipment of your 6445 or motor to Pacific Scientific constitutes authorization to repair the unit. Refer to Pacific Scientific's repair policy for standard repair charges. Your unit will be repaired and return-shipped via UPS Ground delivery. If another means of shipping is desired, please specify this at the time of receiving an RMA#.

Appendix A - Specifications

Electrical

Input voltage 120 Vac (+10%, -15%) 60 Hz

OR

240 Vac (+10%, -15%) single phase, 50 Hz

Input current 5.0 A rms maximum

Fuse 5 A Slo-Blo 250 Vac

Drive circuit Two-phase bipolar, chopper current regulated

Internal bus voltage 66 Vdc out (J6) nominal

Rated current 5.0 A rms (full step)
3.5 A rms (microstepping)

Step size	<u>Switch selectable</u>	<u>Steps/motor (1.8° stepper motor)</u>
	Full	200
	1/2	400
	1/5	1,000
	1/10	2,000
	1/25	5,000
	1/50	10,000
	1/125	25,000
	1/250	50,000

Step input-output lag	<ol style="list-style-type: none"> 1. With digital electronic damping control enabled and with step frequencies <u>less than 500 full steps per second</u>, input-to-output lag is less than 500 microseconds. At step frequencies <u>greater than 500 full steps per second</u>, input-to-output lag is less than 270 degrees of the input step pulse period. 2. With digital electronic damping control disabled, input-to-output lag is less than 10 microseconds for all step frequencies.
------------------------------	--

Chopper frequency	20 KHz, nominal (inaudible)
--------------------------	-----------------------------



Maximum pulse rate	<u>Switch selectable:</u>	<u>Pulses/second:</u>
	full step	40,000 pulses/second
	1/2 step	80,000 pulses/second
	1/5	100,000 pulses/second
	1/10	100,000 pulses/second
	1/25	500,000 pulses/second
	1/50	500,000 pulses/second
	1/125	500,000 pulses/second
	1/250	500,000 pulses/second

Minimum ramp time	1. With digital electronic damping control <u>enabled</u> - 50 milliseconds to 20,000 full steps/sec.
	2. With digital electronic damping control <u>disabled</u> - no minimum.

Control input	Enable
----------------------	--------

Control outputs	Fault: Open collector NPN, 100 mA sink maximum @ 16 Vdc V_{ce} (off) maximum
	+5Vdc: External +5Vdc output @ 450 mA maximum.

Programmable inputs	16 general inputs to be operated with open collector type logic interfaces.
Programmable outputs	12 discrete open collector outputs under software control. Each output sinks 100mA maximum @ 16 Vdc V_{ce} (off) maximum.
Encoder Input/Ouptut	To be operated with quadrature type encoder signals, differential line driver. This input can be configured by software as a step and direction input, 720 KHz maximum (220 nsec input LPF).
Step/Dir Out	Step out, $\overline{\text{Step out}}$, Dir out, $\overline{\text{Dir out}}$ To be used for controlling external devices. Each output sinks up to 24 mA maximum @ 5.25 Vdc V_{ce} (off) maximum.
Environmental	
Operating temperature	0 to 50 degrees C at full rated current
Storage temperature	-40 degrees to 70 degrees C
Humidity	10 to 90%, non-condensing
Altitude	5,000 feet (1500 meters)

Mechanical

Power dissipation

For an estimate of the power dissipation for use in cabinet cooling requirements, use the values shown:

For an RMS current of (amps):	Use a value of (watts):
5.0	50
2.5	20

Dimensions

Refer to section 2.4

Weight

6 lbs.

Appendix B - Order Number & Ordering Information

Background This appendix lists the 6445 part numbers and gives information on ordering.

6445 part
number table

Part	Order Number	Comment
Microstep Indexer/Drive	6445	5.0 A RMS
Connector kit	CK6445	PCD 3-, 5-, 9- and 17-pin connectors, and 9-pin D connector with housing.
Installation Manual	MA6445-HW	
Programming Manual	MA6445-SW	
Motor cable	SPC-xxx-6410 SPC-xxx-6410-KN *	xxx represents length in feet; for example, SPC-005 is a cable 5 feet long. For lengths over 50 feet, contact Pacific Scientific. The connectors are MS on the motor end and PCD on the drive end to connect Pacific Scientific motors.
Encoder Cable	SEC-xxx SEC-xxx-KN*	xxx represents length in feet; for example, SEC-010 is a cable 10 feet long. For cable lengths over 50 feet, contact Pacific Scientific. The connectors are MS.

***Note:** Cables for K and N series motors.



How to order	Contact Pacific Scientific to order these parts.
Call	815-226-3100 from 8am to 5pm Eastern Standard Time.
Fax	815-226-3048
Write	Pacific Scientific 4301 Kishwaukee Street Rockford, IL 61105

Appendix C - Series/Parallel Connections

Introduction

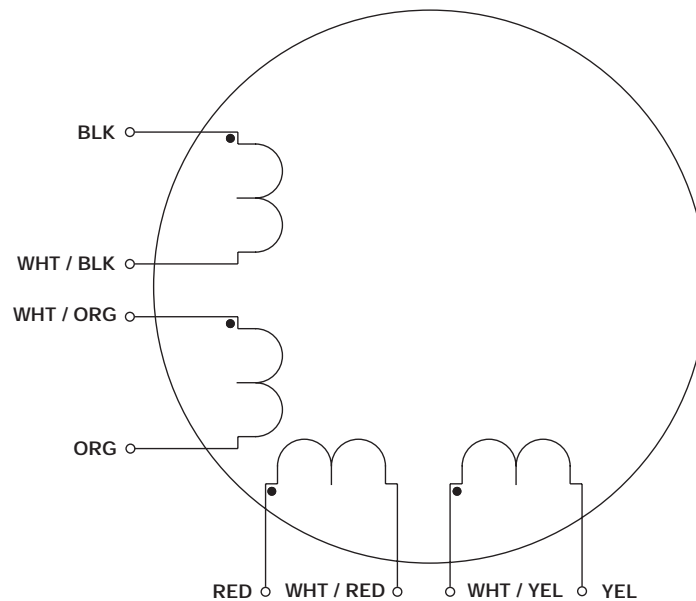
Several motor connections are possible when using a bipolar drive.

- 8-lead motor
- 6-lead motor
- 4-lead motor

The various connection schemes produce different torque/speed characteristics. They also affect the current rating in the motor.

8-lead motor

The 8-lead motor is the most versatile configuration. It can be connected by the user in either an 8-lead, 4-lead (series or parallel) or 6-lead configuration.



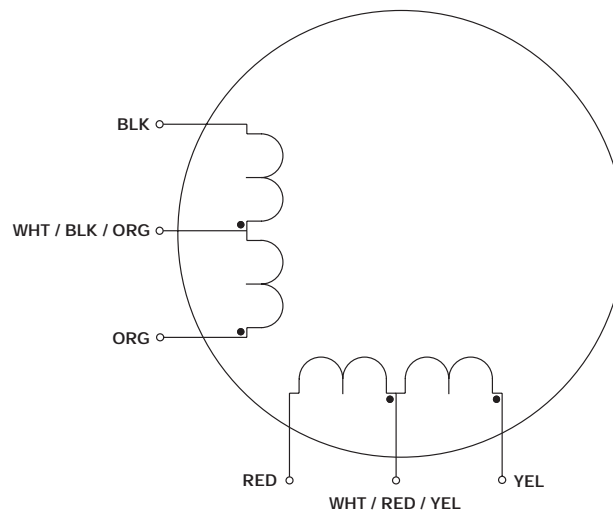
**Connection
table**

Refer to the table below for detailed connection information.

Connection	Terminal #	Lead Color	Drive Connection
4-lead bipolar series	1	Black (Blk)	A
	3	Orange (Org)	\bar{A}
	2	Red	B
	4	Yellow (Yel)	\bar{B}
	6 & 5	Wht/Blk & Wht/Org	none
	7 & 8	Wht/Red & Wht/Yel	none
4-lead bipolar parallel	1 & 5	Blk & Wht/Org	A
	3 & 6	Org & Wht/Blk	\bar{A}
	2 & 7	Red & Wht/Yel	B
	4 & 8	Yel & Wht/Red	\bar{B}
6-lead unipolar	1	Black (Blk)	A
	3	Orange (Org)	\bar{A}
	2	Red	B
	4	Yellow (Yel)	\bar{B}
	6 & 5	Wht/Blk & Wht/Org	none
	7 & 8	Wht/Red & Wht/Yel	none

6-lead motor

The 6-lead motor is normally used with unipolar drives. In some cases, the 6-lead motor can be used in a 4-lead series configuration for use with bipolar drives.



Connection table

Refer to the table below for detailed connection information.

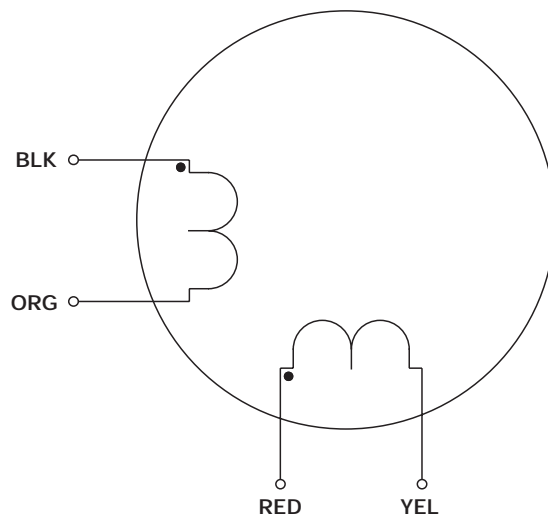
Connection	Terminal #	Lead Color	Drive Connection
6-lead unipolar	1	Black (Blk)	A
	3	Orange (Org)	\bar{A}
	2	Red	B
	4	Yellow (Yel)	\bar{B}
	5	Wht/Blk/Org	open
	6	Wht/Red/Yel	open

Connection	Terminal #	Lead Color	Drive Connection
4-lead bipolar series	1	Black (Blk)	A
	3	Orange (Org)	\bar{A}
	2	Red	B
	4	Yellow (Yel)	\bar{B}
	5	Wht/Blk/Org	None
	6	Wht/Red/Yel	None

Note: Terminals 7 and 8 are not used.

4-lead motor

The 4-lead motor is for use only with bipolar drives.



Connection table

Refer to the table below for detailed connection information.

Connection	Terminal #	Lead Color	Drive Connection
4-lead bipolar	1	Black (Blk)	A
	2	Orange (Org)	\bar{A}
	3	Red	B
	4	Yellow (Yel)	\bar{B}

Note: *Terminals 5, 6, 7 and 8 are not used.*

Winding Connections

Series

Connecting both halves in series results in the drive current flowing through twice as many turns compared with using one half-winding only. For identical currents, this doubles the “amp-turn” and produces a corresponding increase in torque. In practice, the torque increase is seldom 100% due to the non-linearity of the magnetic material. Equally, the same torque will be produced at half the drive current when the windings are in series.

Doubling the effective number of turns in the windings means that the inductance increases by a factor of four. This causes the torque to drop off much more rapidly as speed increases. As a result, the series mode is only useful at low speeds. The maximum shaft power obtainable in series is typically half that available in parallel using the same current setting on the drive.

Conversely, connecting the windings in series will double the total resistance and the current rating is reduced by a factor of 1.4. This provides a safe current of 3.5 amps for a 5.0 amp motor series.

Parallel	A winding that can be connected in parallel is either an 8-lead motor or 6-lead motor.
8-lead	<p>Connecting the two half-windings of an 8-lead motor in parallel allows the current to divide itself between the two coils. It does not change the effective number of turns and therefore the inductance remains the same. At a given drive current, the torque characteristics will be the same for the two half-windings in parallel as it is for one of the windings on its own.</p> <p>Connecting the windings of an 8-lead motor in parallel has the same effect as halving the total resistance. For the same power dissipation in the motor, the current may now be increased by 40%. Therefore, the 5 amp motor will accept 7 amps with the winding in parallel. This provides a significant increase in the available torque.</p>
6-lead	<p>“Parallel” in a 6-lead motor refers to the use of one half-winding only. The current rating of a stepper motor is determined by allowable temperature rise. Unless the motor manufacturer’s data states otherwise, the rating is a “unipolar” value and assumes both phases of the motor are energized simultaneously. Therefore, a current of 5 amps means that the motor will accept 5 amps flowing in each half-winding.</p>

Summary

As a general rule, parallel connection is preferred over the other options. It produces a flatter torque curve and greater shaft power. Series connection is useful when a high torque is required at low speeds. It allows the motor to produce full torque at low speeds from lower current drives.

Care should be taken to avoid overheating the motor using series connection since its current rating is lower in this mode. Series connection also carries a greater likelihood of resonance problems due to high torque produced in the low speed region.

Index

A

- AC Switch, 1-4,
 - location, 3-9
 - setting, 3-9
- Address settings, 3-6
- Air ventilation, 2-5
- Applications, 1-4

B

- Bipolar chopper drive, 1-2
- Bus capacitors, safety, 2-4

C

- Cabinet selection, 2-5
- Cable
 - J1, 2-10
 - J3, 2-12
 - J6, 2-18
 - J7, 2-21
 - J8/J9, 2-29
 - J10, 2-39
 - J11, 2-36
- Computer troubleshooting, 4-6
- Connections
 - diagram, 1-4, 2-9
 - testing, 3-10
- Connector
 - J1, 2-10
 - J3, 2-11 - 2-18
 - J6, 2-18

- J7, 2-20
- J8/J9, 2-26
- J10, 2-38
- J11, 2-33
- Current, 1-1

D

- Definition, general drive, 1-1
- Differential wiring
 - inputs, 2-31
 - outputs, 2-32
- Digital electronic damping, 1-3, 3-4
 - benefits, 3-4
 - definition, 3-4
- DIR variable, 3-3
- Direction
 - inputs, 2-33
 - outputs, 1-3
- Discrete I/O, 2-26
 - cable, 2-29
 - connector, 2-29
 - inputs differential wiring, 2-31
 - I/O table, 2-26
 - outputs differential wiring, 2-32
 - procedure, 2-29
- Drive
 - current/stepsize, see S1 switch
 - features, 1-1
- Dimensions, 2-6

E

- Earth ground, safety, 2-4
- Enabling the drive, 3-11
- Encoder connection, 2-33
- Encoder inputs, 1-3, 2-3
- Encoder/step & direction input, 2-33
 - cable, 2-34
 - connector, 2-36
 - diagram, 2-37
 - ground loops, 2-35
 - Pacific Scientific cable, 2-34
 - procedure, 2-36
- External 66Vdc, 2-18
 - cable, 2-18
 - connector, 2-18
 - diagram, 2-19

F

- Fan input, distance, 2-5
- Fault LED, 4-3
- Frequency, instability, 3-4
- Fuse, replacement, 4-2

G

- GO.VEL, 3-11
- Ground loops, 2-21, 2-29, 2-36, 2-39

H

- Help, getting, 3-11
- Holding torque and idle current reduction, 3-5
- Home switch, 2-28

I

- I/O, return, 2-29
- ICR, see Idle current reduction
- Idle current reduction
 - setup, 3-5
 - benefits, 3-5
 - definition, 3-5
- Indexer features, 1-2
- Input/Output
 - connections diagram, 2-9
- Inputs, 1-3
 - differential wiring, 2-31
 - encoder/step and direction, 2-33
 - installation, 2-26
 - programmable, 2-28
 - table 2-26 to 2-29
- INPn, variable, 2-27
- Inspecting, 2-1
- Instability frequency, 3-4
- Installation, 2-1
- Internal power supplies, 1-2

J

- J1-120/240 Vac power, 2-10
 - cable, 2-10
 - connector, 2-10
 - procedure, 2-11
- J3-Motor, 2-11
 - cable, making your own, 2-11
 - connector, 2-11
 - 8-lead series procedure, 2-16
 - 8-lead parallel splashproof procedure, 2-18
 - 4-lead procedure, 2-15
 - Pacific Scientific, cable, 2-12

J6-External 66 Vdc, 2-18
cable, 2-18
connector, 2-18
diagram, 2-19

J7-Serial port, 2-20
cable, 2-21
connector, 2-21
multi-unit control, 2-20
RS-422 or RS-485 converter,
2-24
RS-422 or RS-485 procedure,
2-23
Table, I/O, 2-20
T10 procedure, 2-25
RS-232 procedure, 2-22

J9-Discrete I/O, 2-26
cable, 2-29
connector, 2-29
I/O table, 2-26
inputs differential wiring, 2-31
outputs differential wiring, 2-32
procedure, 2-29

J8-Discrete I/O, 2-26
cable, 2-29
connector, 2-29
inputs differential wiring, 2-31
outputs differential wiring, 2-32
procedure, 2-29

J11-Encoder/step & direction
input, 2-33
cable, 2-36
connector, 2-36
ground loops, 2-35
input table, 2-33
Pacific Scientific cable, 2-34
procedure, 2-36

J10-Step and direction outputs,2-38
cable, 2-39
connector, 2-39
fault output, and enable input,
2-6
ground loops, 2-38
output table, 2-39
procedure, 2-40

Jog, 3-11
Jog- functionality, 2-28
Jog+ functionality, 2-28

L

LEDs, 4-1
DISABLE, 4-3
POWER, 4-2
 μ FAULT, 4-5
Limit functionality, 2-28

M

Manual, how to use, 1-6
Memory, 1-2
 μ FAULT, 4-5
Motor, 2-11
cable, making your own, 2-12
connector, 2-11
8-lead series procedure, 2-16
8-lead parallel splashproof
procedure, 2-18
4-lead procedure, 2-15
pre-built, cable, 2-12
selection, 2-2
Motor phase current, 1-3, 3-6
Motor terminals, safety, 2-4
Motor winding current, 2-2

- Mounting, 2-5
 - dimensions, 2-6
 - guidelines, 2-5
 - procedure, 2-5
- Multiple units, 2-3, 2-23

N

- NEMA enclosure, 2-5
- Noise pickup reduction, 2-8

O

- 120/240 Vac power, 2-10
 - cable, 2-10
 - connector, 2-10
 - procedure, 2-11
- Order information, Appendix B
- Outputs
 - differential wiring, 2-32
 - general, 1-3
 - procedure, 2-18
 - table, 2-26
- OUTn, variable, 2-26
- Overview, general, 1-1

P

- PacCom, Tool Kit, 4-6
- Packing list, 2-1
- Pacific Scientific, StepperBASIC, 1-2
- Pin out/connections summary, Appendix C
- Power dissipation and cabinet cooling, 2-7

- Power dissipation and idle current reduction, 3-5
- Power-up, 3-10
- PREDEF.INPn, variable, 2-27
- PREDEF.OUT, variable, 2-26
- Pre-defined outputs, 2-26
- Programmable inputs, 2-28

R

- RAM, battery-backed, 1-3
- Repair procedure, 4-7
- Replacement procedure, 4-7
- RMT.START statement, 2-28
- RS-422 or RS-485, 1-2, 2-23
- RS-232, 1-2, 2-22

S

- S1 and S2 switches
 - location, 3-1
 - setting, 3-1
- S1 Switch
 - default switch setting, 3-2
 - idle current reduction, setup, 3-5
 - digital electronic damping control, set up, 3-4
 - setting up functions using, 3-1
 - step set up, 3-3
- S2 Switch, Serial address setup, 3-6
- Safety, 2-4
- SEEK.HOME statement, 2-28
- Serial address, 3-6
 - switch, see S2 switch

- Serial port, 2-20
 - cable, 2-21
 - connector, 2-21, 2-15
 - multi-unit control, 2-14
 - RS-422 or RS-485, 1-2, 2-23
 - RS-422 or RS-485 converter, 2-24
 - T10, procedure, 2-25
 - RS-232, 1-2, 2-22
- Shock hazard, reduction, 2-8
- Short circuit protection, circuitry, 1-2
- Shunt regulator circuitry, 1-2
- Specifications, Appendix A
- Start functionality, 2-28
- Statement, SEEK.HOME, 2-28
- Status indicators, 1-2, 3-3
- STEP ACTIVE, 3-3, 3-6
- STEP.DIR.INPUT, variable, 2-33
- Step and direction outputs, 1-2, 2-38
 - cable, 2-39
 - connector, 2-39
 - ground loops, 2-39
- Step inputs, 2-33
- Step outputs, 1-3
- Step set up, 3-3
 - benefits, 3-3
 - definition, 3-3
- Step size, 1-3, 3-3
- Stop functionality, 2-28
- Stop switch, emergency, 2-28
- Storage, 2-1
- System diagram, 1-5

T

- T10 terminal, 2-25
 - installation, 2-25
 - parameters, 2-25
- Temperature, 2-1, 2-2, 2-5
- Testing, 3-1
 - connections, 3-10
 - excessive motion, 3-10
 - procedure, 3-10
 - signals, 3-11
- Troubleshooting, 4-1

U

- Unpacking, 2-1

V

- Variable
 - DIR, 3-11
 - INPn, 2-27
 - OUTn, 2-26
 - PREDEF.INPn, 2-27
 - PREDEF.OUTn, 2-26
 - RMT.START, 2-28
 - SEEK.HOME, 2-28
 - STEP.DIR.INPUT, 2-33
- Ventilation, 2-2
- Voltage, internal drive, 2-2

W

- Warranty, 1-6
- Weight, 2-5
- Wiring, 2-9