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Model 5230 INSTRUCTION MANUAL
TABLE OF CONTENTS

LIST OF FIGURES

SECTION 1

INTRODUCTION

The 5230 is a driver package which operates from 115 volts AC and provides the necessary functions to convert step and direction inputs into motor winding currents,driving a two phase bipolar stepping motor. The standard output is 2.5 amps with a 35 volt DC bus. The 5230 is designed for use with Pacific Scientific's SIGMA line of hybrid stepping motors and will work with either the standard SIGMA line or the SIGMAX enhanced high performance line of stepping motors. The motor winding must be compatible with the output rating of the driver package.

1.1 Overview of Operation

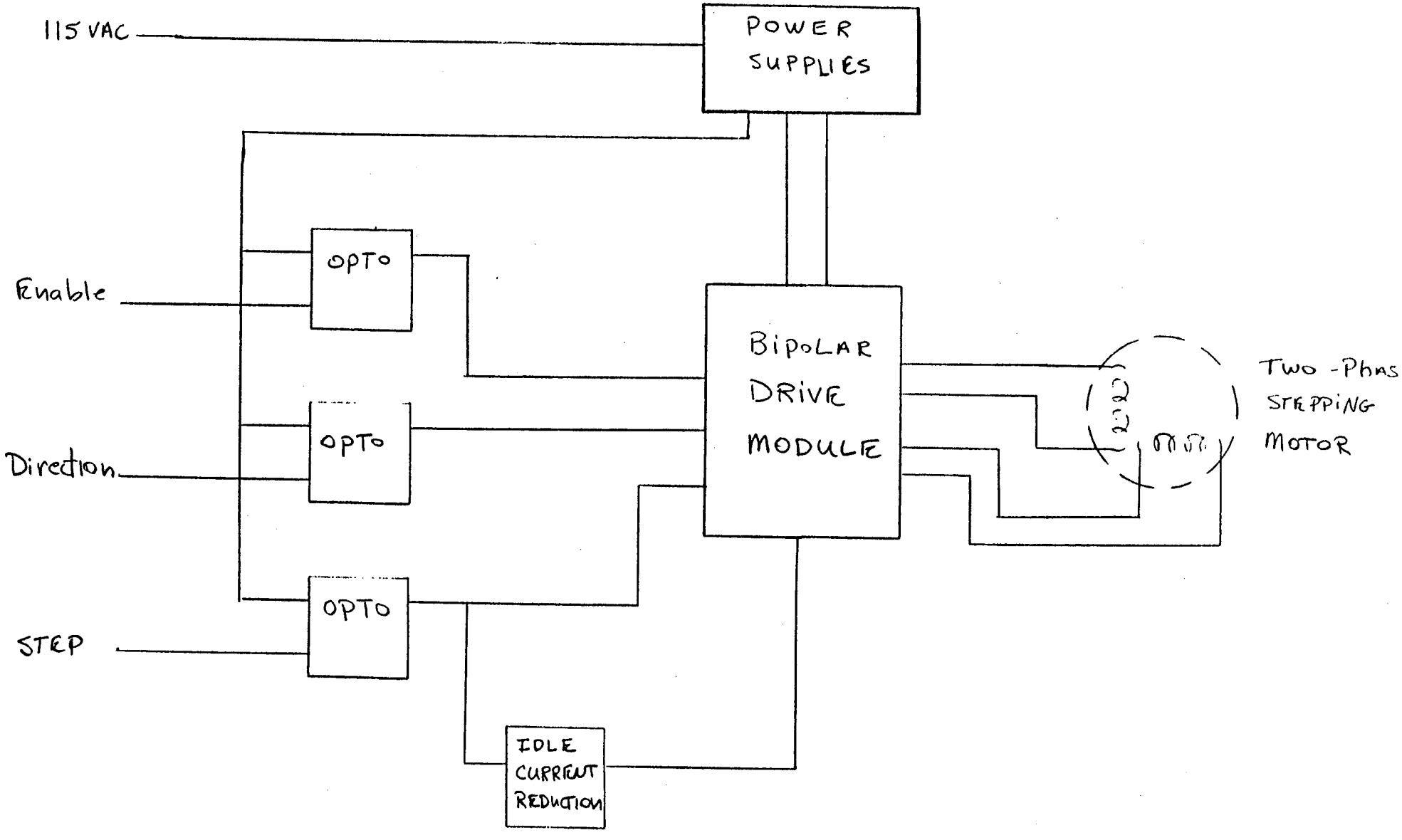
Figure 1.1 is a functional block diagram of the 5230. The driver package consists of a two phase bipolar chopper drive module, optical isolation, idle current reduction circuitry and power supplies.

The drive module is a two phase bipolar chopper utilizing MOSFET transistors for high performance, low loss operation. The chopping frequency is nominally set to 17 KHZ. The standard output is 2.5 amps with a 35 volt DC bus. The drive module incorporates full short circuit and overtemperature protection.

Optical isolation is provided on the step, direction and the enable lines. The use of optical isolation increases the options available for system grounding. The source commanding the step and direction lines is not tied directly to the motor power supply ground in the 5230 allowing the system ground point for these signals to be made external to the unit.

Idle current reduction is switch selectable and reduces the motor winding current to 1.25 amps 100 milliseconds (.1 seconds) after the last input step. This feature reduces motor power dissipation in applications where there is a dwell period longer than 100 milliseconds.

The power supply includes a line operated step down transformer. The outputs of the transformer are rectified and and in the case of the logic supplies regulated to provide power to the drive and isolated power to the user side of the optical isolators. The use of a separate power supply for the user side of the optical isolators frees the user from having to provide isolated power to the driver package. This supply can provide up to 200 MA for user circuitry.



Functional Block Diagram

Figure 1.1

SECTION 2

SPECIFICATIONS

2.1 Electrical

Circuit Type	:	Two phase bipolar chopper, current source output. Either recirculating or non-recirculating selectable by jumper E3.
Chopping frequency	:	17 KHZ nominal
Rated Current	:	2.5 +/- .1 amps with a 802D2220B055 motor (rated current can vary more than 10% with some motor windings).
Idle Current Reduction	:	When enabled sets motor phase current to 1.25 Amps .1 second after the last step input.
Rated Voltage	:	35 Volt DC with 115 Volt AC input
Step size	:	Full or Half Step Jumper Selectable with E4
Maximum Step Input	:	20 KHZ
Input Power	:	115 +/- 10% volt AC 60 HZ @ 1.5 amp maximum

2.2 Environmental

This unit is of an "open frame" design and is intended to be placed within a cabinet. The cabinet should be ventilated by filtered or conditioned air to prevent the accumulation of dust and dirt on the units electronic components. The air should also be free of corrosive or electrically conductive containments.

The unit is cooled by natural convection. To ensure proper cooling maintain the spacing recommendations outlined in section 2.6. Also sufficient airflow must be maintained to keep the cabinets internal ambient temperature within the units ratings given the power dissipation estimates in section 2.5.

Operating Temperature	:	0 to 50 degrees C at full rated current 0 to 60 degrees C at 70% full rated current When mounted as specified in section 3.2
Storage Temperature	:	-25 to 85 degrees C
Humidity	:	0 to 95%, non-condensing
Altitude	:	1500 Meters (5000 feet)

2.3 Mechanical

Figure 2.1 shows the mechanical outline of the 5230. Three slots are provided for mounting the unit on a vertical surface. The unit must be mounted vertically to ensure proper cooling. The unit weight is approximately 6 pounds and should be mounted accordingly.

2.4 Connector data

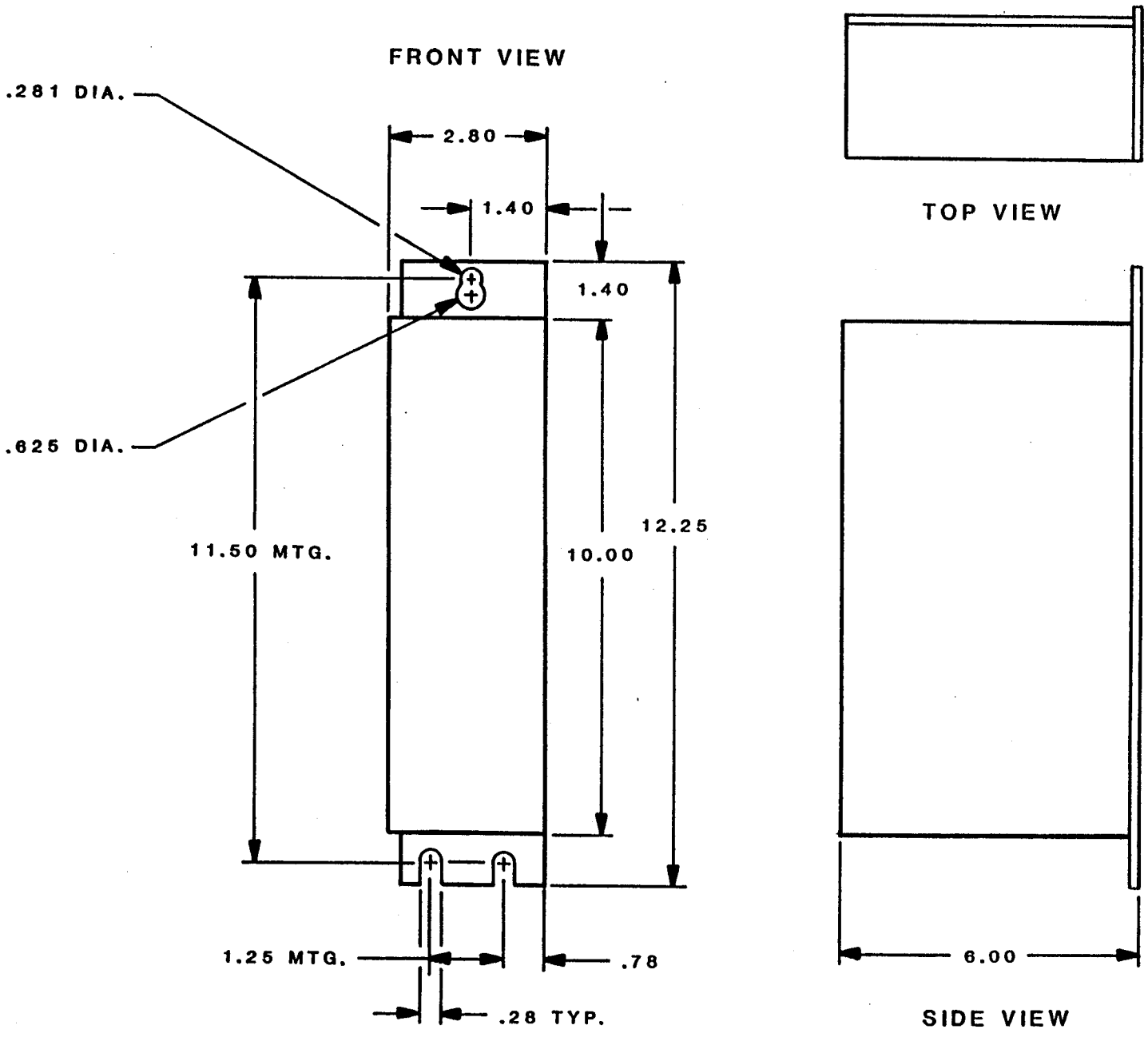
J2 : female DA-9
9 pin D connector

J3 : 5 pin plug-in screw terminal connector
mating connector is supplied

J4 : 3 pin plug-in screw terminal connector
mating connector is supplied

2.5 Power Dissipation

The power dissipation of the 5230 is determined by a number of factors such as motor winding impedance, input step rates, idle current reduction usage , line voltage, ect. For estimating the power dissipation for determining cabinet cooling requirements a number of 25 watts should be used.



MECHANICAL OUTLINE

FIGURE 2.1

2.6 Mounting

Figure 2.1 shows the mechanical outline of the 5230. Mounting is accomplished by three slots located on the unit. The unit must be mounted vertically on a flat, solid surface taking into account its weight of approximately 6 pounds.

The unit should not be subjected to excessive vibration or shock. The environment should be free of corrosives, moisture, and dust. Refer to Section 2.2 for the environmental specifications of the 5230. To insure proper cooling, there must be a minimum unobstructed space of 4 inches above and below the unit and 1 inch on each side.

Since this unit is of an "open frame" construction, it should be located within an enclosure to protect it from physical or environmental damage. The unit will fit in a standard 8 inch deep NEMA enclosure for industrial applications.

SECTION 3

INPUT SIGNAL CONNECTIONS

There are three connectors located on the front of the unit through which all connections are made to the 5230.

J2	:	Driver Interface Connector
J3	:	Motor Connector
J4	:	115 VAC Power Connector

3.1 J2 Driver Interface Connector

J2 - 1 : Step input. The motor will step on the low to high going transition. Refer to figures 3.1 and 3.2 for timing and input characteristics.

J2 - 2 : Direction input. A high or open connection will set the direction of motion clockwise. A low input will set the direction counterclockwise with a motor connected as specified. Refer to figures 3.2 and 3.3 for timing and input characteristics.

J2 - 3 : Chopper Synch Signal. This is an output from the chopper oscillator which can be used to synchronize the chopping frequency of several driver packages together. Consult factory for use of this feature, an addition of a component to the printed circuit board is required. This signal is referenced to the drive module return, not directly to the user supply return.

J2 - 4 : Drive module return. This return is used in conjunction with the synch signal and is not referenced directly to the user supply return.

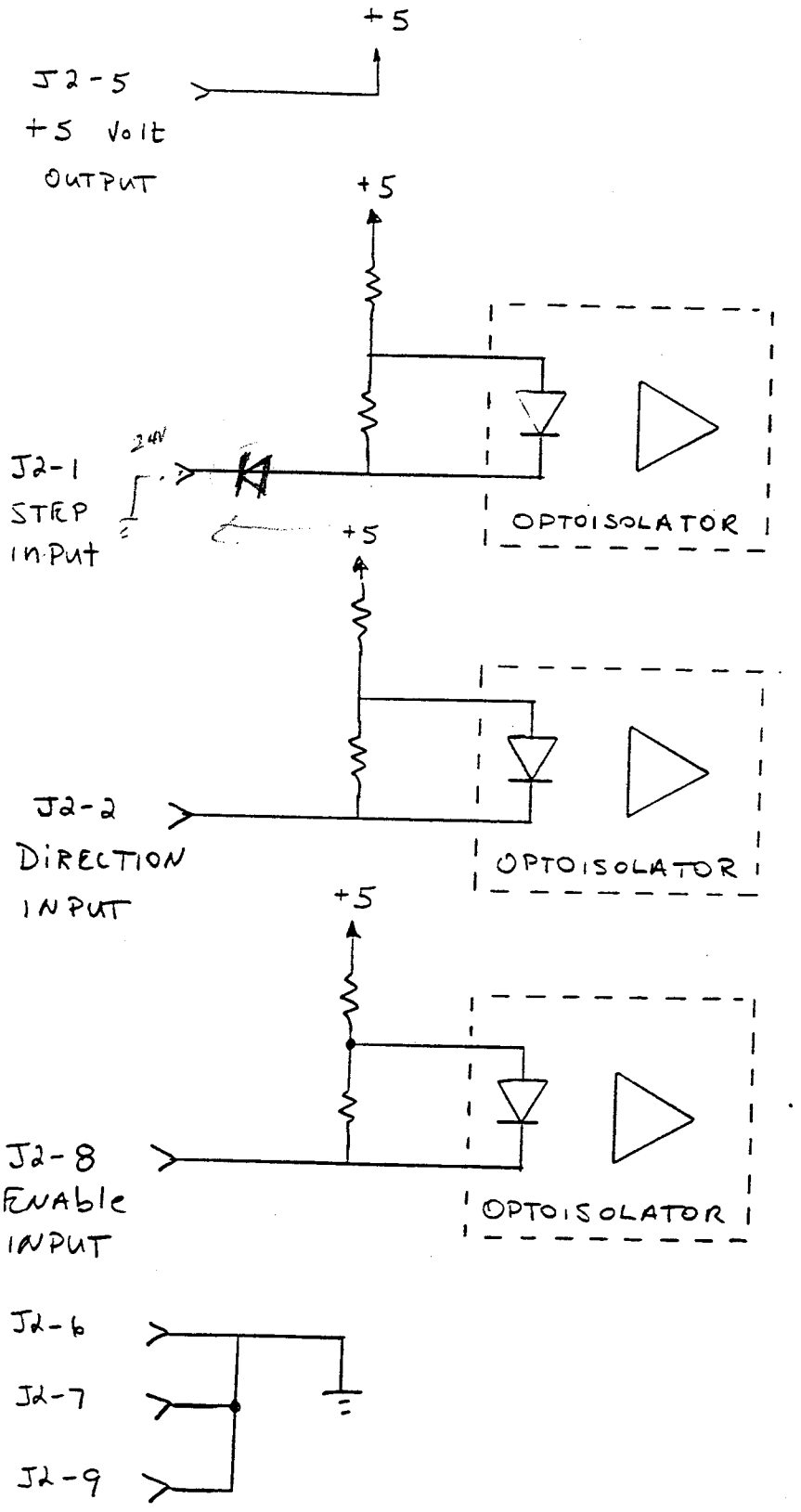
J2 - 5 : + 5 volt user supply output. This supply is for the user side of the optoisolators and can supply up to 200 MA for external circuitry.

J2 - 6 : User supply return.
J2 - 7 : User supply return.

J2 - 8 : Enable input. A logic high level or an open connection enables the drive. A logic low disables the drive current to the motor. Refer to figure 3.2 for input characteristics.

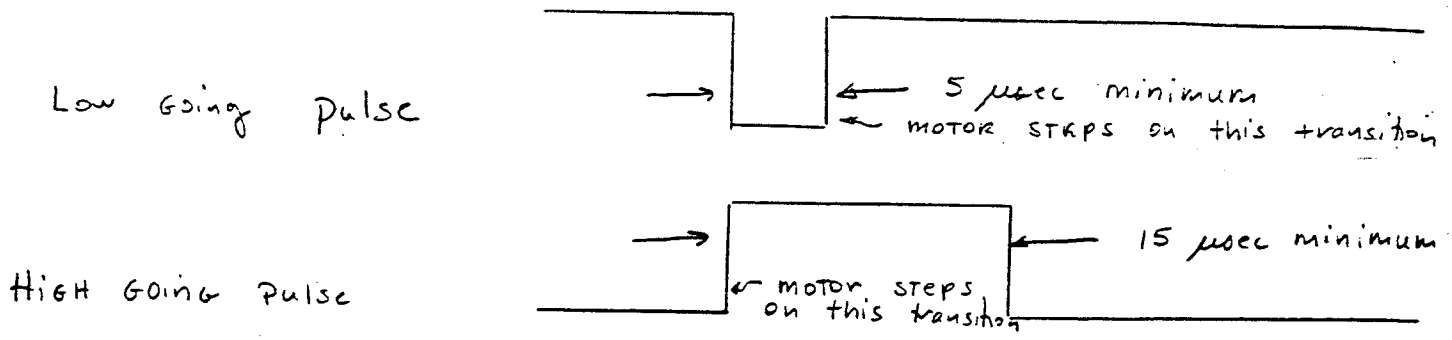
J2 - 9 : User supply return.

figure 3.1 input circuits



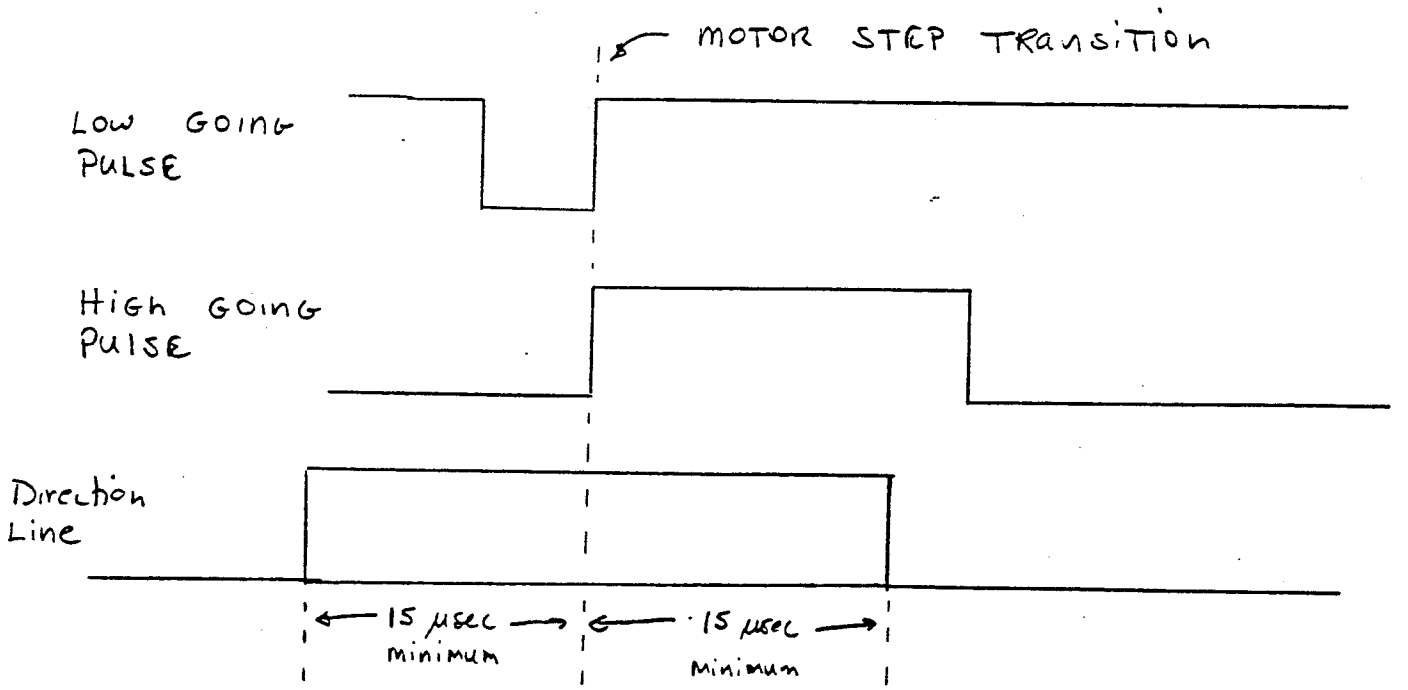
Input Characteristics

Figure 3.1



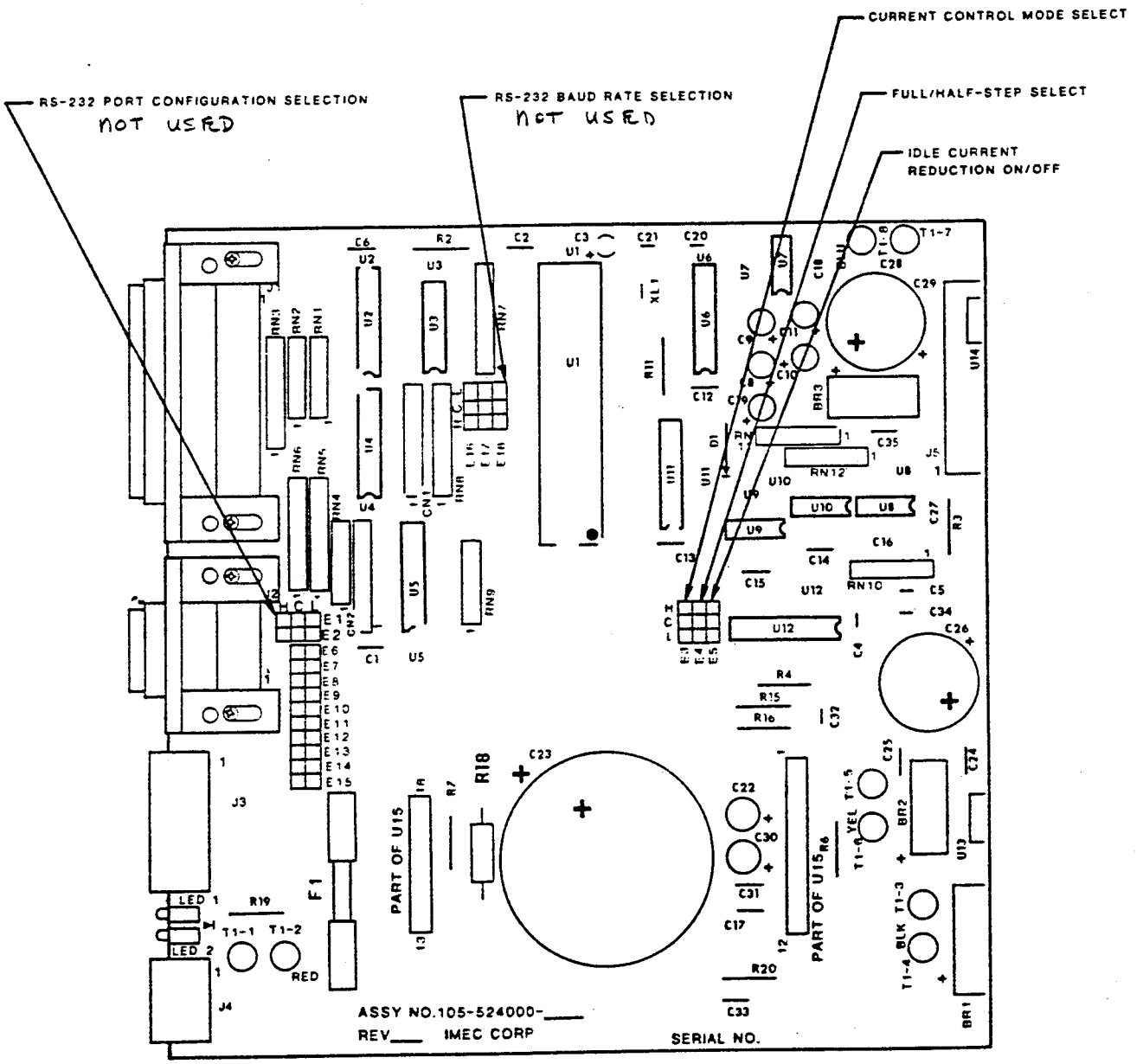
STEP INPUT Timing

Figure 3.2



Direction Input Timing

Fig 3.3



Jumper Locations

Figure 4.1

3.2 J3 Motor Interface Connector

J3 - 1 : Motor phase A connection.

J3 - 2 : Motor phase A connection.

J3 - 3 : Motor phase B connection.

J3 - 4 : Motor phase B connection.

J3 - 5 : Motor power return. The motor case can be connected to this point to reduce system electrical noise.

Refer to figure 3.4 for typical motor connections for Pacific Scientific bipolar stepping motors.

3.3 J4 115 VAC Power Connector

J4 - 1 : Chassis ground point. This terminal is the safety ground point for the unit and must be tied to earth ground to prevent shock hazard.

J4 - 2 : 115 VAC input.

J4 - 3 : 115 VAC input.
No special phasing of the 115 VAC inputs is required.

SECTION 4

JUMPER SELECTABLE FUNCTIONS

The function selection jumpers are located on the printed circuit board of the 5230. The board is accesed by removing the cover of the unit which is held on by four screws, two located on each side. Figure 4.1 shows the locations on the printed circuit board of the jumpers.

WARNING

DANGEROUS VOLTAGES EXIST INSIDE THE UNIT. DO NOT APPLY POWER WHILE THE COVER IS REMOVED. DO NOT REMOVE THE COVER WHILE POWER IS APPLIED.

E1 : Not Used

E2 : Not Used

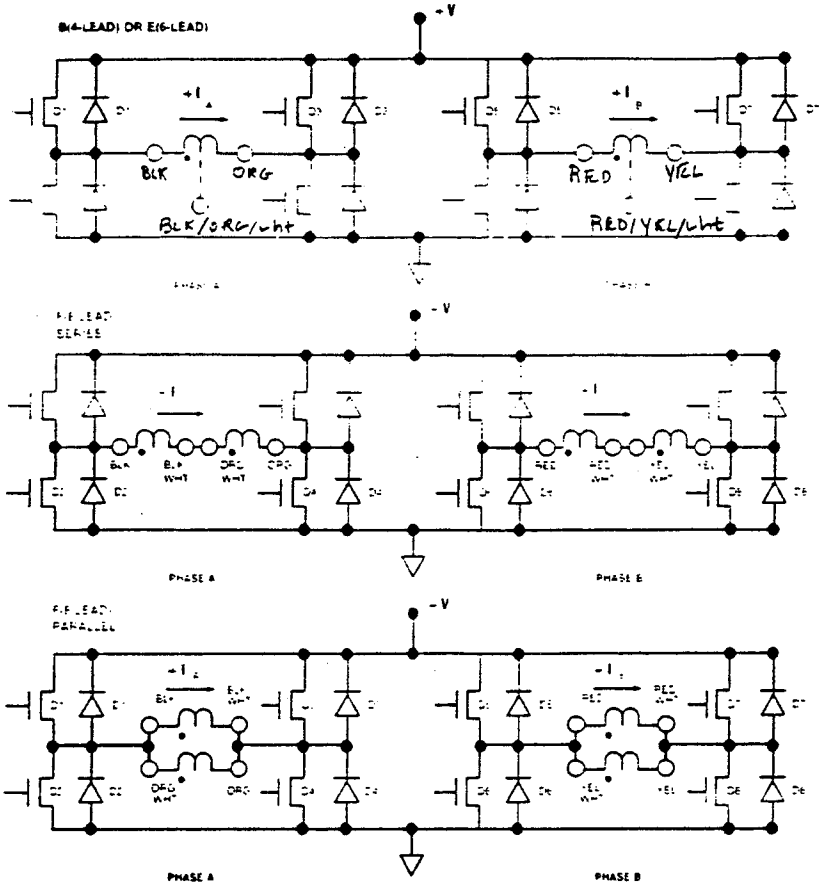
E3 : Control Jumper. This jumper sets the drive module switching mode. Position H - C places the drive in a non recirculating or fast decay mode of operation. Position L-C sets a recirculating mode of operation. The standard setting is in the L-C position which minimizes switching losses and audible noise. The H-C position is useful with high impedance winding motors and reducing mid-range instability. Refer to section 6.2.

E4 : Full / Half step operation. In the H-C position the driver operates in a full step mode. In the L-C position the drive is in a half step mode. The standard setting is for half step operation. Half step operation increases the resolution of the motor and is less susceptible to mid-range instability. There is however a loss of 30% of low speed torque compared to full step in some positions.

E5 : Idle Current Reduction. In the H-C position the idle current reduction circuit is enabled. If with in 100 milliseconds (.1 seconds) after a step input another step input is not received the motor winding current will be reduced to 1.25 amp nominal. The current is automatically boosted up to rated value on the next step input. This feature is useful in applications where the torque required to hold position is safely met by 1.25 amp of winding current. Operating with reduced current will lower motor power dissipation by 75% and can result in a large reduction in motor heating in applications where a portion of the move cycle is in a dwell period greater than 100 milliseconds.

The remaining jumpers E6 - E15 should not be moved, they are configuration jumpers required to bring the appropriate signals to J2 and should in the following positions.

E6			:	in
E7			:	out
E8	-	E16	:	in



Winding configuration	Leaded motor 2.2", 3.4", 4.2"	Splash-proof 3.4" motor	Splash-proof 4.2" motor
B 4-lead	Black	2	1
	Orange	3	3
	Red	1	2
	Yellow	4	4
E 6-lead	Black	1	1
	Orange	5	3
	Red	2	2
	Yellow	6	4
	Black/Orange White	3	5
	Red Yellow White	4	6
F 6-lead	Black	—	1
	Orange	—	3
	Red	—	7
	Yellow	—	8
	Black White	—	6
	Orange/White	—	5
	Red/White	—	4
	Yellow/White	—	2

Motor Connections

Figure 3.4

SECTION 5

INSTALLATION/SET-UP

Due to the wide variety of uses for the 5230, it is the responsibility of the user or those applying the unit to determine the suitability of this product for any intended application. In no event will Pacific Scientific Company be responsible or liable for indirect or consequential damage resulting from the use of this product.

The figures, tables, and examples shown in this manual are intended solely to supplement the text. Because of the varied requirements of any particular application, Pacific Scientific Company cannot assume responsibility or liability for actual use based upon the illustrative uses and applications included in this manual.

WARNING

DANGEROUS VOLTAGES, CURRENTS, TEMPERATURES, TORQUES, FORCES, AND ENERGY LEVELS CAN EXIST IN THE PRODUCT AND ITS ASSOCIATED STEPPING MOTOR. EXTREME CAUTION AND CARE SHOULD BE EXERCISED IN THE APPLICATION OF THIS EQUIPMENT. ONLY QUALIFIED INDIVIDUALS SHOULD WORK ON THIS EQUIPMENT AND ITS APPLICATION.

5.1 Unpacking and Inspection

Remove the 5230 from its shipping carton and check the items against the packing list. A nameplate located on the side of the unit identifies the unit by model number, serial number, and date code.

Inspect the unit for any physical damage that may have been sustained during shipment. All claims for damage whether concealed or obvious must be made to the shipper by the buyer as soon as possible after receipt of the unit.

Remove all packing materials from the unit. If the unit is to be stored, it should be stored in a clean, dry place. The storage temperature must be between -25 and 85 degrees C. To prevent damage during storage, it is recommended that the unit be stored in its original shipping carton after completing inspection for damage.

For mounting refer to section 2.6 in the specification section.

5.2 Interconnection Wiring

WARNING

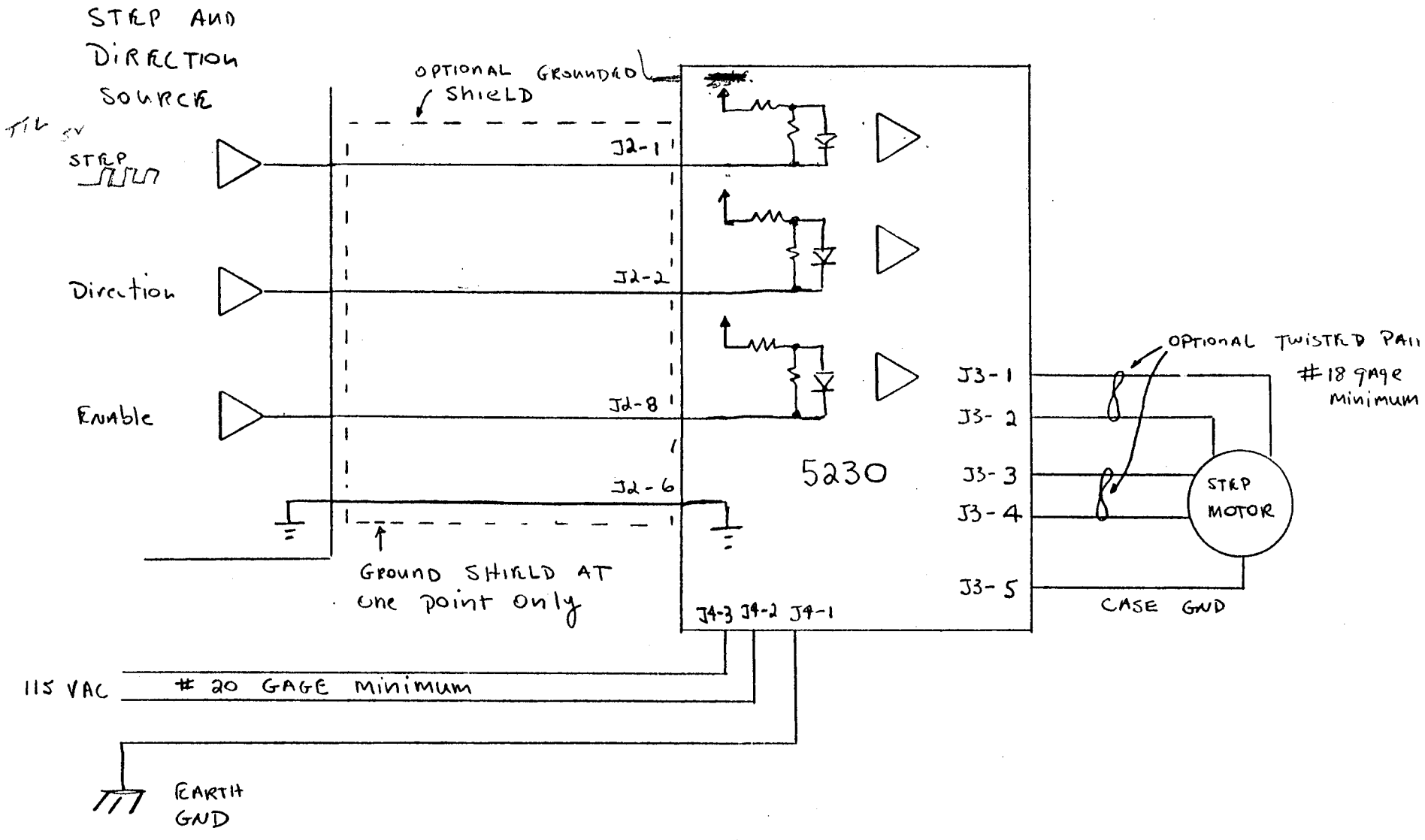
THE J4 CONNECTOR SHOULD NEVER BE PLUGGED OR UNPLUGGED WITH 115 VAC POWER APPLIED. SUCH ACTION PRESENTS A SHOCK HAZARD AND ALSO WILL DAMAGE THE CONNECTOR PINS DUE TO ARCING. ALWAYS INSURE THAT 115 VAC POWER IS OFF BEFORE INSTALLING OR REMOVING THE J4 CONNECTOR.

Figure 5.1 illustrates the interconnection wiring of the 5230 to a stepping motor and a step, direction source. This figure includes information on mating connectors and wire sizes.

Wiring sizes, wiring practices, and grounding/shielding techniques described in this manual are intended as a guideline only. Due to the variety of applications served by this product, no single method of interconnection is universally applicable. The information included in this manual represents common industrial wiring practices and should prove satisfactory in the majority of applications. However, local electrical codes, special operating conditions, or system configurations should take precedence over the information provided herein.

To reduce the possibility of noise pickup, power and signal wiring should be routed separately. Signal wiring should be shielded. Motor phase wiring should be twisted to reduce radiated noise.

To minimize shock hazard, all components should connected to a common earth ground point.



Interconnection Diagram

Figure 5.1

5.3 Initial Power Up

Every 5230 is burned-in and fully tested before leaving the factory. However, it is possible that damage has been sustained by the unit during shipment. This procedure should be followed to insure that the unit has not sustained shipping damage and has been installed properly.

The initial power up sequence makes use of a motor and a step and direction source, such as the Sigma Line 3076 indexer, to test the functionality of the 5230.

WARNING

THIS INITIAL POWER UP PROCEDURE SHOULD BE PERFORMED 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.

(1) Verify that the unit is wired and mounted per instructions in this manual. Be especially careful in checking the 115 VAC input connections and the motor connections.

(2) Verify that the jumper settings are per the following:

E5	H-C
E4	L-C
E3	L-C

(3) Unplug the J3 motor connector. Make sure 115 VAC power is OFF when you do this.

(4) Apply 115 VAC power. Verify that the green power LED is on and the red disable LED is off.

(5) Remove 115 VAC power from the unit.

(6) Plug the J3 motor connector into the unit.

(7) Apply 115 VAC power to the unit.

(8) Verify that the power on LED is on and the disable LED is off

(9) Verify that the motor has holding torque.

(10) Input a step command to J2-1 (refer section 3 for input requirements) the motor should move.

(11) Connect J2-2 the direction input to signal ground, J2-7, the direction of motion should change.

(12) Connect J2-8 the enable input to ground, J2-7, the motor should stop and loose holding torque.

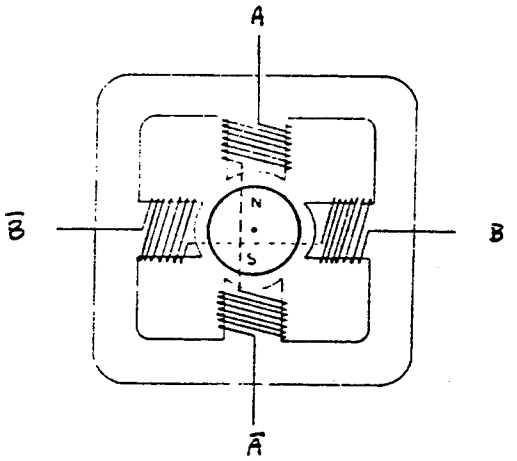
If the unit successfully passed the above procedure, you may now try exercising the unit on your own. If the unit does not pass the above tests contact the Pacific Scientific Company or its representatives for assistance.

SECTION 6

THEORY OF OPERATION

6.1 Stepping Motor Basics

A hybrid stepping motor can be simplified to the diagram shown in Figure 6.1. The stator is a two-phase winding and the rotor is a permanent magnet. The rotor aligns itself with the field created by the two-phase stator winding. By controlling the winding currents in the proper sequence, torque is produced and the rotor will rotate in the desired manner. The phase currents are bidirectional and sequencing of these phase currents is termed commutation. There are two basic types of stepping motor commutation possible with the module.



Simplified Stepping Motor Diagram
Figure 6.1

FULL-STEP DRIVE

In this type of commutation, both stepping motor phases are energized at all times. The commutation sequence is:

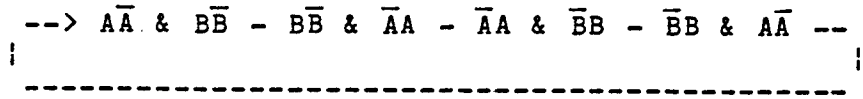
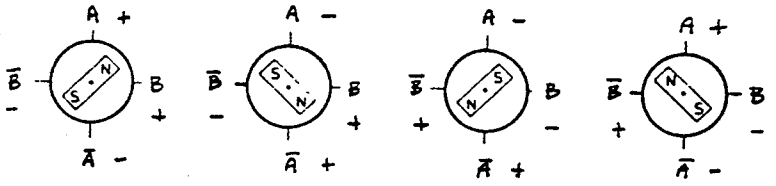


Figure 6.2 shows this commutation sequence for clockwise motor rotation.



Full-Step Drive
Figure 6.2

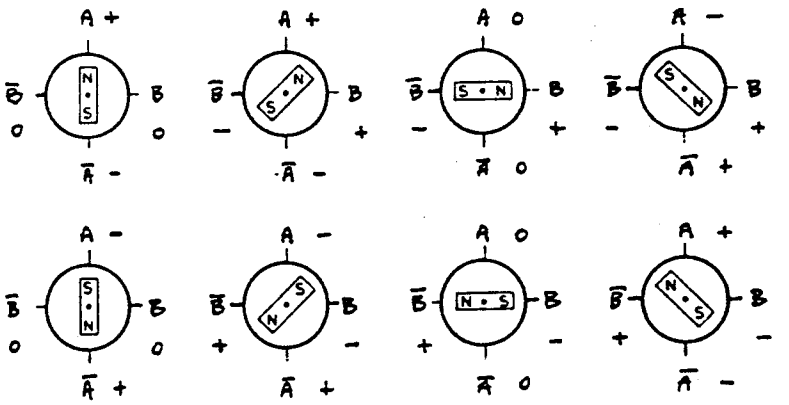
This type of commutation is selected by setting jumper E4 to the H-C position prior to unit power up. The 5230 is now set for Full-Step operation. Do NOT change the state of E4 with power applied.

HALF-STEP DRIVE

This type of commutation alternates between one phase energized and two phases energized. This halves the step size (doubles step resolution) but gives irregular torque. The torque with two phases energized is 1.4 times higher than that produced with one phase energized. The commutation sequence is:

-> $A\bar{A}$ - $A\bar{A}$ & $B\bar{B}$ - $B\bar{B}$ - $B\bar{B}$ & $\bar{A}A$ - $\bar{A}A$ - $\bar{A}A$ & $\bar{B}B$ - $\bar{B}B$ - $\bar{B}B$ & $A\bar{A}$ -
¦ ¦

Figure 6.3 shows the Half-Step drive sequence.



Half-Step Drive
Figure 6.3

Half step commutation is selected by setting the E4 jumper to the L-C position prior to applying power to the unit. Do NOT change the state of E4 with power applied.

Note that all of the figures are simplified and show a stepping motor with a 90 degree full-step or 45 degree half-step. Pacific Scientific's SIGMA Line of stepping motors are designed with a 1.8 degree full-step or 0.9 degree half-step.

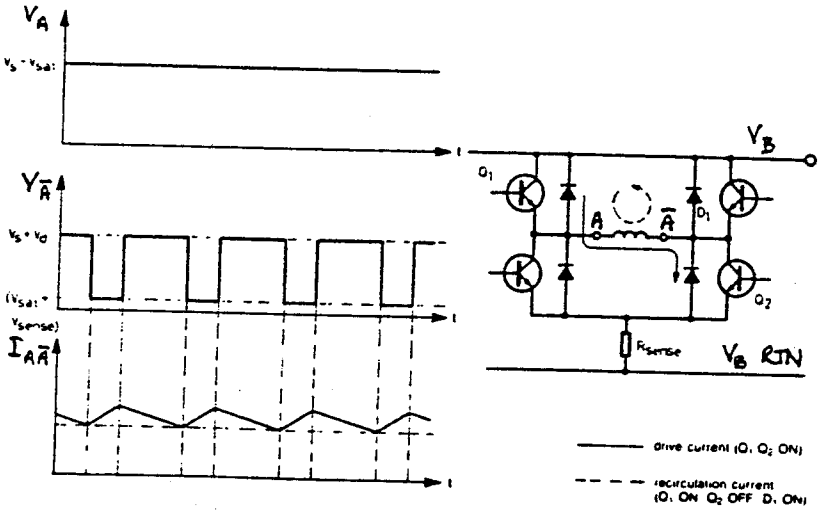
6.2 Motor Current Regulation

Motor phase currents are controlled by two switch mode (chopper), MOSFET, full-bridges. Pulse-width-modulation (PWM) switching provides efficient and precise current control to obtain good torque-speed characteristics from the stepping motor.

Two modes of PWM current control are available in the 5230. The first is Recirculating mode which is obtained by setting jumper E3 to the L-C position. Figure 6.4 illustrates this mode of control.

An internal PWM oscillator supplies pulses at a fixed frequency (17 kHz nominal) to a pair of flip-flops. The flip-flops turn on a pair of transistors in each bridge. In Figure 6.4, transistors Q1 and Q2 are turned on to obtain a phase current of AA. The other pair would be turned on if a phase current of AA was required.

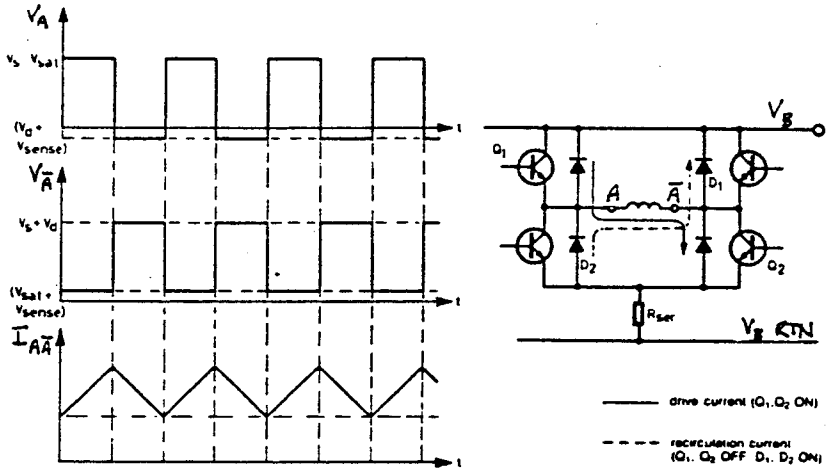
The phase current ramps up until the current sensed by resistor Rsense equals the current defined by a current reference voltage. At this point, the flip-flop is toggled which turns transistor Q2 off and causes the current to recirculate through transistor Q1 and diode D1. The current decays slowly in this recirculation path until the next PWM oscillator pulse which toggles the flip-flop and turns transistor Q2 back on causing the current to start ramping back up.



Recirculation Mode (Slow Decay)
Figure 6.4

The second mode of operation is Non-recirculating. This mode is obtained by setting jumper E3 to the H-C position. Operation in this mode is identical to that of the recirculating mode except that when the current sensed by resistor Rsense equals the current reference voltage transistors Q1 and Q2 are both turned off. This causes the current to flow through diodes D1 and D2 as shown in Figure 6.5. Rather than recirculating locally through just the motor phase winding, the current flows back through the Bus supply hence it is non-recirculating.

The current decays until the next PWM oscillator pulse which turns transistors Q1 and Q2 back on. The current decay in this mode is much faster since the Bus supply voltage is driving the current down.



Non-Recirculation Mode (Fast Decay)
Figure 6.5

In most applications, recirculation mode is preferred. The power losses in the drive module and stepping motor are lower in this mode due to the lower amplitude ripple current. This mode should be used whenever possible.

In some applications, it may be necessary to use the non-recirculation mode. While this mode introduces higher drive module and motor losses due to higher ripple currents, it reduces the drives sensitivity to back EMF from the motor. This improved back EMF rejection reduces mid-range stability problems. Mid-range stability problems are inherent in any stepping motor system and can cause the motor to fall out of synch due to the reduction of torque at mid-range speeds. Using the non-recirculation mode will reduce the systems susceptability to mid-range instability.

SECTION 7

INPUT SIGNAL CONNECTIONS SUMMARY

J2 DRIVER INTERFACE

J2 - 1	:	Step Input
J2 - 2	:	Direction input
J2 - 3	:	Chopper Synch Signal
J2 - 4	:	Driver module return
J2 - 5	:	+ 5 voltuserr supply output
J2 - 6	:	Connected to user supply return
J2 - 7	:	Connected to user supply return
J2 - 8	:	Enable input
J2 - 9	:	Connected to user supply return.

J3 MOTOR INTERFACE CONNECTOR

J3 - 1	:	Motor phase A connection
J3 - 2	:	Motor phase A connection
J3 - 3	:	Motor phase B connection
J3 - 4	:	Motor phase B connection
J3 - 5	:	Motor power return

J4 115 VAC POWER CONNECTOR

J4 - 1	:	Chassis ground point
J4 - 2	:	115 VAC input
J4 - 3	:	115 VAC input

SECTION 8

JUMPER FUNCTION SUMMARY

E1 : Not Used
E2 : Not Used

E3 : Control jumper
H-C Non recirculationg
L-C Recirculating

E4 : Full / Half step
H-C Full Step
L-C Half step

E5 : Idle Current Reduction
H-C Enabled
L-C Disabled

E6 : in
E7 : out
E8 : in
E9 : in
E10 : in
E11 : in
E12 : in
E13 : in
E15 : in
E16 : in

SIGMA Line
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