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Part# 903-643510-00
List Price $25 U.S.
January, 1997
Rev 1

M A 6 4 3 5

6 4 3 5 Oscillator/Drive

Installation & Hardware Reference Manual

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Table of Contents

1 Overview of the 6435

In this chapter

This chapter introduces the 6435 stepper drive. Topics covered are:

- 6435 definition
- Other system components
- System diagram
- How to use this manual
- Warranty information

1.1 6435 Definition

Overview

The Pacific Scientific 6435 Oscillator/Microstepping Drive Package is an economical microstepping drive and ramped oscillator card combined with an off line AC Input switching power supply. The oscillator card contains a stable wide range voltage controlled oscillator (VCO) and associated control circuitry which provides step pulses and direction command signals to the drive card. The drive card converts step and direction command signals into motor winding currents to control a two-phase stepper motor.

Principal features include independent acceleration and deceleration profiles which enable the motor to be operated at high speed in a reasonable time. In addition, microstepping and digital electronic damping provide for high resolution and smooth operation through both the low speed and mid-speed resonance regions.

Run speed pulse frequency is controlled by an on-board potentiometer, an external user's potentiometer or a bipolar external analog input voltage. Acceleration and deceleration ramps are also potentiometer controlled. When a bipolar analog voltage is used as the input, the direction command is derived from a polarity detector on the ramped oscillator card. Deceleration can include a slow speed adjustable potentiometer before stopping, to enhance accuracy of stopping position. Control signals are optically isolated.

The output current of the 6435 is dip switch selectable from 0.625A rms (0.88A peak in microstep mode) to 5A rms (7.1A peak in microstep mode).

The Pacific Scientific 6435 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.

Microstepping - switch selectable: full, 1/2, 1/5, 1/10, 1/25, 1/50, 1/125, and 1/250 step capability.

Digital Electronic Damping - patented circuit eliminates torque loss and/or motor stalling through the mid-speed region, that is inherent in all open loop stepper applications.

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.

Bus overvoltage - disables the drive if the internal bus or 66 Vdc output voltage exceeds 83 Vdc. The drive must be power cycled to clear fault.

MOSFET power device - allows chopper frequency of approximately 20 KHz, eliminating acoustical noise often associated with choppers.

Power supply features

66 Vdc Output - three pin pluggable connector (J6) designed 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 A or 300 W ± 10%.

Oscillator features

Acceleration and deceleration circuitry -Acceleration rate is non-linear which produces an exponential velocity ramp profile. This method improves the acceleration profile since at low motor speed a higher acceleration rate is produced and a lower acceleration rate at high speeds. Constant deceleration rate resulting in a linear velocity ramp allowing a more precise and repeatable stopping position. The acceleration and deceleration rates are adjustable with the on-board potentiometers to optimize system performance.

Two independent run speeds - selected by using the Low_Spd input. The motor high speed range is controlled by the Run Speed potentiometer, low speed range is controlled by the Low Speed potentiometer. Low speed setting is typically selected prior to stopping the motor to improve stopping position repeatability. It can also be used as an independent secondary speed.

Internal and/or external speed command - allows for stand alone and/or speed following operation.

Separate (latched) and/or single RUN/STOP inputs - allows for direct clutch brake replacement application.

Optically isolated signal interface connection - optical isolation is provided on the RUN/STOP, low speed, direction, and enable inputs. The use of optical isolation increases the options available for system grounding. The source commanding these control signals is not tied directly to the motor power supply ground, allowing the system ground point for these control signals to be made external to the unit.

UL Recognized - 508C (Type R) - PENDING File E137798. This also complies with CSA Standard for Process Control Equipment, C22.2 No. 142-M1987.

Vibration - PENDING IEC Standard 68-2-6.

User adjustments

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.

Using DIP switch S1

Step size - sets the amount of shaft rotation per pulse. 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 - 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. **DO NOT apply 240 Vac with AC Switch in 120 Vac position.**

Using plug-on jumpers

Run and/or Stop controls - allows for independent inputs or a single input for Run/Stop. With separate input control mode (E4 jumper installed) the 6435 is controlled by two separate optically isolated inputs. This separate input control mode is useful for functioning in a clutch brake application. In the single input mode (E4 jumper removed) , the drive run or stop is controlled directly from the run input only.

Internal or External speed source - the analog speed command is derived from the internal run speed potentiometer, external user's potentiometer, external analog input, and external analog input scaled by internal run speed potentiometer sources depending upon the on-board E1 and E3 jumpers setting configurations.

Oscillator frequency range - sets the voltage controlled oscillator (VCO) output full scale frequency range. With E2 jumper installed, the maximum full scale VCO output frequency is set to 250 KHz for Run Speed and 180 KHz for Low Speed controls. When removed E2 jumper, the maximum full scale output frequency is set to 500 KHz for run speed and 370 KHz for low speed controls. This feature offers user's selectable speed resolution for the best system performance.

Min speed control - sets the minimum speed which is the initial motor speed. The minimum speed is set to 4 KHz and 2 KHz maximum (E5 jumper removed) for high and low frequency range respectively. Steps below this frequency are inhibited to insure no movement at end of deceleration ramp. This functionality can be disabled by installing the on-board E5 jumper.

Note: *Motor stalling may occur if this feature is used with step sizes less than 1/5 step.*

Direction controls - This optically isolated input controls the direction of motor rotation when all on-board direction controls jumpers are removed. Motor rotation is CCW if the opto is driven and CW otherwise. The direction of the motor can also be controlled by the analog input or on-board plug on jumpers (E6, E7, and E8).

Using on-board potentiometer

Acceleration and deceleration controls -Acceleration rate is non-linear resulting in an exponential velocity ramp. Constant deceleration rate resulting in a linear velocity ramp. Accel Ramp Pot (R14) and Decel Ramp Pot (R17) adjust the initial acceleration and deceleration rate of the motor from 0.4 msec to 0.4 sec (accel. single time constant) and 6.0 msec to 1.4 sec (decel. time).

Run speed and low speed controls - Run Speed Potentiometer (R7) and Low Speed Potentiometer (R43), both independent speed potentiometers, set the steady state run speed of the motor when the optically isolated input RUN/STOP or LOW_SPD opto is driven. The motor speed ramps up from the selectable MIN_SPD threshold (enable or disable with E5 jumper) until it reaches the final speed. Run Speed Potentiometer adjusts the final motor speed from 8 KHz to 500 KHz and 4 KHz to 250 KHz for high and low frequency range operation. Unlike the Low Speed Potentiometer which is adjustable from 8 KHz to 370 KHz and 4 KHz to 180 KHz for high and low frequency ranges.

Typical applications

Typical applications for 6435 include:

- X-Y tables and slides
- Packaging machinery
- Robotics
- Specialty machinery
- Index feed of material
- Labeling machines
- Clutch brake replacement
- Smart conveyor systems
- Semiconductor wafer polishing
- Constant speed applications

1.2 Other System Components

Overview

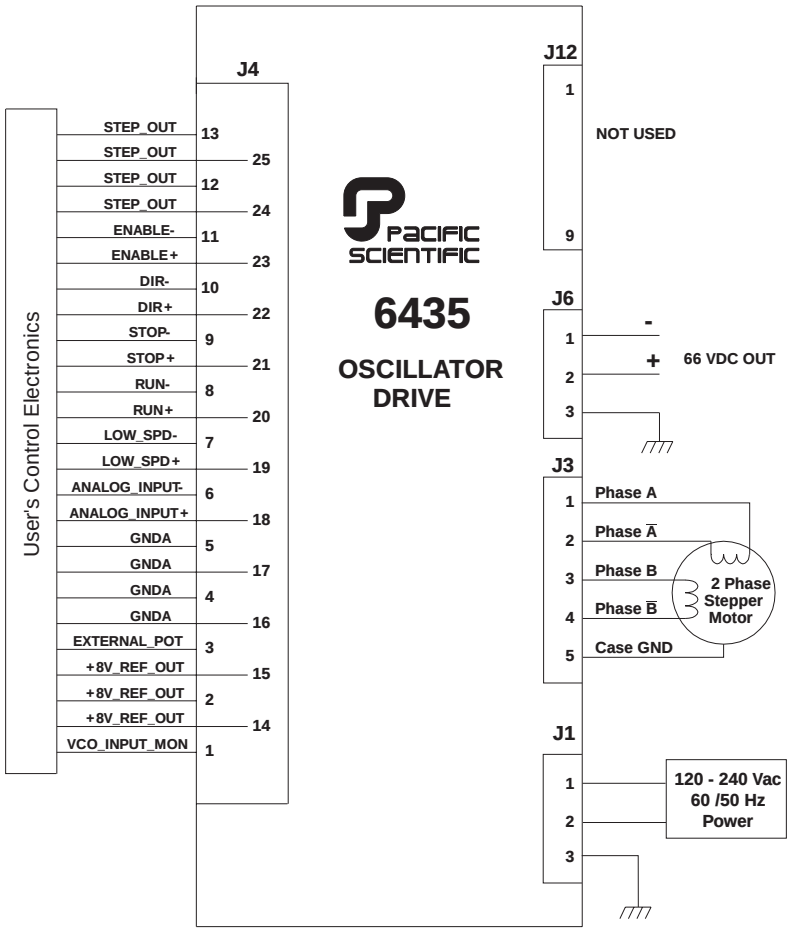
The other components that, along with the drive, comprise a complete motor control system are:

- Single logic power supply (4.75 - 5.25 Vdc) required for opto isolation
- Motor

Installation guidelines for these components are described in Chapter 2, “Installing the 6435 Stepper Motor Drive.”

System Block Diagram

The following diagram shows the drive in a typical system.



1.3 How to Use this Manual

This manual contains information and procedures to install, setup, and troubleshoot the 6435 stepper motor drive.

The most effective way to use this manual is to follow the installation and power up instructions contained in Chapter 2 and Chapter 3.

1.4 Warranty

The Pacific Scientific 6435 drive has 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 6435

In this chapter

This chapter explains how to install the 6435 stepper motor drive. Topics covered are:

- Unpacking and inspecting the 6435
- Installing and using the 6435 unit safely
- Selecting other system components
- Mounting the 6435 in your installation
- Connecting input/output cables

2.1 Unpacking and Inspecting

Unpacking procedure

1. Remove the 6435 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 inside the chassis 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 within 10 days of receipt of the unit.

Storing the unit

After inspection, store the drive 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 Installing and Using the 6435 Unit Safely

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 misuse of this product.

Note: *Read this manual completely to effectively and safely operate the 6435 unit.*

Warning

The circuits in the 6435 drive are a potential source of severe electrical shock. Follow the safety guidelines to avoid shock.

Safety guidelines

To avoid possible personal injury whenever you are working with the 6435 unit:

- Do not operate the drive without the motor case tied to earth ground.

  Note: *This is normally done by connecting the motor's case to J3-5 of the 6435 and connecting J1-3 of the 6435 to earth ground. These pins are marked by a* ⏚ *symbol on the silkscreen and are shown on the diagram on page 2-4.*

- Do not make any connections to the internal circuitry. The input and output signals are the only safe connection points.
- Always remove power before making or removing connections from the unit.
- Be careful of the J3 motor terminals when disconnected from the motor. With the motor disconnected and power applied to the drive, these terminals have high voltage present, even with the motor disconnected.
- Do not use the ENABLE input as a safety shutdown. Always remove power to the drive for a safety shutdown.

2.3 Selecting Other System Components

Selecting external analog input and logic input power supplies

The 6435 drive requires an external +5Vdc (±0.25) logic power supply for all user's control inputs and 0 to +10Vdc (±0.10) analog input power supply if the analog speed command is derived from external input source configuration.

Selecting a motor

The 6435 is designed for use with Pacific Scientific's line of hybrid stepper motors or most other 2 phase stepper motors. The drive works with either the standard line or the enhanced high performance line of stepper motors. The motor winding current rating must be compatible with the output current of the drive package.

Refer to the Torque/Speed Curves in the Pacific Scientific *Motion Control Solutions Catalog* or contact your local Pacific Scientific distributor for sizing and motor compatibility assistance.

2.4 Mounting the 6435 Unit

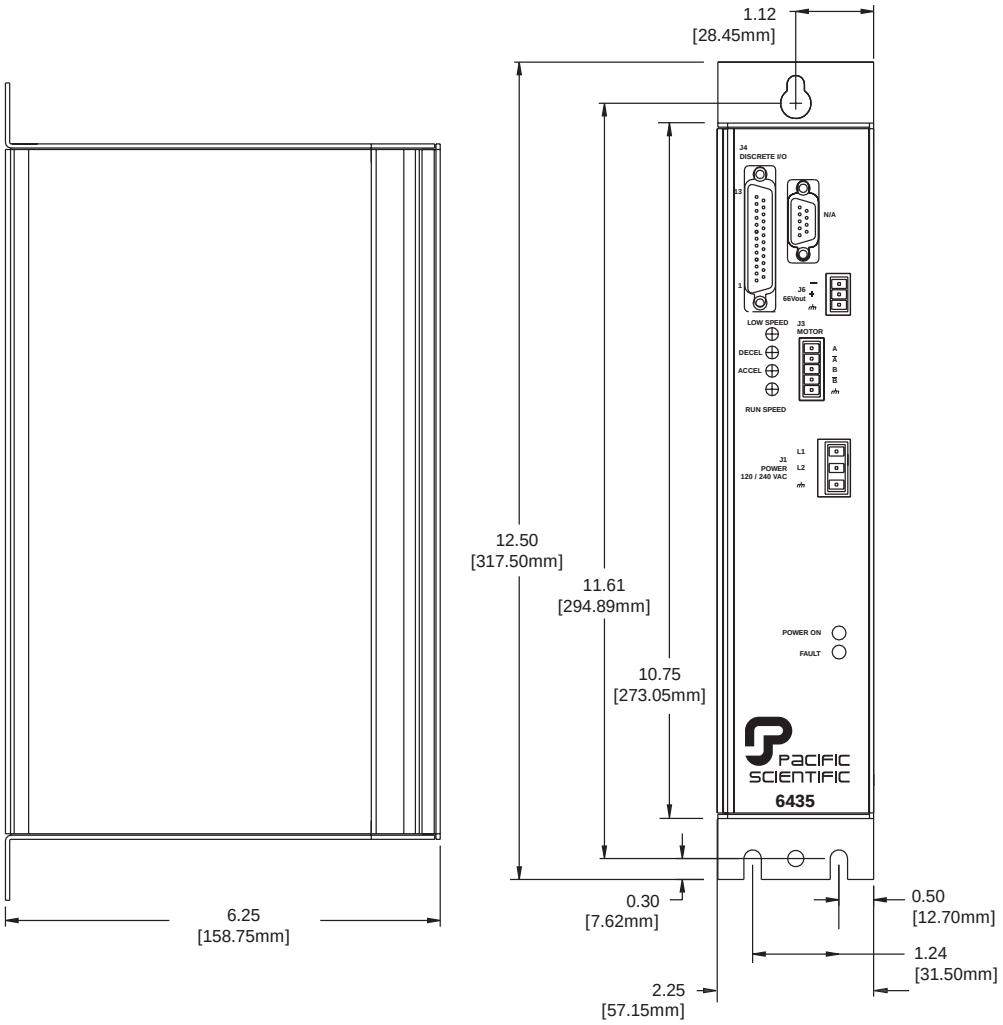
Mounting guidelines

Your installation should meet the following guidelines:

- Vertical orientation for the unit.
- Flat, solid surface capable of supporting the approximate 6.0 lb. weight (2.7 kg. mass) of the unit.
- Free of excessive vibration or shock.
- Minimum unobstructed space of 4 inches (10 cm) above and below the unit.
- Maximum ambient temperature of 50° C

Mounting dimensions

When mounting the 6435, please refer to the dimensions below:



2.5 Connecting to the 6435

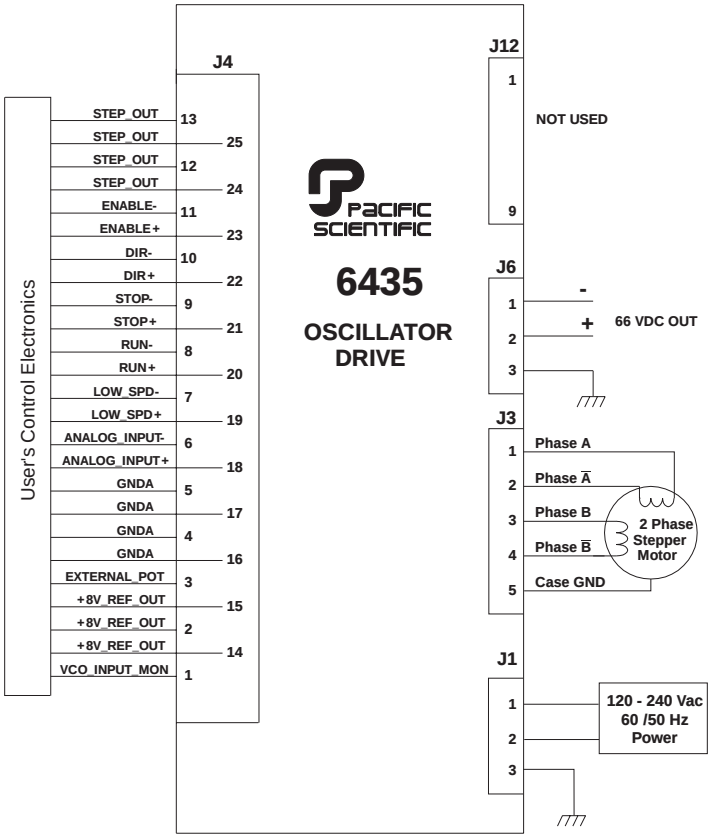
Introduction

The five input/output (I/O) connectors are:

- J1 - Power connector
- J3 - Motor connector
- J4 - Signal connector
- J6 - External 66 Vdc Out
- J12 - Not used

These inputs and outputs are shown on the following page.

Connection diagram



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 then described here.

Noise pickup reduction

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

Shock hazard reduction

Refer to section 2.2 for safety information that must be followed to reduce shock hazard.

2.5.1 J1 120/240 Vac Power Connector

Introduction

The J1 power connector should be used to power the 6435 from 120/240 Vac (60/50 Hz).

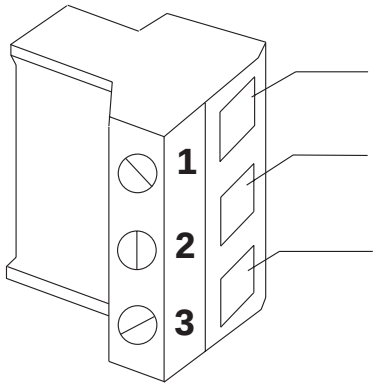
Mating connector

The J1 120/240 Vac power connector mates to a PCD 3-pin screw cable connector. The mating connector, supplied with the unit, is type ELFP03210.

Cable requirements

Use #16 AWG for the power supply cable. Use cable twisted at about 3 to 4 turns per inch (1 to 1.5 turns per centimeter).

Cable diagram - J1 power cable



White - AC L1

Black - AC L2

Green - Earth Ground

Procedure

1. Strip the wires 0.27 inch (7mm).
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 solder the tips of the cables going into the PCD connector. This can result in a loose connection.

2.5.2 J3 Motor Connections

Introduction

The J3 motor cable connects the drive to the motor windings and motor case. J3 utilizes a plug-in screw terminal/type connector to simplify assembly and allow quick connect and disconnect.

Note: *Never disconnect the motor connection while the drive is enabled. This may damage the drive and void the warranty.*

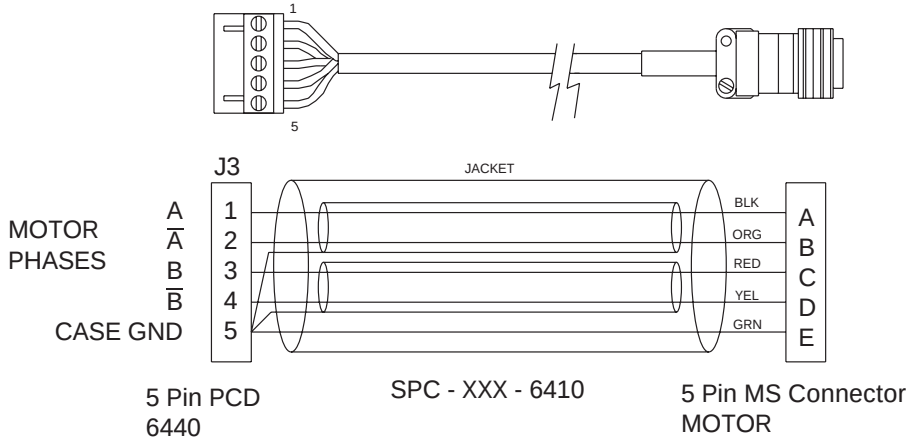
Pacific Scientific cable

Pacific Scientific makes cables that connect directly from J3 to our system motors. To order the cable from Pacific Scientific, use the order number SPC-xxx-6410, where "xxx" is the length, in feet (one-foot increments) up to 50 feet. For example, SPC-050-6410 is a cable 50 feet long.

Pacific Scientific makes cables for both E and H series stepper motors (SPC-xxx-6410) and K and N series stepper motors (SPC-xxx-6410-KN). Please refer to the correct diagram on the following page.

Pacific Scientific cabling diagram

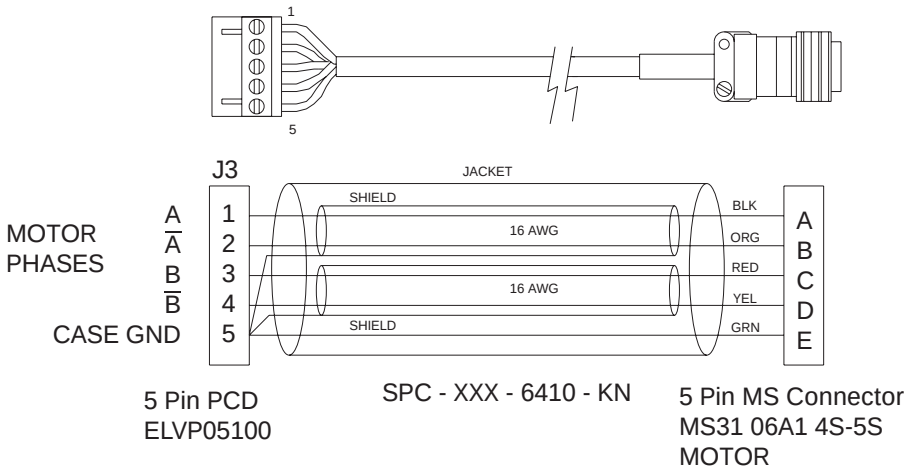
If you are using Pacific Scientific **E** and **H** series motor cable, with the mating connectors already attached, install as follows:



Note: *All wires are #16 AWG.*

Pacific Scientific cabling diagram

If you are using Pacific Scientific's **K** or **N** series stepper motors, install as follows:



Making your own cable

To make your own motor cable, follow the guidelines given below for wiring to the J3 mating connector. Depending on your motor configuration, refer to the appropriate diagram at the end of this section to determine the motor connections required.

J3 connection table

Output	Pin	Explanation
Motor Phase A	J3-1	Motor Phase A excitation. Twisted Pair.
Motor Phase $\overline{A}$	J3-2	
Motor Phase B	J3-3	Motor Phase B excitation. Twisted Pair.
Motor Phase $\overline{B}$	J3-4	
Drive Case (Earth) Ground	J3-5	Connected to the motor case ground.

Mating connector

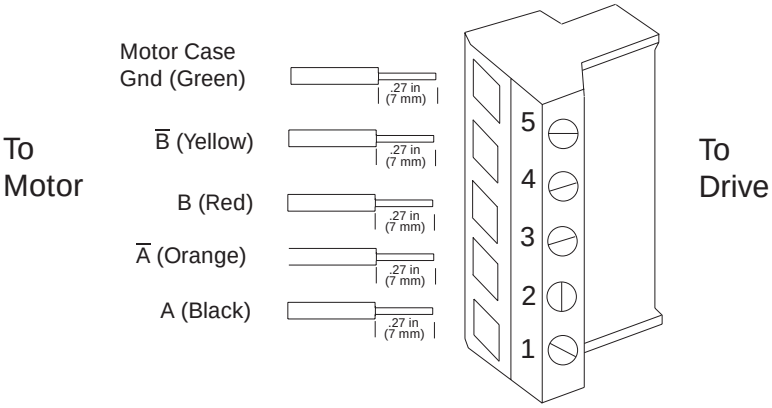
The J3 motor connector on the 6435 mates to a PCD 5-pin screw cable connector. The mating cable connector is type ELVP05100.

Cable requirements

The mating connector terminals will accept #16 to #18 AWG wire. Pacific Scientific recommends using #16 AWG.

For the motor cable, use cable with two twisted pairs twisted at about 3 to 4 turns per inch (1 to 1.5 turns per centimeter) for the motor phase excitations and a fifth wire for the case ground. As an option, the cable may be shielded to reduce radiated noise. A single shield can be used around both phase excitations and the ground wire or each phase excitation (twisted pair) can be individually shielded as in the Pacific Scientific cables. Connect shields to pin 5 of the mating connector.

Cabling diagram - J3 motor



Note: *The colors in the diagram follow the Pacific Scientific stepper motor cable color code.*

Procedure

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

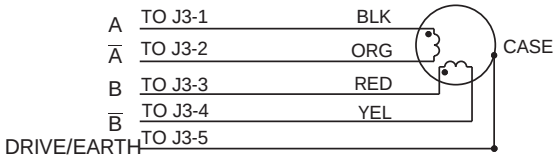
Note: *Make sure the screws on the PCD connector are tightened down firmly on the wiring.*

Caution

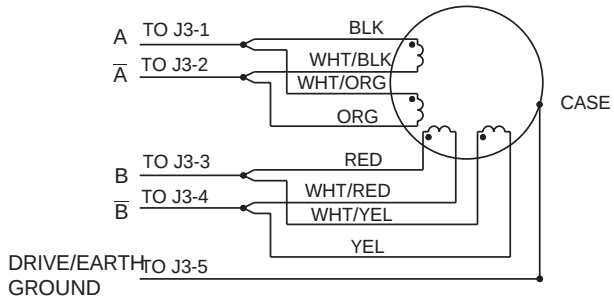
Do not solder the tips of the cables before insertion into the connector. Solder can contract and cause a loose connection over time.

Flying Lead Connection

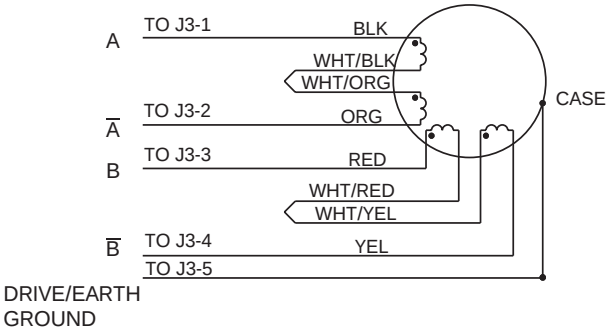
The figure below shows the connections required between the 6435 connector J3 and Pacific Scientific motors having flying leads. Connections are shown for 4 lead motors, 8 lead motors with paralleled windings, and 8 lead motors with series windings. Wire nuts may be used for the winding connections at the motor end.



FOUR LEAD MOTOR



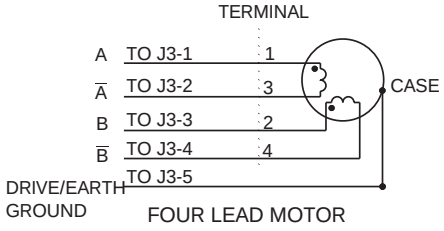
EIGHT LEAD MOTOR CONNECTED IN PARALLEL



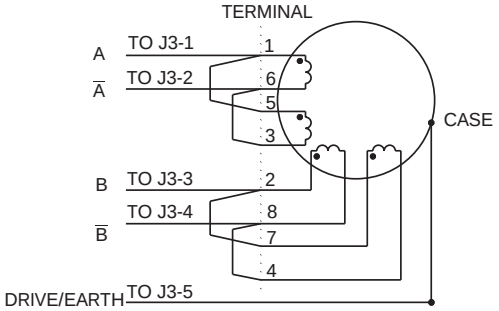
EIGHT LEAD MOTOR CONNECTED IN SERIES

Terminal board connections

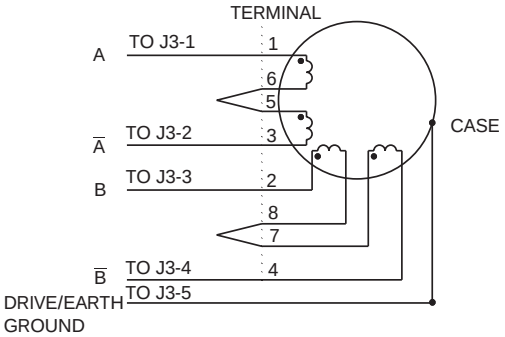
The figure below shows the connections required between the 6435 connector J3 and Pacific Scientific stepper motors having a terminal board in the rear end bell. Connections are shown for 4 lead motors, 8 lead motors with paralleled windings, and 8 lead motors with series windings.



FOUR LEAD MOTOR



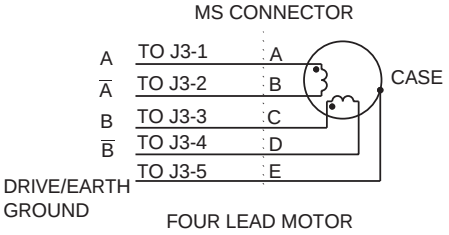
EIGHT LEAD MOTOR CONNECTED IN PARALLEL



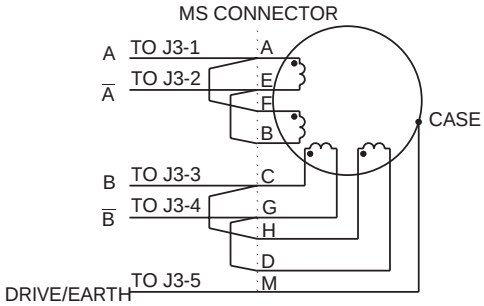
EIGHT LEAD MOTOR CONNECTED IN SERIES

MS connectors connection

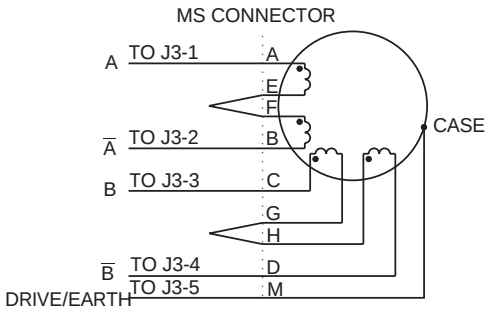
The figure below shows the connections required between the 6435 J3 connector and Pacific Scientific stepper motors having MS connectors. Connections are shown for 4 lead motors, 8 lead motors with paralleled windings, and 8 lead motors with series windings.



FOUR LEAD MOTOR



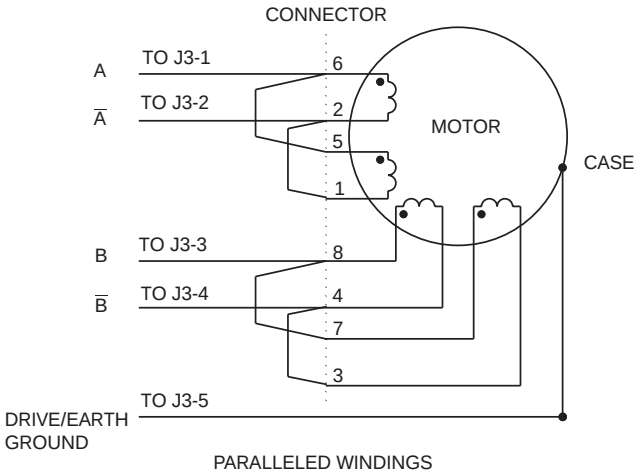
EIGHT LEAD MOTOR CONNECTED IN PARALLEL



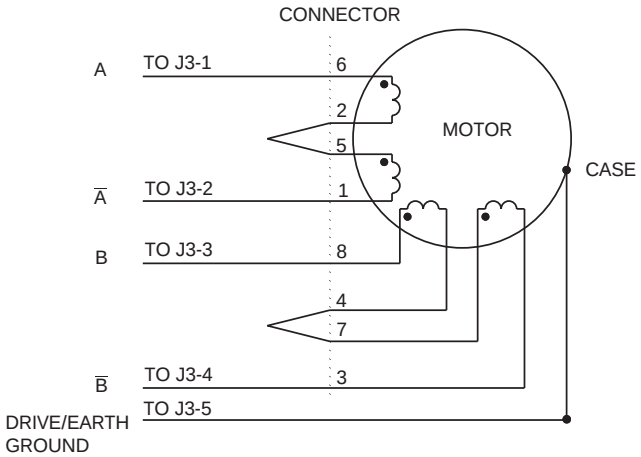
EIGHT LEAD MOTOR CONNECTED IN SERIES

Power Max motor connections

The figure below shows the connections required between the 6435 and Pacific Scientific Power Max Motors. Power Max motors have an eight pin connector and can be configured with either parallel or series windings.



PARALLELED WINDINGS



SERIES WINDINGS

2.5.3 J4 Signal Interface Connection

Introduction

The J4 control I/O signal interface accepts external speed potentiometer, analog input, direction, and enable signals from a user's control input or other sources and outputs pulse signals (STEP_OUTPUT) which indicates the 6435 is applying current to the motor windings. The control I/O interface also provides +8.0 volts for external reference voltage (+8V_REF_OUT) to power an external user's speed potentiometer and a monitor test point (VCO_INPUT_MON) to monitor the accel/decel motion profile.

J4 signal table

Input/Output	Pin(s)	Explanation
VCO_INPUT_MON	(J4-1)	Accel/Decel profile and final run speed command monitor point.
+8V_REF_OUT	(J4-2, 14, 15)	+8V user supply output. This supply is for the external customer potentiometer and step output interface and is referenced directly to the internal drive module GNDA.
EXTERNAL_POT	(J4-3)	Connection to the wiper which is the center tap of the external customer potentiometer. The voltage at this point controls the VCO oscillator frequency.
GNDA	(J4-4, 5, 16, 17)	Drive module return. This return is used in conjunction with the external customer potentiometer and step output interface and is not referenced directly to the user supply return.

Table cont'd

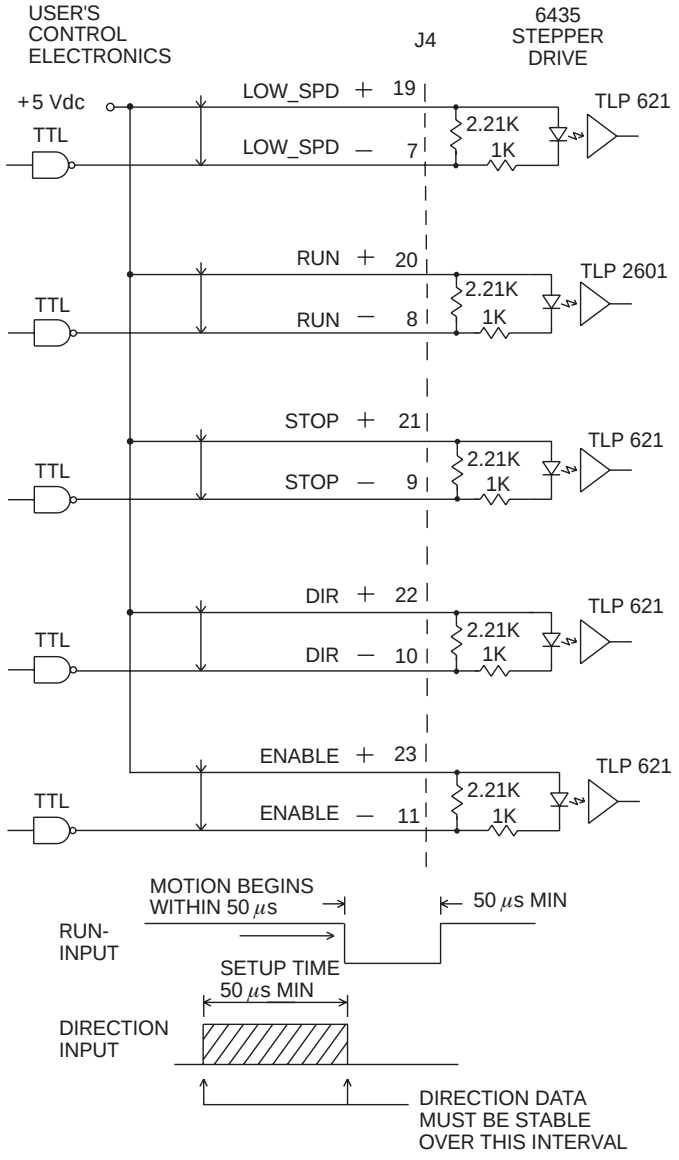
Input/Output	Pin(s)	Explanation
ANALOG_IN+	(J4-18)	Differential amplify analog input with customer supplied -10Vdc to +10Vdc analog input voltage for external analog input control. Analog input has an input impedance of 20KΩ.
ANALOG_IN-	(J4-6)	
LOW_SPD+	(J4-19)	Optically isolated input that selects the source of the analog speed command. The analog command is derived from the low speed potentiometer with low speed opto on.
LOW_SPD-	(J4-7)	
RUN_SPD+	(J4-20)	Optically isolated input that initiates the move of the motor rotation. In separate latched input mode, the RUN opto is placed in the RUN state when the RUN opto is driven momentarily. In single run mode, the run opto is controlled directly from the RUN input.
RUN_SPD-	(J4-8)	
STOP+	(J4-21)	Optically isolated input that terminates motor rotation. In separate latched input mode, the STOP opto is placed in the STOP state when the STOP opto is driven momentarily. In single STOP mode, the STOP opto is controlled directly from the STOP input. The 6435 is designed to be in the STOP state after applying power to insure that motion does not occur unintentionally.
STOP-	(J4-9)	

Table (cont'd)

Input/Output	Pin(s)	Explanation
DIR+	(J4-22)	Optically isolated input that determines the direction of motor rotation. If standard motor wiring is followed, the motor will turn clockwise if the opto current is zero. The sense of the DIR+ input can be reversed by reversing the connection of either (but not both) motor phase connectors (i.e. switching A and $\overline{A}$ OR B and $\overline{B}$). Refer to the figure at the end of the table for timing and circuit information.
DIR-	(J4-10)	
ENABLE+	(J4-23)	Optically isolated input used to enable or disable the 6435's power stage. The power stage is enabled if the opto current is zero and disabled if the opto is driven. Inserting the jumper reverses this functionality. See figure at the end of the table for circuit information. There is a delay of approximately 500μs after enabling the drive and power stage becoming active.
ENABLE-	(J4-11)	
STEP_OUT	(J4-12, 13, 24, 25)	The VCO output step pulses rate is proportional to the analog speed command and available to connected up to four additional 6410 drives.

Typical interface

The figure below shows a typical interface between the user's electronics and the 6435. The TTL gates should have totem pole outputs and be capable of sinking at least 10.0 mA at 0.4 volts.

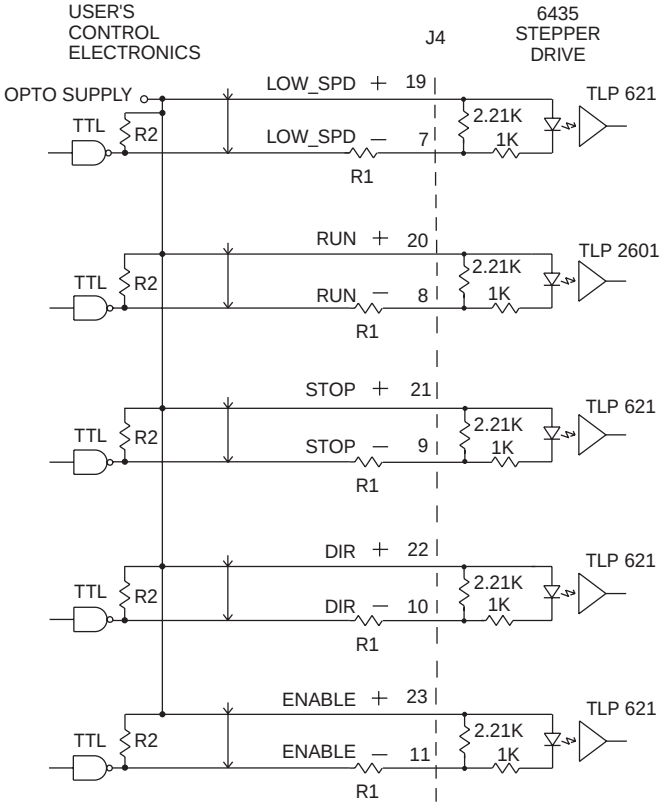


Higher voltage interface

Voltages up to 30 volts can be used for the opto power input to the 6435 drive. However, a resistor must be put in series with the command inputs as shown below. Values for several common supply voltages are given in the following table.

If the drives have open collector outputs, pull up resistors (R2) should be added as shown. A typical value of R2 is 2.7K.

Opto Supply to 6435	R1
+12 Vdc	1.5 K
+15 Vdc	2.2 K
+30 Vdc	6.8 K



Mating connector

The J4 signal interface connector is 25 contact female D connector. The mating cable connector is an ITT Cannon DB-255 with ITT Cannon DB110963-3 Hood.

2.5.4 J6 - External 66 Vdc Output Connection

Introduction

The J6 external 66 Vdc output allows the 6435 to power additional drives.

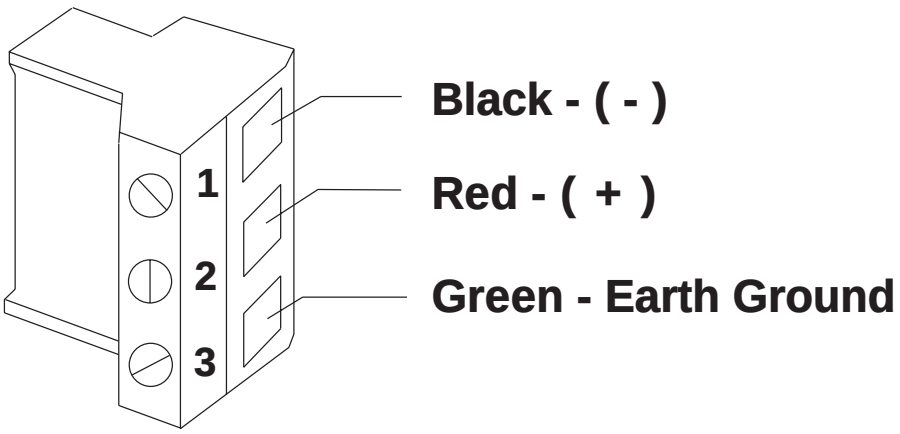
Mating connector

The J6 output connector mates to a PCD 3-pin screw cable connector. The mating connector, supplied with the unit, is type ELVP03100.

Cable requirements

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

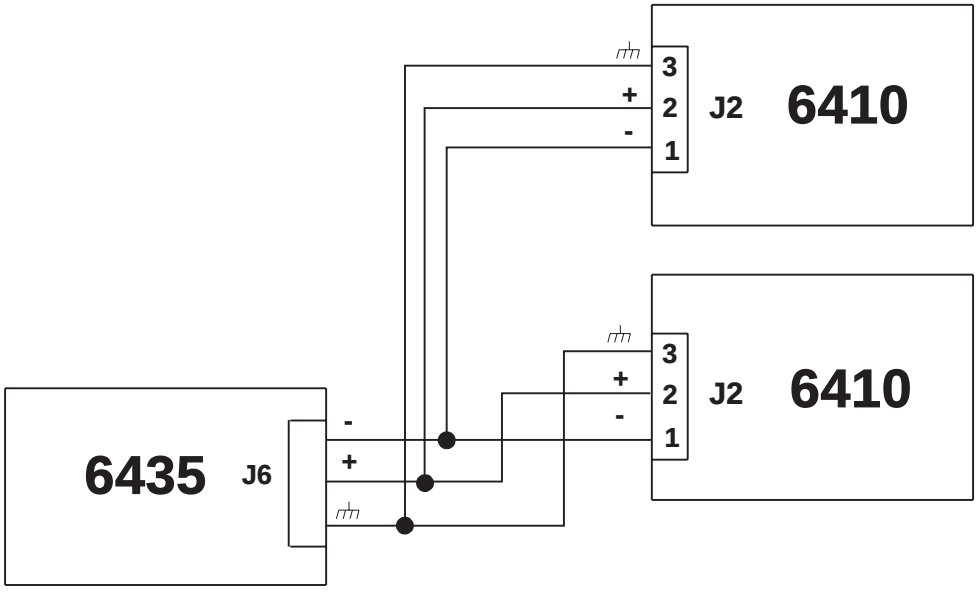
Cable diagram - 66 Vdc Output



Connection diagram

In multi-axis applications, if additional 6410s are added, it is preferable to run each power connection from the J6 DC output to the 6435 as shown below. DO NOT daisy-chain the power connections.

Note: *The total power available for both the internal and external drives is 66 Vdc @ 4.6 A or approximately 300 W ±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 6435 is powering additional 6410s with J6, a total of 1000 µf (maximum) 100 Vdc aluminum electrolytic capacitor, rated for 2A ripple current or greater @ 10 KHz and 105°C, must be installed at the 6410 (as close to the 6410 as possible) if the cable length is over 3 feet.* ***DO NOT*** *exceed 1000 µf total on J6 external connector.*

3 Powering Up the 6435 Drive

In this chapter

This chapter explains how to power up the 6435 drive after installation. Topics covered are:

- Oscillator Board potentiometers and Jumpers E1 - E8
- Setting up functions using switch S1
- AC Switch (SW1) Settings
- Testing the installation

This section is intended to familiarize the 6435 user with the hardware adjustments and settings required to power up and operate the 6435 drive.

Introduction

The 6435 drive is a two board assembly incorporating a Drive and an Oscillator card set. The topmost visible board is the Oscillator. The Oscillator board mounts on the Drive board and is separated by standoffs.

Drive

The drive has an eight position DIP switch (S1) controlling drive current, digital electronic damping, idle current reduction and step size. The DIP switch (S1) is easily accessible without removing the Oscillator card.

Oscillator

The Oscillator has four multi-turn potentiometers (R7, R14, R17, and R43) and eight plug on jumpers (E1 through E8) controlling motor run speed, low speed, accel/decel, high/low frequency range, min speed threshold (enable or disable), run/stop command (separate latched input or single input mode), and direction control.

Power

The power board has an AC switch (SW1) to select 120 or 240 Vac operation.

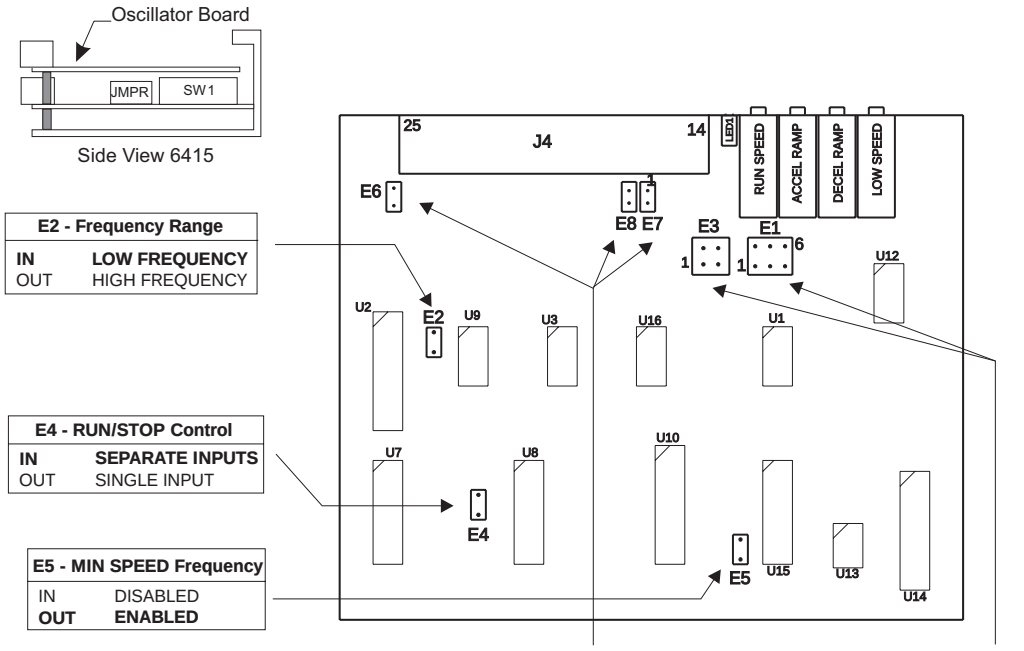
Warning

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

3.1 Oscillator Board Settings

Location of jumpers and pots

Note: *Default settings are in **bold**.*



E2 - Frequency Range	
IN	**LOW FREQUENCY**
OUT	HIGH FREQUENCY

E4 - RUN/STOP Control	
IN	**SEPARATE INPUTS**
OUT	SINGLE INPUT

E5 - MIN SPEED Frequency	
IN	DISABLED
OUT	**ENABLED**

Control Source	E6	E7	E8	DIR Opto	Analog In	Rotation
DIR+/DIR-	OUT	OUT	OUT	Driven	--------	CCW
	OUT	OUT	OUT	Not Driven	-------	CW
Jumpers	IN	IN	OUT	Driven	-------	CCW
	OUT	**OUT**	**OUT**	Not Driven	-------	CW
Analog In	IN	OUT	IN	Driven	Negative	CCW
	IN	OUT	IN	Not Driven	Positive	CW

E1	E3 -	Velocity Control Mode
1-2 IN	**1-2 IN**	Internal RUN SPEED Potentiometer
3-4 IN	N/A	External Potentiometer
5-6 IN	1-2 IN	External Analog Input
1-2 IN	3-4 IN	External Analog Input scaled by internal RUN SPEED potentiometer

3.1.1 Potentiometer Settings

Potentiometer Settings

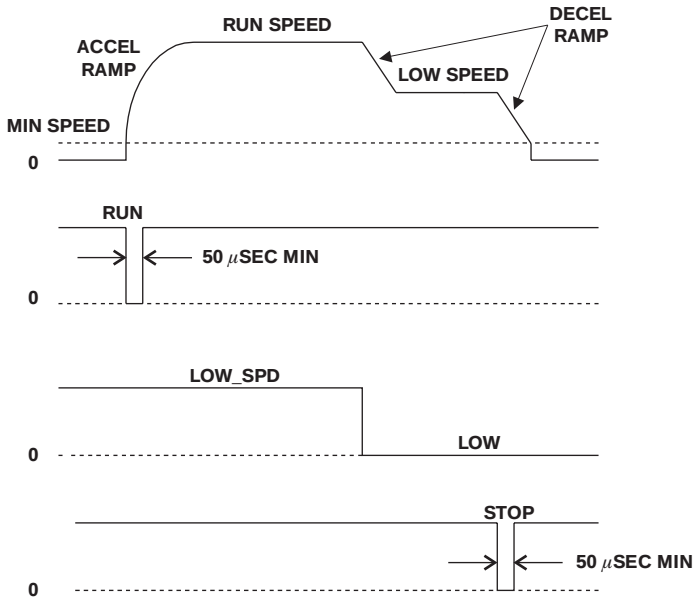
The 6435 has four potentiometers which adjust the output move profile of the motor. The acceleration rate and deceleration rate are usually adjusted and not changed for a particular motor/load combination. The run speed and low speed potentiometers are adjustable during operation with the velocity ramping up or down to the new velocity.

Adjustments for RUN SPEED, LOW SPEED, ACCEL RAMP, and DECEL RAMP are made with 4 multi-turn potentiometers.

LOW SPEED is typically set lower than RUN SPEED to allow for accurate stopping. It can also be used as a second RUN SPEED. ACCEL RAMP is typically set to minimize time to reach RUN SPEED without allowing the motor to stall. The DECEL RAMP is linear and stable, allowing a more precise, repeatable stopping position.

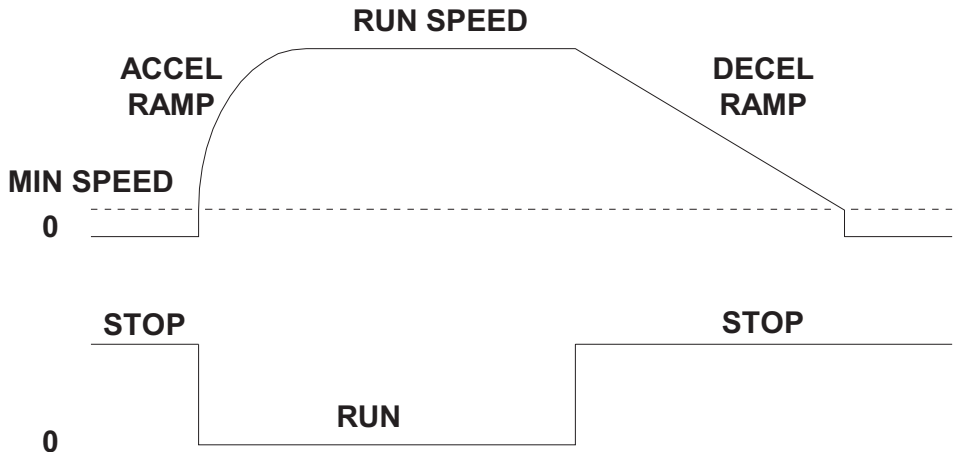
The figure below shows the typical velocity (pulse frequency) profile in response to separate RUN/STOP and RUN/LOW commands.

Separate command signals



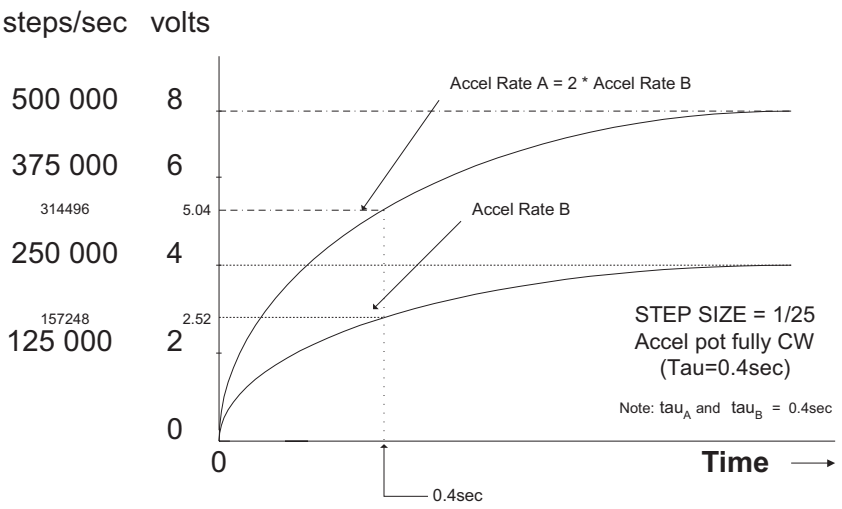
Single Command Signal

The figure below shows the typical velocity (pulse frequency) profile in response to a single RUN/STOP command.

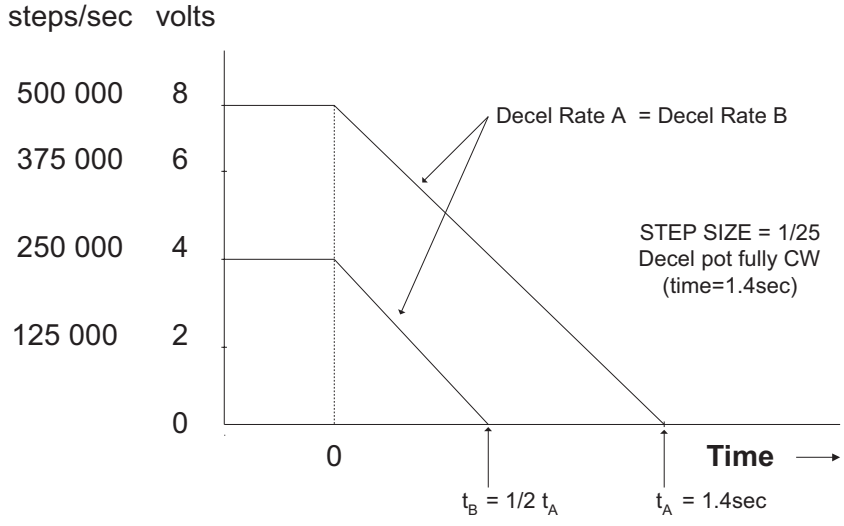


Acceleration rate is non-linear resulting in an exponential velocity ramp. Deceleration rate is constant, resulting in a linear velocity ramp. Accel Ramp Potentiometer (R14) and Decel Ramp Potentiometer (R17) adjust the time for acceleration and deceleration. With fixed accel potentiometer and step size settings, the acceleration rate is a function of speed control inputs. For example, increasing the run speed command by a factor of two will result in twice the acceleration rate.

Accel Ramp Pot



Decel Ramp Pot



3.1.2 Jumper Settings

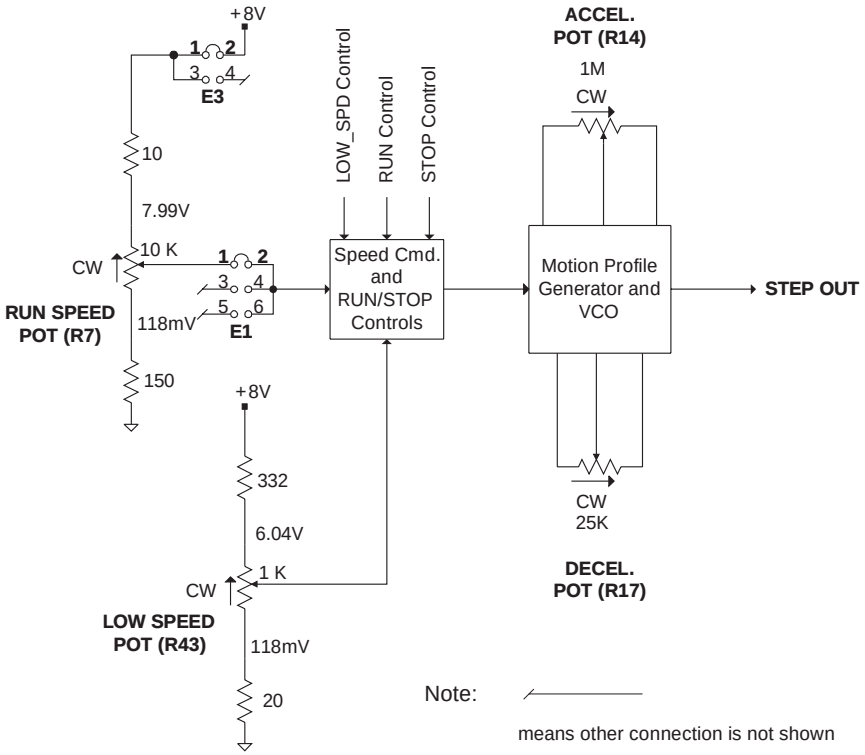
The Oscillator is configured with several jumpers as follows:

Speed Command Settings

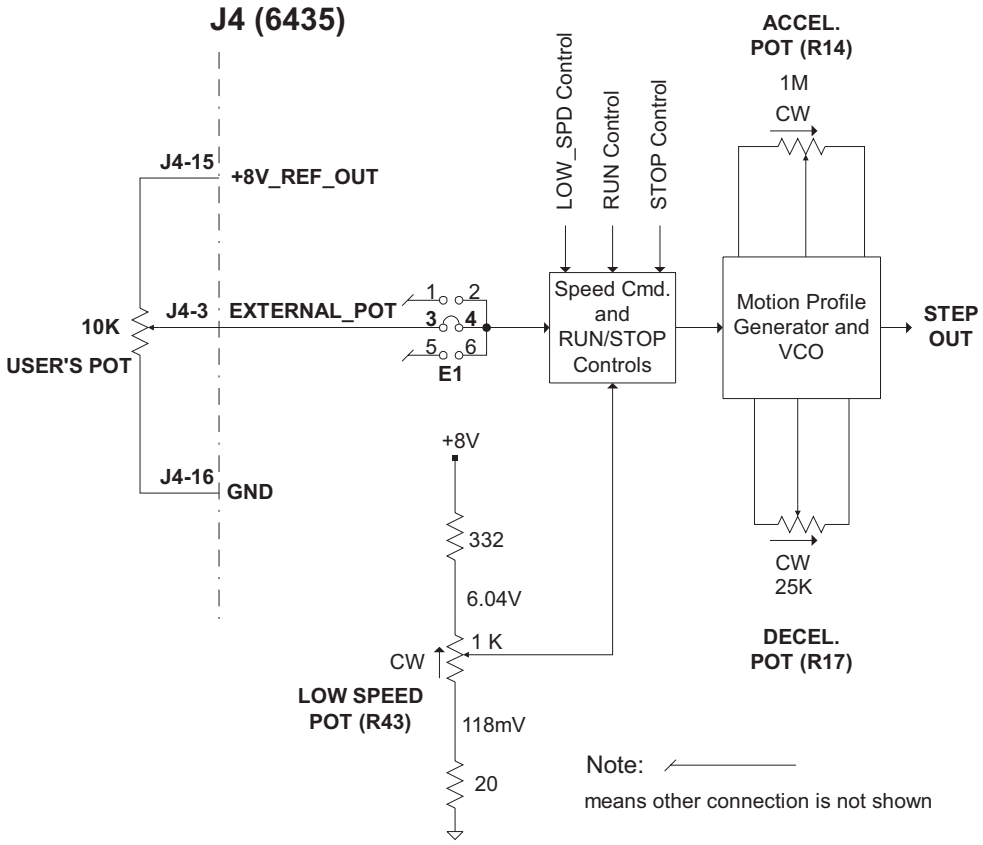
The analog speed command is derived from one of the following sources depending upon the E1 and E3 jumper configuration:

E1	E3	Velocity Control Mode
1-2 IN	1-2 IN	Internal RUN SPEED Potentiometer
3-4 IN	N/A	External Potentiometer
5-6 IN	1-2 IN	External Analog Input
1-2 IN	3-4 IN	External Analog Input scaled by internal RUN SPEED potentiometer

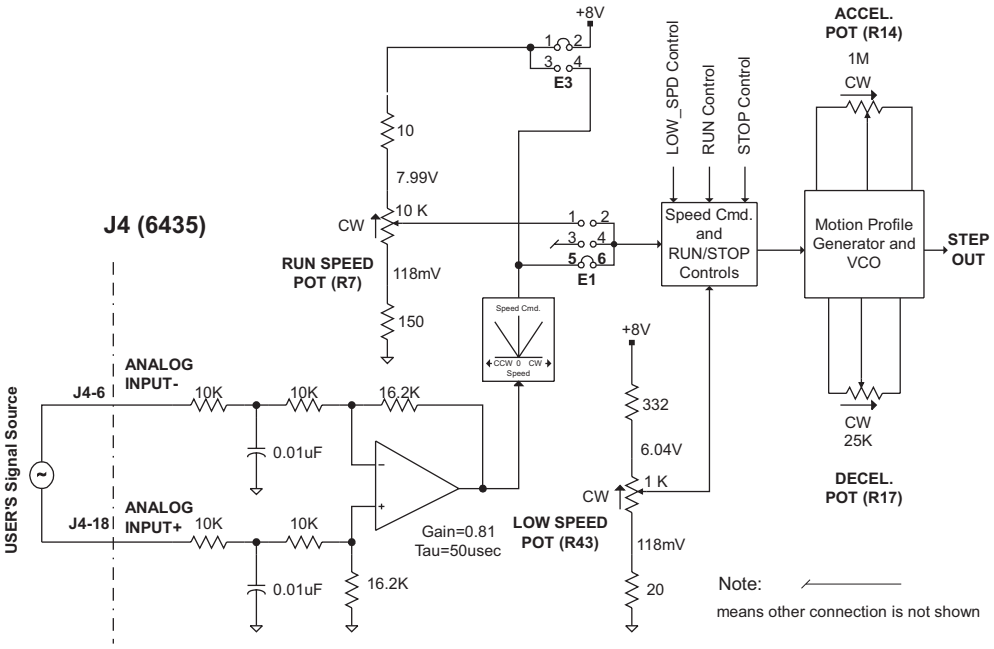
Internal RUN SPEED Pot



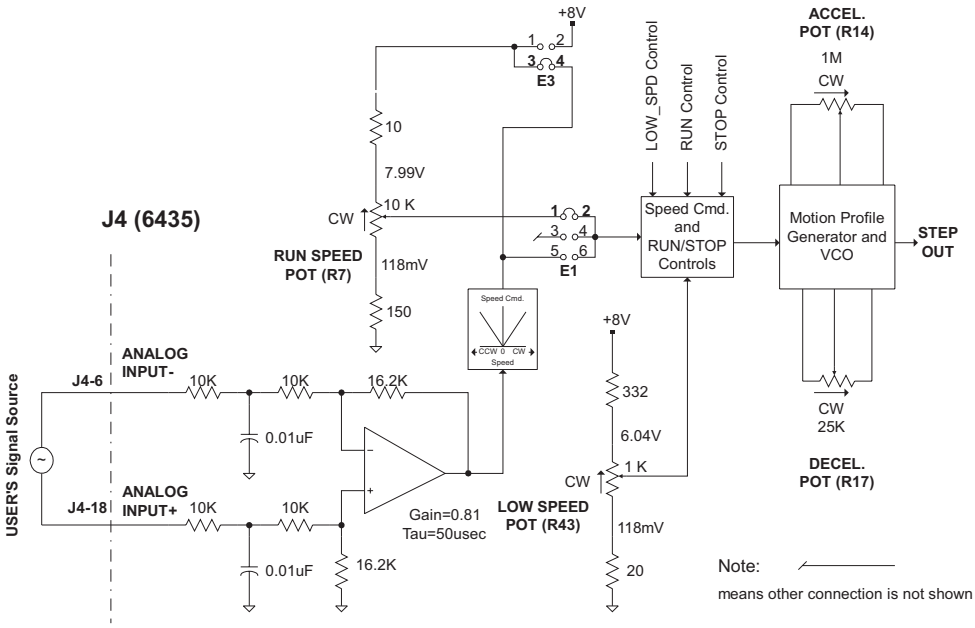
External Potentiometer



External Analog Input



External analog input with internal RUN SPEED pot

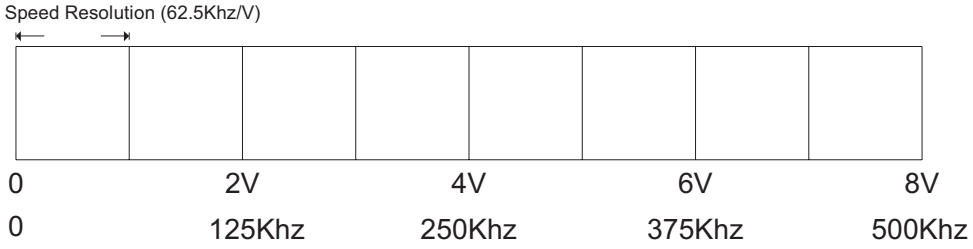


Frequency Range Settings

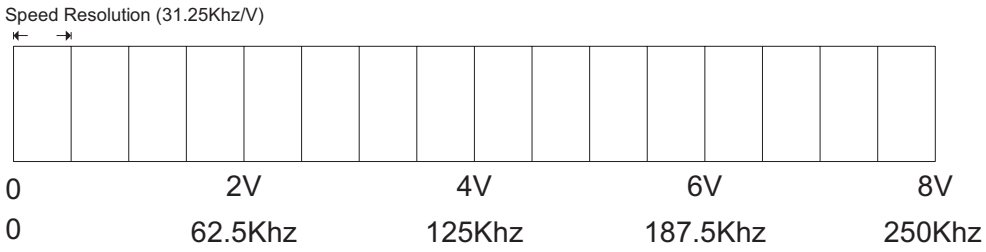
E2 jumper sets the VCO maximum output pulses frequency range. There are two frequency ranges selectable by a jumper to enhance output speed resolution.

E2	Frequency Range
IN	Low Frequency 250 KHz maximum VCO output pulses
OUT	High Frequency 500 KHz maximum VCO output pulses

Coarse Resolution (E2 Removed)



Fine Resolution (E2 Installed)



Run/Stop Command

E4	RUN/STOP Control
IN	Separate Inputs
OUT	Single Input

With the E4 jumper installed, the RUN/STOP (Clutch brake) mode of the 6435 is controlled by two separate optically isolated inputs. When the RUN opto is driven momentarily, the RUN/STOP latch is placed in the RUN state and the oscillator frequency ramps to the selected speed at a rate controlled by the ACCEL potentiometer. When the STOP opto is driven momentarily, the RUN/STOP latch is placed in the STOP state and the oscillator frequency ramps to zero frequency at a rate controlled by the DECEL potentiometer.

The RUN/STOP latch is designed to be in the STOP state after applying power to the 6435 to insure that motion does not occur unintentionally.

Single Input (E4 jumper removed)

If the E4 jumper is removed, the RUN/STOP mode of the drive is controlled directly from the RUN input. When the RUN opto is driven, the oscillator frequency ramps to the selected speed at a rate controlled by the ACCEL potentiometer. When the RUN opto is off, the oscillator frequency ramps to zero frequency at a rate controlled by the DECEL potentiometer.

Minimum Speed Threshold Setting

E5 jumper sets the VCO minimum output pulses frequency threshold depending on the E2 jumper configuration. Steps below this frequency are inhibited to insure no movement at end of decel ramp.

This functionality can be disabled by inserting jumper E5.

E5	MIN SPEED Frequency
IN	Disable minimum speed
OUT	Enable minimum speed

Min Speed Threshold: 4 KHz Max for high frequency range
2 KHz Max for low frequency range

Direction Command Setting

DIR+/DIR-

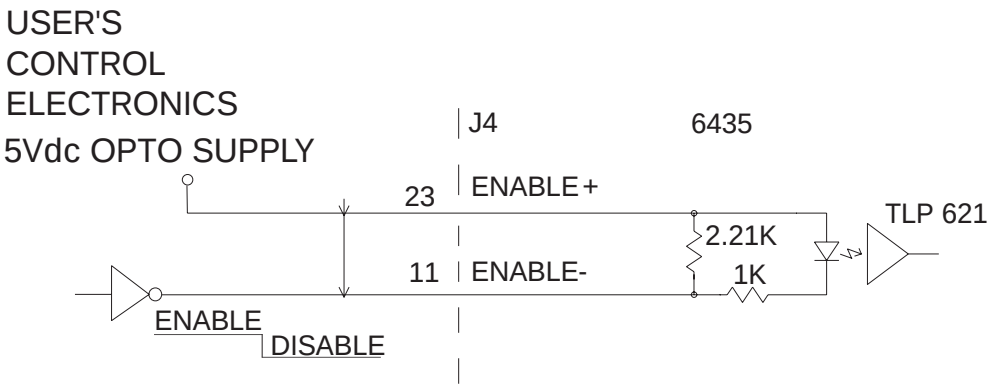
This optically isolated input controls the direction of motor rotation when the E6, E7 and E8 jumpers are removed. Motor rotation is CCW if the opto is driven and CW otherwise. The direction of motor rotation can also be controlled by the analog input or plug on jumpers as shown.

Control Source	Jumper E6	Jumper E7	Jumper E8	DIR Opto	Analog In	Rotation
DIR+/DIR-	Out	Out	Out	Driven	——-	CCW
	Out	Out	Out	Not Driven	——-	CW
Jumpers	In	In	Out	Driven	——-	CCW
	Out	Out	Out	Not Driven	——-	CW
Analog In	In	Out	In	Driven	Negative	CCW
	In	Out	In	Not Driven	Positive	CW

Oscillator - Enable

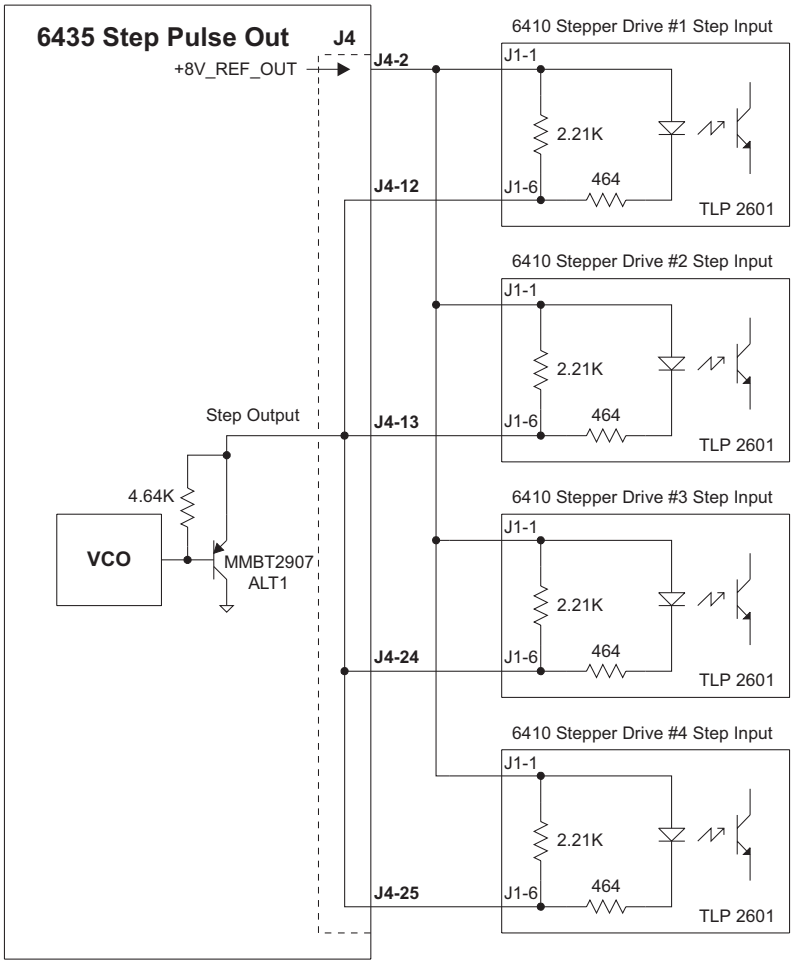
The 6435 Enable input factory default is the drive is enabled unless the Enable opto is driven.

Minimum opto current (opto on) 3 mA
Maximum opto current (opto on) 4.5 mA



Oscillator - External Step Pulse

The step pulse output from the VCO is available on J4-12, J4-13, J4-24, and J4-25. This can be connected to up to four additional 6410 drives.



Note:

100 mA Max (Max Reverse voltage = -50 Vdc)@ 25°C Ambient
50 mA Max (Max Reverse voltage = -50 Vdc)@ 50°C Ambient

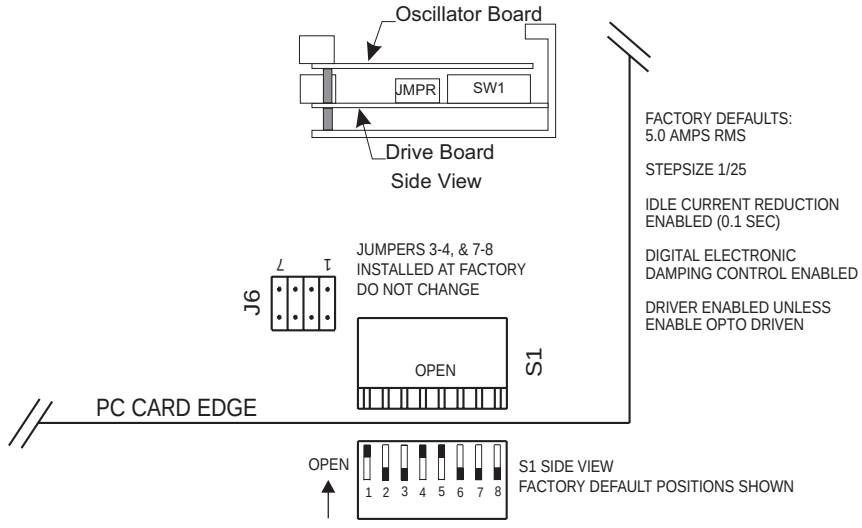
3.2 Drive Board Settings - Switch S1

Introduction

DIP switch S1 on the drive board sets the following:

- Step size
- Motor current level
- Digital electronic damping ON/OFF
- Idle current reduction

Location of S1



SW1 POSITION 1	SW1 POSITION 2	SW1 POSITION 3	STEP SIZE DEC JMPR IN
CLOSED	CLOSED	CLOSED	FULL
CLOSED	CLOSED	OPEN	HALF
CLOSED	OPEN	CLOSED	1/5
CLOSED	OPEN	OPEN	1/10
OPEN	CLOSED	CLOSED	1/25
OPEN	CLOSED	OPEN	1/50
OPEN	OPEN	CLOSED	1/125
OPEN	OPEN	OPEN	1/250

SW1 POSITION 6	SW1 POSITION 7	SW1 POSITION 8	MOTOR CURRENT AMPS RMS
CLOSED	CLOSED	CLOSED	5.0
CLOSED	CLOSED	OPEN	4.375
CLOSED	OPEN	CLOSED	3.750
CLOSED	OPEN	OPEN	3.125
OPEN	CLOSED	CLOSED	2.5
OPEN	CLOSED	OPEN	1.875
OPEN	OPEN	CLOSED	1.25
OPEN	OPEN	OPEN	0.625

SWI POSITION 4	DIGITAL ELECTRONIC DAMPING
CLOSED	DISABLED
OPEN	ENABLED

IDLE-T JUMPER	SW1 POSITION 5	IDLE CURRENT REDUCTION
IN	CLOSED	DISABLED
IN	OPEN	0.1 SEC DELAY

3.2.1 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:

Decimal	
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 1/5 or smaller results in:

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

3.2.2 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.

3.2.3 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 can be set to 0.1 second. Current to both motor windings is reduced by one-half.

The ICR function can be enabled/disabled and the time delay between the last step command and current reduction can be set to 0.1 seconds 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

3.2.4 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.

3.3 Setting AC Switch on Power Board

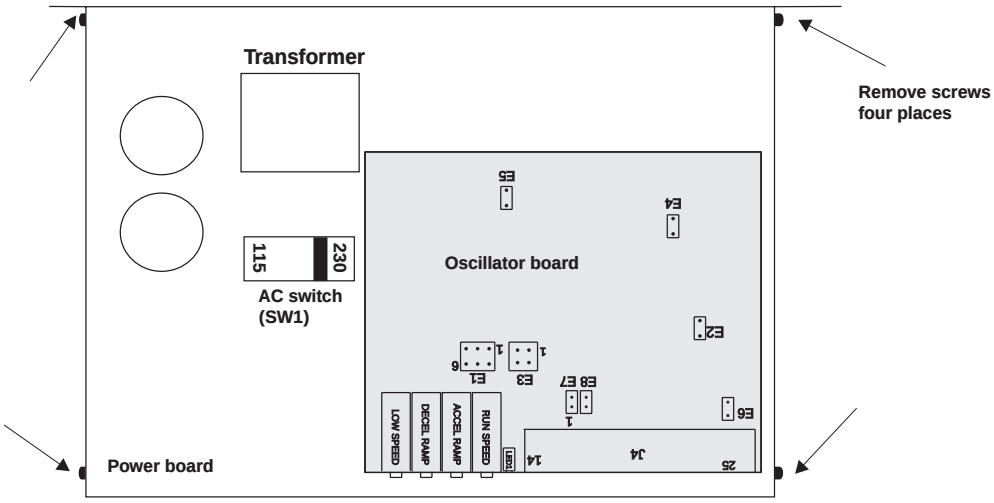
Introduction

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.*

3.4 Testing the Installation

Background

The following procedure verifies that the 6435 is installed properly and that it was not damaged during shipment.

Procedure

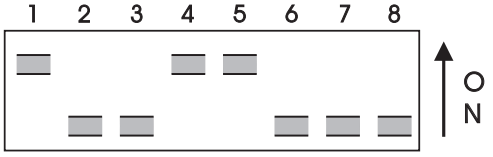
After installing the 6435 as described in Chapter 2, test your installation as follows.

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 all wiring and mounting to verify correct installation.
2. With the power Off, check that S1 is set as follows (factory default settings):



These settings reflect the following:

- Step size of 1/25
- Digital electronic damping enabled
- Idle current reduction enabled
- 5 A rms motor current

Warning

If the motor is rated at less than 5 A rms winding current, set positions 6, 7, & 8 accordingly.

3. Switch On power.

Signals test

1. Connect the motor leads and power supply wires to the 6435 Oscillator Board connectors as shown in Section 3.1.

Note: *J1 on the lower board is not used.*

2. Wire the control signals for the independent RUN, STOP and DIRECTION control into connector J4.

3. Pull the RUN signal Low (J4-8) and the motor will ramp up to speed. Pull the STOP signal low (J4-9) and the motor decelerates to a stop. When the DIRECTION signal is pulled low (J4-10) the motor will run in the CCW direction, looking at the motor shaft. If the desired rotation for a low signal is CW, swap the connections of the motor leads on pins J3-1 and J3-2.

Note: *Remove power from the drive before swapping the leads.*

4. If the motor emits a high frequency noise but the shaft is not rotating, stop the motor. Lower the RUN SPEED by turning the RUN SPEED potentiometer CCW. Increase the ACCEL RAMP by turning the ACCEL RAMP potentiometer CW.

5. After successfully establishing motion, the system can be powered down and connected to a load.

Getting help

If you need further assistance with your installation, please contact your local distributor.

4 Maintaining/Troubleshooting

In this chapter This chapter covers maintenance and troubleshooting of the 6435 unit.

4.1 Maintaining the 6435 Drive

Introduction The 6435 drives are designed for minimum maintenance. The following cleaning procedure, performed as needed will minimize problems due to dust and dirt build-up.

Procedure Remove superficial dust and dirt from the unit using clean, dry, low-pressure air.

4.2 Troubleshooting the 6435 Drive

Introduction The 6435 has an "POWER ON LED" output which is on when the drive is enabled and off when the drive is disabled or faulted due to any of the following:

- Output overcurrent (line-to-line or line-to-neutral short)
- Bus overvoltage
- Low voltage supply out of tolerance

Procedure Use the troubleshooting tables to diagnose and correct most problems. If you are unable to achieve satisfactory operation, contact your local Pacific Scientific Distributor or the Applications Engineering Department.

4.2.1 Troubleshooting the power board

Corrective action table Use the following table to troublshoot the power board.

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 ±3%. 1. If output voltage > 70 Vdc and < 78 Vdc add a load and ensure Vdc is ≈ 66Vdc. 2. If output voltage > 78 Vdc, return 6435 to factory for service.
	Drive board fault	See Section 4.2.2

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 and red LED keeps flashing **OR** Motor stops after running once.	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.
	Drive Board Fault.	See Section 4.2.2
	Internal failure.	Return to factory for service.

4.2.2 Troubleshooting the drive board

Corrective action table Use the following table to troublshoot the drive board.

SYMPTOM	CORRECTIVE ACTION
Motor produces no torque	Disconnect AC Power. Disconnect the motor cable and cycle the J1 power supply Off and On. Check the step output and VCO input monitor point. Also, check motor cable and motor for shorts across the windings or between the windings and the motor case.
	Verify that DIP Switch S1 position 6, 7, and 8 (current select) are set correctly. Re-check that the motor cable is wired correctly and properly plugged into the drive.
Motor produces torque but does not turn.	Make sure that the STEP output is switching.
Motor rotates in the wrong direction.	Check polarity of the DIRECTION input. Also, verify that the direction selection jumpers (E6, E7, E8) are set correctly. Reverse the A and $\overline{A}$ motor phases.
Motor does not reach expected position.	Check that the step size setting of the drive and speed potentiometer are set correctly. Verify that the motor does not stall. If it does: 1. Use a finer step size to avoid low-speed resonance problems. 2. Enable Digital Electronic Damping (S1 position 4 OFF).

4.2.3 Troubleshooting the oscillator board

Corrective action table

SYMPTOM	CORRECTIVE ACTION
Drive is disabled.	1. Turn the bus power off. 2. Disconnect the motor winding from the drive. 3. Turn the bus power back to on., check that the +8V reference output (+8V_REF_OUT) is within specifications. 4. Remove any external connections to the enable input opto (ENABLE). 5. Reapply the power. If still disabled, drive has internal short.
Motor produces torque, but does not run.	1. No Step pulses out - Check that there is a final speed command voltage at the VCO monitor test point (VCO_INPUT_MON) and the step pulses output (STEP_OUT) is switching. Also verify that E1 and E3 jumpers are set correctly. 2. Loss of phase current in one winding. Check phase current in both phases by placing an ammeter in series with each winding. If not present, check for open circuit in motor phase winding by measuring resistance. 3. One motor phase not wired correctly at stepping motor. Check stepping motor wiring. 4. Step pulses output (STEP_OUT) is too high. Lower step pulses output by adjusting Run Speed and Accel/Decel Potentiometers. Also check to make sure that the step size and frequency range jumper (E2) are set correctly.
Motor misses steps.	Incorrect run speed or low speed. Adjust run speed potentiometer or low speed potentiometer. Incorrect accel ramp time or decel time. Adjust accel potentiometer or decel potentiometer.

If the drive is defective

If you cannot correct the drive problem, or if it is defective, return it to Pacific Scientific for repair or replacement.

Return procedure

1. Call Pacific Scientific at (815) 226-3100 from 8am to 6pm Eastern Standard Time to get a Returned Materials Authorization Number (RMA#).

Note: *Do not attempt to return the 6435 or any other equipment without a valid RMA#. Returns received without a valid RMA# will not be accepted and will be 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 drive 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 motors is:*

Pacific Scientific

4301 Kishwaukee Street

Rockford, IL 61105

Attn: Stepper Repair Department, RMA# _____

Shipment of your drive or motor to Pacific Scientific constitutes authorization to repair the unit. Refer to Pacific Scientific's repair policy for standard repair charges. Your repaired unit will be 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 120/240 Vac (+10%, -15%) 60/50 Hz

Rated drive current (motor phase current)

Setting	
5 A	5A ± 0.25A
4.375	4.375 ± 0.2A
3.75	3.75 ± 0.2 A
3.125	3.125 ± 0.15 A
2.5	2.5 ± 0.15 A
1.875	1.875 ± 0.125
1.25	1.25 ± 0.125
0.625	0.625 ± 0.1 A

Fuse 5 A Slo-Blo 250 Vac

Drive circuit Two-phase bipolar, chopper current regulated

Chopper frequency 20 KHz, nominal

Step size

Switch settable	Steps/motor revolution (1.8^{o} stepper motor)
Full	200
1/2	400
1/5	1000
1/10	2000
1/25	5000
1/50	10000
1/125	25000
1/250	50000

Signal input requirements

(See circuit diagram, Section 2.5.3)

Optically Isolated Inputs:

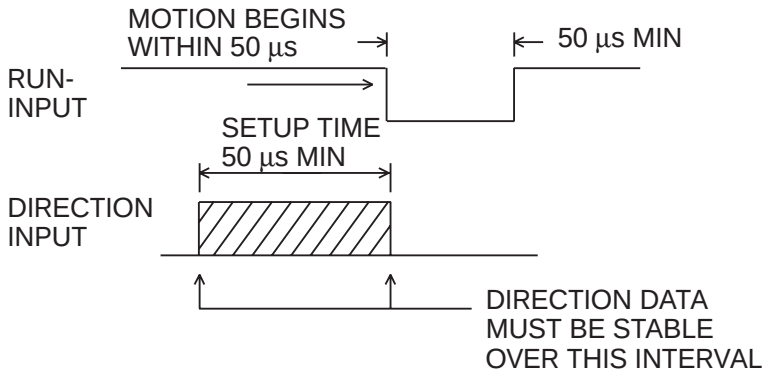
Input	Min Input Current - Opto ON	Max Input Current	Max Reverse Voltage
J4-19, J4-7 Low Speed	3.0 mA	4.5 mA	5 volts
J4-22, J4-10 Direction	3.0 mA	4.5 mA	5 volts
J4-23, J4-11 Enable	3.0 mA	4.5 mA	5 volts
J4-20, J4-8 Run	3.0 mA	4.5 mA	5 volts
J4-21, J4-9 Stop	3.0 mA	4.5 mA	5 volts

Signal output characteristics (See circuit diagram, Section 2.5.3)

J4-1 VCO Input Monitor	≅ 100KΩ Input Impedance
J4-2, J4-14, J4-15 +8 V Ref Out	50 mA max @ 25°C Ambient 25 mA max @ 50°C Ambient
J4-3 External Pot	≅ 1MΩ Input Impedance
J4-12, J4-13, J4-24, J4-25 Step Out	100 ma Max (Max Reverse voltage = -50 Vdc)@ 25°C Ambient 50 ma Max (Max Reverse voltage = -50 Vdc)@ 50°C Ambient

Maximum step rate 500 KHz

Run/Direction timing requirements The figure below show the required timing relationship between the RUN and DIRECTION inputs:



Specifications

Minimum ramp time for step rate (Accel/Decel)

50 milliseconds (This restriction only applies with digital electronic damping circuit enabled.

Driver state generator transition delay relative to input step

1. With digital electronic damping circuit enabled, at pulse frequencies less than 500 full steps/sec, delay is less than 500 μsec. At frequencies greater than 500 full steps/sec, delay is less than 270° of the input pulse period.
2. With digital electronic damping circuit disabled, delay is less than 10 μsec at all step frequencies.

RUN SPEED Control (Analog Input)

Analog Input Range

± 10 Vdc
Also controllable with internal or external potentiometers

Analog Input Impedance

20 KΩ (differential amp)

High Frequency Range

RUN SPEED Control	8 KHz to 500 KHz
LOW SPEED Control	8 KHz to 370 KHz

Low Frequency Range

RUN SPEED Control	4 KHz to 250 KHz
LOW SPEED Control	4 KHz to 180 KHz

RUN SPEED/LOW SPEED

Stability Over Temp. /Range	±1% of full scale (typical)

ACCEL RAMP (exponential)

accel pot fully CW	0.4 sec (single time constant)
accel pot fully CCW	0.4 msec (single time constant)

DECEL RAMP (linear)

decel pot fully CW	1.4 sec
decel pot fully CCW	6.0 msec

MIN SPEED

4 Khz Maximum (high frequency range)
2 KHz Maximum (low frequency range)

Steps below this frequency are inhibited to insure no movement at end of decel ramp. This functionality can be disabled by inserting jumper E5.

Note: *Motor rpm = 0.3 * Freq. (Hz)/step size. For example: If frequency = 500,000 Hz and step size = 125, rpm = 1200.*

Environmental

Operating Temperature

Full rated current 0 to 50° C ambient air

Storage temperature

-40°C to +70°C

Humidity Range

10 to 90%, non-condensing

Mechanical

Dimensions Refer to Section 2.4

Weight 6.0 lb nominal

Connectors

AC Input	PCD ELFH03210 connector. Mating connector: PCD ELFP03210.
Signal	9 contact female D connector, Mating connector: ITT Cannon DE-9P with ITT Cannon DE110963 Hood and D20419 Clamp Kit.
Motor	PCD ELVH0510 connector. Mating connector: PCD ELVP05100.
66 Vdc output	PCD ELVH0310 connector. Mating connector: PCD ELVP03100.

Appendix B Ordering Information

Background

This appendix lists 6435 part numbers and gives information on ordering.

6435 part number table

Part	Pacific Scientific Order #	Comment
Stepper Drive	6435	
Connector Kit	CK6435	25-pin D connector
		5-pin PCD
		3-pin PCD
		3-pin PCD
Installation and Hardware Manual	MA6435	
Motor Cable	SPC-xxx-6410 SPC-xxx-6410-KN*	xxx represents length in feet; for example, SPC-005-6410 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 to Pacific Scientific motors.

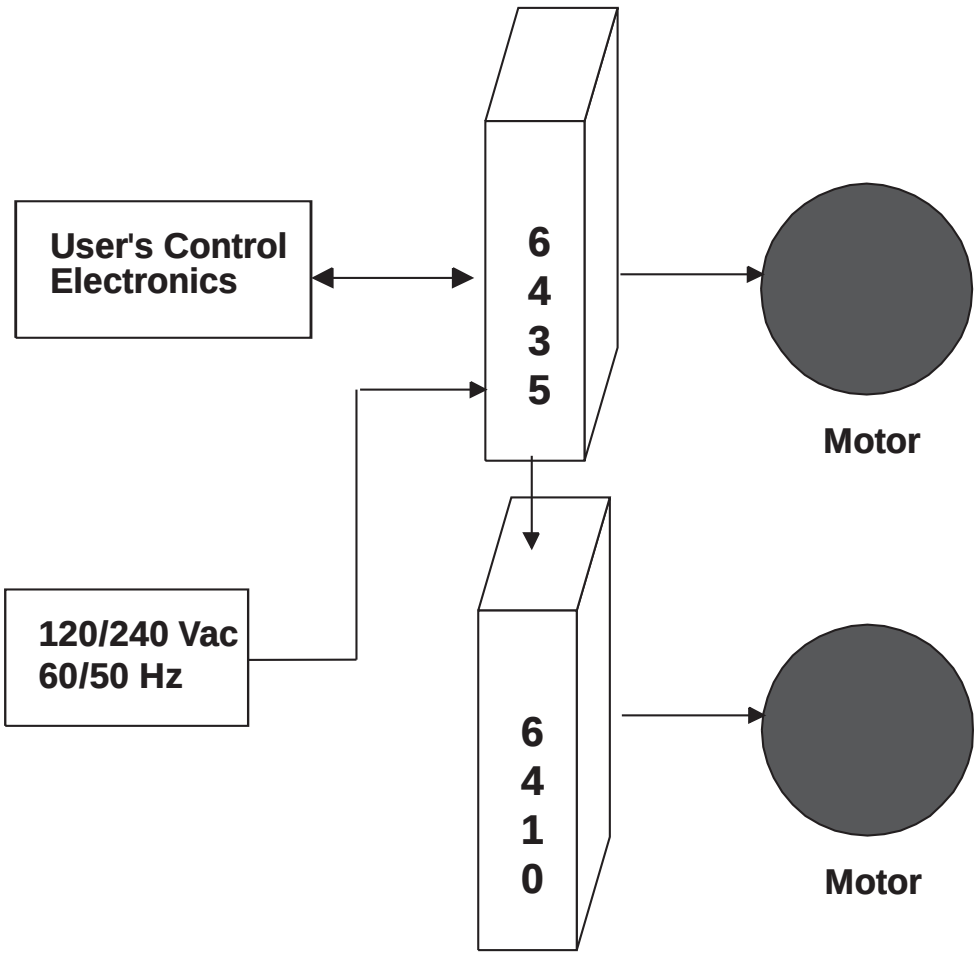
***Note:** *Cables for* **K** *and* **N** *series stepper motors.*

How to order	Contact Pacific Scientific to order these parts.
Call	815-226-3100 from 8am to 6pm Eastern Standard Time.
Write	Pacific Scientific 4301 Kishwaukee Street Rockford, IL 61105
Fax	815-226-3048

Appendix C Application Examples

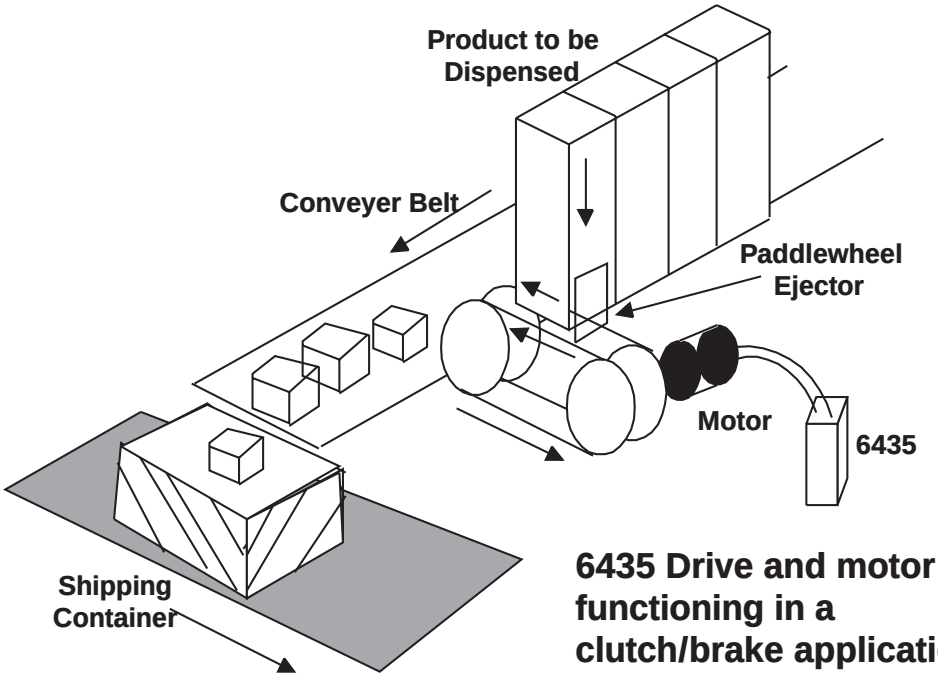
Introduction The following examples give a flavor of just a few of the myriad applications for the 6435.

C.1 Standalone Operation



C.2 6435 Dispensing Product onto Conveyer Belt

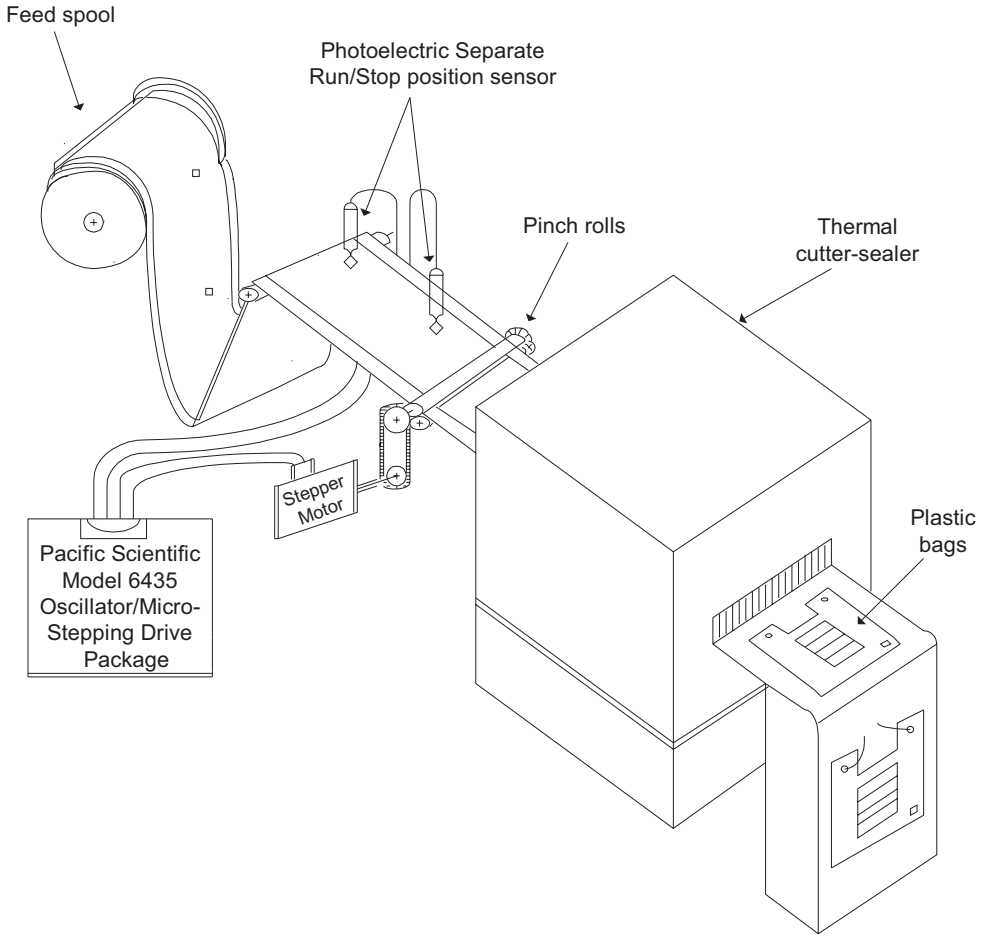
This example shows the 6435 Oscillator/Microstepping Drive Module and motor dispensing products onto a conveyor belt and into a shipping container. The stepper motor supplies start-stop motion to a paddlewheel ejector to dispense the product. An optic sensor is used to advance the paddlewheel to the starting point. An external Start signal initiates motion to eject the product, the motion continues for one revolution until the paddlewheel is aligned for the next cycle.



6435 Drive and motor functioning in a clutch/brake application

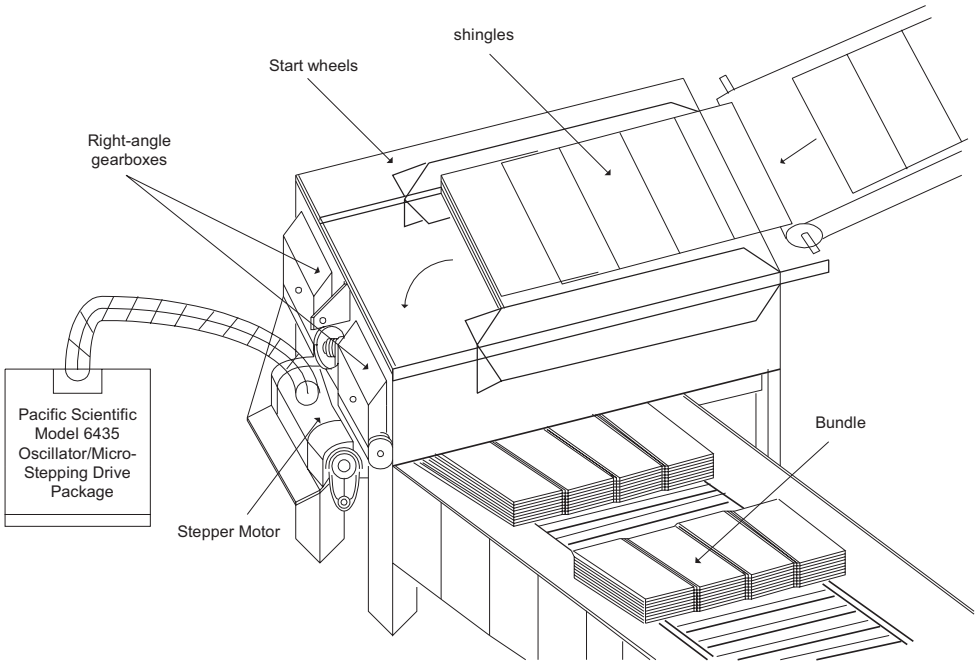
C.3 6435 Clutch Brake

Cut-and-Seal Machine uses 6435 Oscillator/Microstepping Drive Module to accurately index pinch rolls so plastic web is in position for cutting and sealing into bags.



C.4 6435 Shingle Catcher

Roofing shingle machine uses 6435 Oscillator/Microstepping Drive Module to catch and stack fast moving shingles and then place them in a bundle forming chamber.



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