# SP2K™ Series
# Multi-Axis Digital Positioning Servodrive User's Manual

Revision 1.4 (6/99)
P/N MNLSP2k-UM-1.4

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Other manuals for use with the SP2k:

Developer's Manual – P/N: MNLSP2k-DM

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# PRODUCT WARRANTY

Westamp Incorporated, hereafter referred to as "Seller", warrants that the article delivered will be free from defects in material and workmanship under normal use and service. The Seller's obligations under this warranty are limited to replacing or repairing, at the Seller's option, any of said articles which shall within two (2) years after shipment be returned to the Seller's factory of origin, transportation charges prepaid, and which are, after examination by the Seller, disclosed to the Seller's satisfaction to be thus defective.

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This warranty shall not apply to any such articles which have been repaired or altered, except by Seller, or which have been subject to misuse, negligence or accident. The aforementioned provisions do not extend the original warranty period of any article which has been repaired or replaced by the Seller.

# FOREWORD

## Manual Organization

This manual is organized in such a manner to present the relevant and necessary information in an order that will allow the user to get up and running quickly. By reviewing the information chapter by chapter in the order presented, the user is provided with important information in a logical manner.

This chapter, for example, provides information necessary to understand all of the options and configurations available with your SP2k series servodrive system.

## Typographic Conventions

⚠ **THIS SYMBOL REPRESENTS A CAUTION THAT WARNS OF POSSIBLE INJURY OR DEATH TO PERSONNEL OR DAMAGE TO MACHINERY. WHENEVER THIS SYMBOL IS PRESENT IN THIS MANUAL, IT IS EXTREMELY IMPORTANT THAT THE TEXT ASSOCIATED WITH THE SYMBOL IS COMPLETELY READ AND UNDERSTOOD. THIS WILL HELP AVOID PERSONAL INJURY, DEATH AND/OR DAMAGE TO MACHINES.**

This symbol represents a caution that warns of possible damage to the servodrive or machinery. Whenever this symbol is present in this manual, it is extremely important that the text associated with the symbol is completely read and understood. This will help avoid damage to the servodrives, motors and machinery.

# SYSTEM OVERVIEW

This chapter provides an overview of all of the system configurations and options that make up the SP2k series servodrive.

## SP2k Series Digital Servodrives

### SP2k Series Input Power

All SP2k Series products include universal AC input power supplies that will accept from 97 to 265 VAC, 50/60 Hz. Note that the motor's achievable top speed is directly proportional to the AC input voltage. All SP2k Series speed versus torque curves for 2-inch BR Series servomotors were generated based on a 120 VAC input. SP2k speed versus torque curves for all other BR Series brushless servomotors were generated based on a 240 VAC, three phase main. Lower than published top speeds can be expected with input voltage mains below the specified input level.

### Overview of Connections

| | |
|---|---|
| Input Power Connector | TB401 |
| Motor Output Power Connector | TB402 |
| DC Power Input/Shunt Connector | TB403 |
| Control Power | P22 |
| Servodrive I/O | P1 |
| Motor Feedback Connector | P2 |
| Servodrive I/O | P11 |
| Axis 2 Servodrive Port | P12 |
| Watchdog Port | P13 |
| Axis 3 Servodrive Port | P14 |
| Axis 4 Servodrive Port | P15 |
| COM Port #1 | P16 |
| COM Port #2 | P17 |
| Analog Input Port | P18 |
| Digital Inputs | P19 |
| Digital Outputs | P20 |
| External I/O Power Input | P21 |

All “TB” connectors are screw terminal blocks. All “P” connectors are quick-disconnect Phoenix screw terminals.

## Adjustments

There are no user adjustments on the SP2k.

## Servo Fault Indications

The SP2k provides individual fault indications for all servodrive faults. In addition, a RESET push-button is provided to reset the servodrive manually after a servodrive fault has been cleared. For safety reasons, the RESET push-button only resets the power electronics. Controller electronics may only be reset by removal and reapplication of control power or by issuing the “REBOOT” command in direct command mode.

The following LED Indications and their descriptions are listed below. For a detailed description of possible causes, refer to the Trouble Shooting Guide, Fault Indications.

| Fault Condition | DESCRIPTION |
|---|---|
| FEEDBACK | Feedback Fault - Loss of an encoder signal. |
| RMS | RMS current has exceeded the servodrive's and/or motor’s rating. |
| SURGE | Surge over currents from the servodrive output, usually caused by a short circuit in the output leads. |
| GROUND | Motor Ground Fault - Non-returning servodrive output currents have been sensed, usually caused by a servodrive output lead shorted to ground. |
| LOGIC | 1- The sum of the + and - 12V has dropped below 22V.<br>2- The 5V supply has dropped below 4.5V. |
| TEMP | 1- Excessive servodrive heat sink temperature.<br>2- Excessive motor temperature. |
| REGEN | Excessive regenerative energy from a decelerating load. |

## P1 Limit / Enable Jumpers

The SP2k servodrive power electronics may be enabled via inputs on the P1 connector. There are both normally open and normally closed enable inputs. The normally closed enable inputs on pins 24, 25 and 26 must be closed to enable the servodrive power stage. Pin 26 is closed internally in the

SP2k by the controller watchdog. The following table outlines the function of these pins.

| P1 Pin | Function /Description |
|---|---|
| 24 | **Normally Closed Negative Limit Input -** When this input is high all negative incremental or absolute MOVE commands are ignored. This input must be taken low for normal operation. Internal pull-ups will hold this pin high (+12v). Internal diodes allow for input voltages of up to 40V to be applied to this pin when in its high state.<br><br>Note that this input disables current in one direction only. The Drive Ready will remain asserted irrespective of the state of this input. |
| 25 | **Normally Closed Positive Limit Input -** When this input is high all positive incremental or absolute MOVE commands are ignored. This input must be taken low for normal operation. Internal pull-ups will hold this pin high (+12v). Internal diodes allow for voltages of up to 40V to be applied to this pin when in its high state.<br><br>Note that this input disables current in one direction only. The Drive Ready will remain asserted irrespective of the state of this input. |
| 26 | **Normally Closed Enable Input -** This input must be taken low for normal operation. An internal connection to the SP2k controller's normally-closed watchdog line continues to satisfy this requirement as long as the controller CPU is functioning normally. If the controller CPU ceases to function, for example, if it were to lose power, the watchdog line would no longer hold pin 26 low, which would then disable the SP2k's servodrive. Connecting pin 26 to pin 27 is not recommended, since this would defeat this protection.<br><br>Note that this input disables all output, and will deactivate the Drive Ready signal. |
| 27 | **Digital Ground** |

The factory default is for P1 pins 24 and 25 to be tied to Ground (P1 pin 27). This allows for normal operation when the normally closed Limit jumpers are not used. Internally, the normally closed watchdog line from the SP2k controller is tied to pin 26.

## Fast Power-Up Jumper

Without P1 pin 29 and 30 shorted together, the servodrive has a 1 to 2 second startup delay to allow system components time to stabilize during power initialization. After the startup delay time, the Drive Ready signal will be asserted (refer to Servodrive Connection Definitions and Specifications). The startup delay may be reduced to between 100 and 200 milliseconds by placing a jumper wire between pins 29 and 30.

## Servodrive I/O

The Control I/O connector provides access to the command signal and encoder feedback signals of the internal servodrive. The command signal is from the first axis of the SP2k motion controller. The encoder signal is for the same axis. It is useful to have access to the command signal for external monitoring and to the encoder signals for master/slave synchronization to other external devices. The table below outlines the pin designations for this connector. Refer to P11 *Control I/O* connector under *Servodrive Connection Definitions and Specifications* for a complete description and specifications for this connector.

| HD15 (P11) Pin# | Function |
|---|---|
| 1 | Speed/Torque **/** (Command Signal) Inverted Input |
| 2 | Speed/Torque (Command Signal) Non-Inverted Input |
| 3 | Ground |
| 4 | Z/ (marker pulse) from encoder |
| 5 | Z (marker pulse) from encoder |
| 6 | B/ (data channel) from encoder |
| 7 | B (data channel) from encoder |
| 8 | A/ (data channel) from encoder |
| 9 | A (data channel) from encoder |
| 10 | Servodrive Fault Reset / Disable Input |
| 11 | Power On output |
| 12 | Fault bit 0 output |
| 13 | Fault bit 1 output |
| 14 | Fault bit 2 output |
| 15 | Fault bit 3 output |

## Axis Control Cables

A High Density cable is available from Westamp for the P11 connector. The cable consists of a matching HD15F connector on the axis servodrive end and a shrouded Phoenix connector for the SP2k on the other. The cable lengths are as follows:

Length: 0.5 foot Part # SP2k-ACC-0005
1.0 foot Part # SP2k-ACC-0010
1.5 foot Part # SP2k-ACC-0015
2.0 foot Part # SP2k-ACC-0020
5.0 foot Part # SP2k-ACC-0050

# Shunt Regulators

## What are they?

A shunt regulator is a dissipative device used to regulate the bus voltage of the servodrive. The bus is the voltage used by the output IGBT transistors to supply voltage and current to the motor. The output IGBT transistors and associated circuitry have safe operating voltage areas that must not be exceeded for reliable operation.

Under certain situations during deceleration of the motor and load, the motor returns a portion of the kinetic energy stored in the moving load back to the servodrive. Since the input rectifiers on the servodrive will not allow the excessive voltage to be returned to the AC line, the bus voltage, if left uncontrolled, will increase to unsafe levels.

Usually the shunt regulator is a passive device with only minimal power dissipation for control circuits. These control circuits "watch" the bus voltage levels and trigger the shunt IGBT power transistors on when the levels reach a preset level of approximately 400 VDC. The power transistor is in series with high power resistors that dissipate the regenerative energy in the form of the heat they generate.

## You need a shunt regulator if...

There are some "rules of thumb" that can be used to determine if a shunt will be needed for a system. These are not absolutes, however. If your system has any of the following characteristics, chances are you will need a shunt regulator:

⇒ High inertia mismatch between the motor and the load (load being greater).

⇒ High mass load.

⇒ Low friction in load.

⇒ Vertical motion without the use of a counterbalance system.

⇒ System doesn't have a shunt and the servodrive shuts down with a "REGEN" fault during deceleration cycle of the motor.

## Shunt Regulator Specifications

There are three shunt regulators available for the SP2K series servodrives. The table below outlines specifications for each.

| Part Number | Peak Power (kWatts) | Cont Power (kWatts) | Trigger ON Voltage | Protective Fuses |
|---|---|---|---|---|
| SP2k-SRM-11 | 1.0 | 0.10 | 370-380 VDC | 1 x 3-2/10A Slow Blow |
| SP2k-SRM-12 | 1.8 | 0.18 | 370-380 VDC | 2 x 3-2/10A Slow Blow |
| SP2k-SRM-13 | 2.6 | 0.26 | 370-380 VDC | 3 x 3-2/10A Slow Blow |

## Using a Shunt Regulator

As shown on the Shunt Regulator Mounting Dimensions drawing (later in this manual), the connections between the shunt regulator and the drive are two DC Bus Input wires which plug into the two input connector on the shunt regulator chassis, and a smaller three input connector for the plus and minus 12 volt logic power.

The DC Bus Input lines are customarily Red for plus (+) and Gray for minus (-). Note that the plus side of this connector is the one closer to the three-input connector. This is to be the red wire, and is to be connected to the plus side of the HIGH VOLTAGE terminal block on the SP2K. The gray minus wire is connected to the minus side of the HIGH VOLTAGE terminal block. It is mandatory that the polarity be correct.

The shunt regulator should be located near the drive, so that the interconnecting wires do not exceed approximately four feet in length. It is also recommended that the bus wires run parallel to each other and separate from other wires, so that the switching transients carried on these wires do not couple to any wires which might be in close proximity. This is to include the logic power wires for the shunt regulator.

The shunt regulator logic portion is powered by plus and minus 12 volts and the customary colors used are green for GND, yellow for + 12 v, and blue for – 12 v. Note that the + 12 v input pin of the logic power connector is nearest the DC Bus Input connector, and that common is the center pin.

Again referring to the Shunt Regulator Mounting Dimensions drawing, the +12 wire connects to J1/P1 pin 10 on the SP2k;

the GND wire to J1/P1 pin 11; and the -12 wire to J1/P1 pin 12. Here also, the polarity must be correct.

**WARNING: Failure to connect the shunt regulator properly can cause irreversible damage to the servodrive and WILL VOID YOUR WARRANTY!**

**WARNING: High voltages are present on the shunt regulator module and TB403 on the servodrive when the servodrive is on and for several minutes after power has been removed. Appropriate precautions must be taken when working with or near the shunt regulator.**

# MOUNTING INSTRUCTIONS

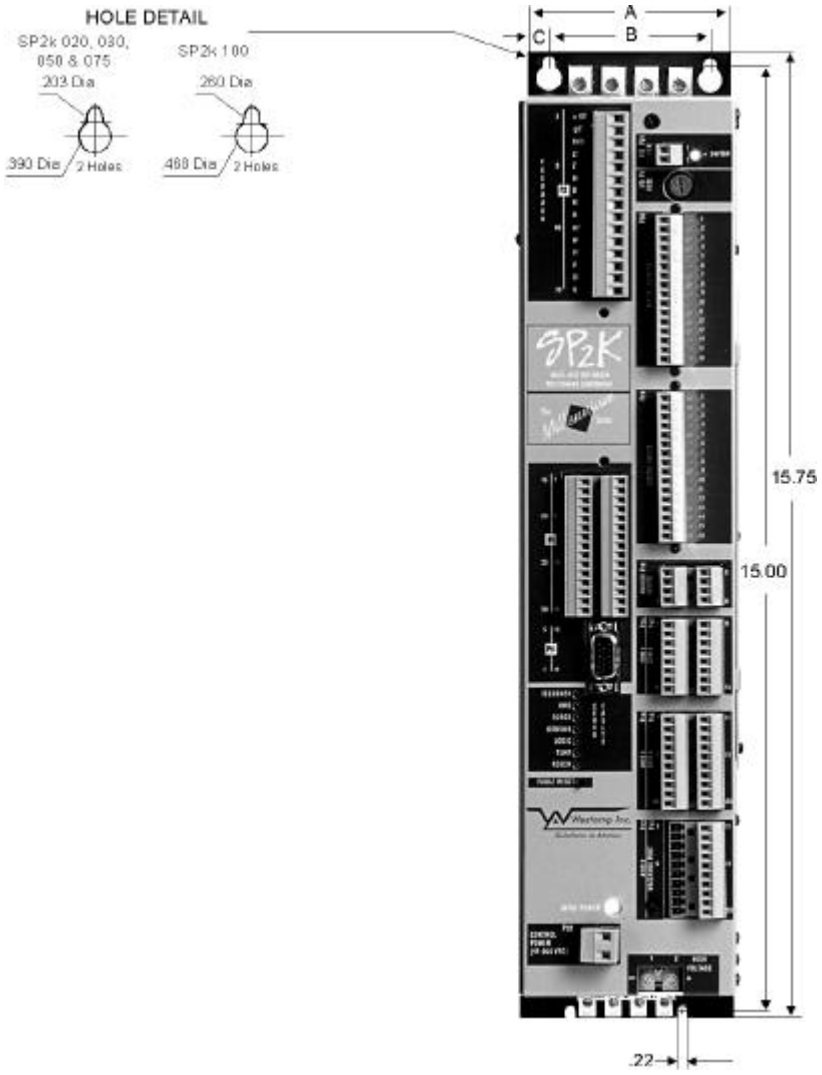
This section provides a step-by-step startup procedure. It is designed to give the user all of the necessary steps to commission an SP2k series servodrive. Each step in this section should be carefully read and completed.

⚠ **WARNING: The following procedures detail working with the servodrive and its components. Many of the procedures include working with LETHAL voltages. These procedures should be carried out only by qualified engineers or technicians working with the appropriate test equipment. PROPER PRECAUTIONS SHOULD BE TAKEN TO AVOID PERSONAL INJURY OR DEATH!**

## ounting Instructions

The first step is mounting your new servodrives in your enclosure. Please use the diagram and the table on the next page to determine the mounting dimensions.

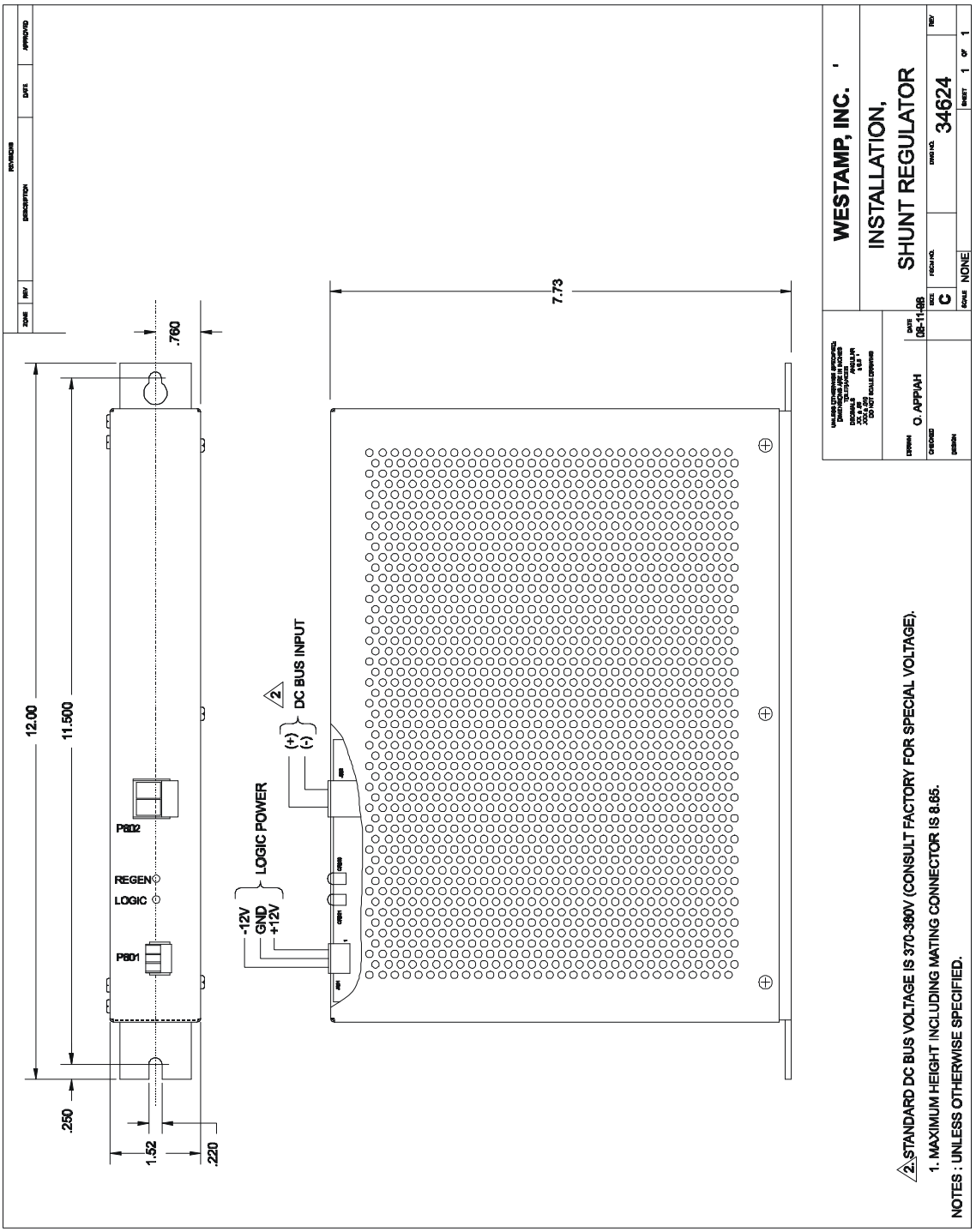
## SP2k Mounting Dimensions




| Model Number | SP2k 020, 030, 050 & 075 | SP2k 100 |
|---|---|---|
| Dimension “A” | 3.52 | 5.25 |
| Dimension “B” | 2.60 | 2.60 |
| Dimension “C” | 0.46 | 1.32 |
| Depth Dimension | 10.12 | 10.12 |

(All dimensions are in inches.)

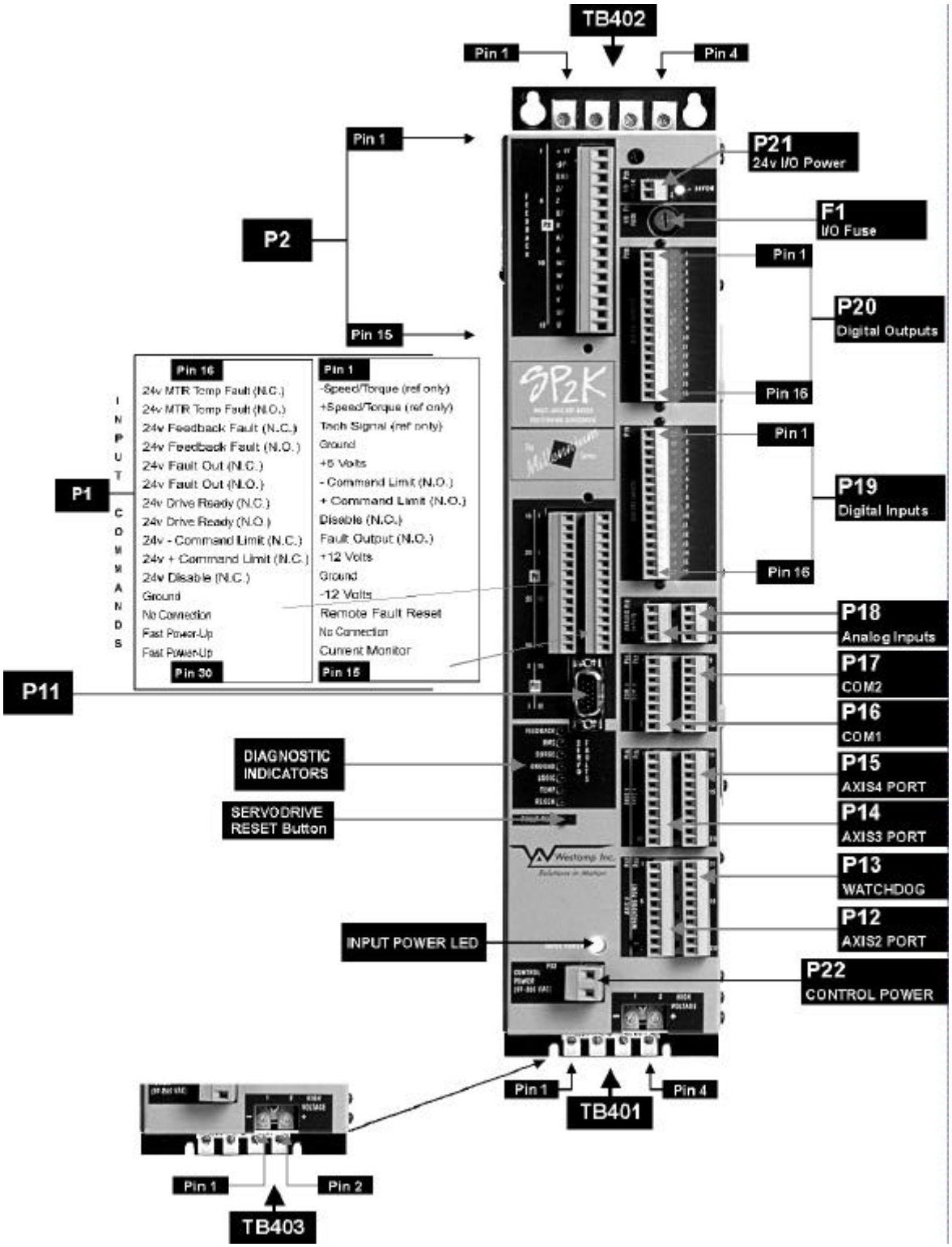
# Shunt Regulator Mounting Dimensions



# MAKING SP2K CONNECTIONS

This section provides an overview of all connection points to the SP2k digital positioning servodrive. The illustration located on the next page shows all of the connections pictorially, followed by a description of each of the connection points on the following pages.

## SP2k Outline Drawing



# AC Power Mains (TB401)

TB401 provides connections for the AC Power Mains, which provides the SP2k's output power IGBT bridge with the necessary voltage and current to drive the servomotor. TB401 does **not** supply power to the digital signal processor or other *control* electronics.

Before connecting the power mains to the servodrive, ensure that the voltage and frequency are within the allowable range. The allowable range for the SP2k series servodrives is from 97 to 265 VAC, single or three phase, 47 to 63 Hertz.

It is recommended that 3-phase input is supplied for all products in this series. However, smaller products in the SP2k series, particularly the SP2k 20, 30 and 50 amp series products, will run on single phase AC input. All SP2k 75 and 100 amp series products must run on 3-phase AC power mains.

## Single Phase Operation

For single phase operation, apply power to pins 1 and 3 on TB401. In addition, place a wire jumper from pin 1 or pin 3 to pin 2 of TB401. The wire jumper should be similar in AWG size to the input AC power wires.

Single phase AC operation requires special consideration to the single phase current capability of the servodrive, which is lower than the three phase current capability. Due to the differences in the power supply ampacities and the servodrive output power, this affects only some drives in the SP2k series. The table below details the effect of single phase operation for each drive and motor combination. Please note that the SP2k 75 and 100 amp series products must always be configured for 3 phase operation.

| Servodrive and servomotor | Cont. Power Derating |
|---|---|
| SP2k 20 amp series & BR13-402000M | 0 |
| SP2k 30 amp series & BR25-402000M | 0 |
| SP2k 30 amp series & BR34-362000M | 10% |
| SP2k 50 amp series & BR45-302000M | 0 |

### Contactor & Fuse Ratings for AC Power Mains

| Servodrive and Motor | Contactor/Fuse Continuous Ratings (amperes)* |
|---|---|
| SP2k 20 amp & BR13-402000M | 3 |
| SP2k 30 amp & BR25-402000M | 5 |
| SP2k 30 amp & BR34-362000M | 5 |
| SP2k 50 amp & BR45-302000M | 6 |
| SP2k 75 amp & BR69-302000M | 9 |
| SP2k 75 amp & BR97-302000M | 12 |
| SP2k 75 amp & BR115-242000M | 13 |
| SP2k 100 amp & BR179-242000M | 19 |
| SP2k 100 amp & BR238-242000M | 25 |
| SP2k 100 amp & BR306-212000M | 25 |
| SP2k 100 amp & BR344-242000M | 34 |

* All current ratings are based on 3 phase input mains. For single phase ratings, multiply above ratings by 1.73.

## Control Power (P22)

The *Control Power* input supplies the SP2k's digital signal processor and servodrive control electronics with power. The Control Power may be applied without the AC Power Mains. This allows the motion controller to maintain axis encoder data, user interface control and machine control when the AC Power Mains are off.

Disconnecting the AC Power Mains via a contactor is strongly suggested (and is part of NEC and NEMA safety requirements) during emergency stop "E-Stop" conditions. The Control Power may remain applied during E-Stop conditions for fault reporting and analysis.

**WARNING: A failure in the I/O section of the SP2k could cause undesirable or hazardous operation of the digital I/O and machine inputs and outputs. If the SP2k is used for machine control via the digital I/O, it is STRONGLY RECOMMENDED that the 24-volt I/O Power be removed under an E-Stop condition and whenever the SP2k's Watchdog contacts open.**

If desired, the Control Power may be obtained from the same source as the AC Power Mains using only one of the three phases. However, this does not provide the option of keeping the digital signal processor powered while ensuring no servomotor movement by disconnecting the AC Power Mains during an e-stop condition.

## 24v I/O Power (P21)

This input provides power to the isolated digital inputs and outputs. The 24 volts applied here should be from a separate power source and should be referenced only to machine inputs and outputs. Referencing this input to system commons and grounds could introduce conducted EMI (noise) into the I/O circuits. The SP2k's I/O circuits are designed for high-speed response. Therefore, it may be necessary to employ software "de-bounce" algorithms in particularly noisy environments.

## Motor Power (TB402)

This connector provides access to the servodrive's output power bridge. Connect to the servomotor as shown.

| SP2k TB402 Pin # | SP2k Designation | Servomotor Pin Designation | Westamp Power Cable Color |
|---|---|---|---|
| 1 | "T" | C | Black |
| 2 | "S" | A | White |
| 3 | "R" | B | Red |
| 4 | Ground Symbol | D | Green |

## Motor Feedback (P2)

This quick-disconnecting Phoenix style header provides connections to the SP2k's feedback electronics and interface for the servomotor. The following table provides information about each pin on the P2 connector:

| Pin # | Function |
|---|---|
| 1 | **+5V** - A maximum of 0.5 amperes is available for external use |
| 2 | **Motor Temp Input-** Input pin for normally closed motor thermal switch (tied from this input pin to +5V). If this circuit is not being used, the JP-3 jumper on the Personality Module must be installed.<br><br>**Note**: Failure to monitor the motor temperature outputs could damage the motor and void your warranty. |
| 3 | **Signal Ground** - Use this pin as the ground for the encoder power and other digital signals. |
| 4 | **Encoder "Z" / input -** Index or marker channel compliment input. |
| 5 | **Encoder "Z" input** - Index or marker channel input. |
| 6 | **Encoder "B" / input** - Encoder data channel B compliment input. |
| 7 | **Encoder "B" input** - Encoder data channel B input. |
| 8 | **Encoder "A" / input** - Encoder data channel A compliment input. |
| 9 | **Encoder "A" input** - Encoder data channel A input. |
| 10 | **Hall "W" / input** - Hall W complement input. |
| 11 | **Hall "W" input -** Hall W input. |
| 12 | **Hall "V" / input** - Hall V complement input. |
| 13 | **Hall "V" input** - Hall V input. |
| 14 | **Hall "U" / input** - Hall U complement input. |
| 15 | **Hall "U" input** - Hall U input. |

## Input Commands (P1)

This double-row 30 pin connector provides access to signals that control the operation of the power output section of the SP2k. All digital I/O to be controlled in software should be connected to P19 and P20, not P1.

The following table describes the function of each pin:

| Pin # | Function |
|---|---|
| 1 | **Ground** |
| 2 | **Torque Command** (equivalent). Scaling is 10 volts equals servodrive peak current, or servomotor peak torque. **THIS IS NOT AN INPUT!** |
| 3 | **Tachometer reference signal output** (not an input): This signal is a reference indication of the encoder-derived tachometer. The gain is 1v/krpm on the servomotor. |

| | |
|---|---|
| 4 | **Signal Common -** This is a signal ground that may be used to reference only analog signals on pins 1 through 3. DO NOT USE THIS AS A CURRENT SINK FOR ANY OTHER CIRCUIT. |
| 5 | **+5V** - Up to 500ma is available for external use. |
| 6 | **- Command Limit** (normally open) When this input is connected to P1 pin 11, or any other ground, or pulled low, negative incremental or absolute move commands are ignored by the servodrive output bridge. Following errors will continue to build if negative moves are in progress while this input is asserted. This input is internally pulled up. The Drive Ready will remain asserted. |
| 7 | **+ Command Limit** (normally open) When this input is connected to P1 pin 11, or any other ground, or pulled low, all positive incremental or absolute move commands are ignored by the servodrive output bridge. Following errors will continue to build if positive moves are in progress while this input is asserted. This input is internally pulled up. The Drive Ready will remain asserted. |
| 8 | **Disable** (normally open) When this input is connected to P1 pin 11, or any other ground, or pulled low, all move commands are ignored by the servodrive output bridge. Following errors will continue to build if moves are in progress while this input is asserted. This input is internally pulled up. The Drive Ready signal will **not** remain asserted while this input is asserted. |
| 9 | **Fault output** (normally open) This output will go from high to low when a servodrive fault occurs. |
| 10 | **+VCC (+12VDC)** - Up to 50ma is available for external use. |
| 11 | **Logic Power Ground** |
| 12 | **-VCC (-12VDC)** - Up to 10ma is available for external use. |
| 13 | **Remote Fault Reset** Any servodrive fault can be cleared by pulling this pin from high to low momentarily. A half second delay will occur after this pin is allowed to go high, before the servodrive becomes enabled. This pin is internally pulled high. |
| 14 | **No Connection** |
| 15 | **Current monitor** - This pin provides a voltage proportional to the output current command. It is scaled to + / - 10 volts = + / - full Peak output current of the servodrive. Its accuracy is +/- 10 % at full scale. Note that the signal is not the actual output current, but it is a command for current to the current loops and is accurate unless the servodrive is saturated. |
| | **SECOND ROW** |
| 16 | **24v MTR Temp Fault Output** (normally closed) **-** The open collector latched output signal at this pin is normally low and will transition to a high when a motor over-temperature fault occurs (the thermal switch within the motor opens). This input is internally pulled up to 12 volts. It may be externally pulled up to 24 volts.<br><br>A motor over-temperature fault will **not** cause the servodrive to shutdown. **Monitoring for this fault is highly recommended. Failure to sense this fault and shutdown the system in an orderly fashion could result in permanent damage to the servomotor and void your warranty!** |
| 17 | **24v MTR Temp Fault Output** (normally open) **-** The open collector latched output signal at this pin is normally high and will transition to a low when a motor over-temperature fault occurs (the thermal switch within the motor opens). This input is internally pulled up to 12 volts. It may be externally pulled up to 24 volts. |

| | |
|---|---|
| | A motor over-temperature fault will **not** cause the servodrive to shutdown. **Monitoring for this fault is highly recommended. Failure to sense this fault and shutdown the system in an orderly fashion could result in permanent damage to the servomotor and void your warranty!** |
| 18 | **24v Feedback Fault Output** (normally closed) **-** The open collector latched output signal at this pin will be low and will transition to a high when a loss of one or more feedback signals occurs. A feedback fault will immediately shutdown the servodrive's output bridge. |
| 19 | **24v Feedback Fault Output** (normally open) **-** The open collector latched output signal at this pin will be high and will transition to a low when a loss of one or more feedback signals occurs. A feedback fault will immediately shutdown the servodrive's output bridge. |
| 20 | **24v Fault** (normally closed) **-** The open collector latched output signal at this pin will be low and will transition to a high when any servodrive fault occurs. |
| 21 | **24v Fault** (normally closed) **-** The open collector latched output signal at this pin will be high and will transition to a low when any servodrive fault occurs. |
| 22 | **24v Drive Ready** (normally closed) **-** The open collector signal at this pin will be low and transition to a high when the servodrive is ready and the output bridge is enabled.<br><br>Faults or disabling the servodrive will change the state of this pin to low. Negative or Positive Command Limit inputs will **not** affect the state of this pin. |
| 23 | **24v Drive Ready** (normally open) **-** The open collector signal at this pin will be high and transition to a low when the servodrive is ready and the output bridge is enabled.<br><br>Faults or disabling the servodrive will change the state of this pin to high. Negative or Positive Command Limit inputs will **not** affect the state of this pin. |
| | |
| 24 | **24v - Command Limit** (normally closed) **-** When this input is high, all negative incremental or absolute move commands are ignored by the servodrive's output power bridge. Following errors will continue to build if a negative move command is in progress while this pin is asserted. This pin is internally pulled up **and must be pulled low for the servodrive to operate.** The Drive Ready signal is not affected by the state of this pin. |
| 25 | **24v + Command Limit** (normally closed) **-** When this input is high, all positive incremental or absolute move commands are ignored by the servodrive's output power bridge. Following errors will continue to build if a positive move command is in progress while this pin is asserted. This pin is internally pulled up **and must be pulled low for the servodrive to operate.** The Drive Ready signal is not affected by the state of this pin. |
| 26 | **24v Disable** (normally closed) **-** When this input is high, all servodrive output will be disabled. This input is internally pulled low by the SP2k controller's normally closed watchdog line. If the controller's CPU ceases to function correctly, this will cause pin 26 to disable the servodrive.<br>The Drive Ready signal is affected by the state of this pin. |
| 27 | **Logic common -** |
| 28 | **No Connection** |
| 29 | **Fast Power-Up** (See pin 30 below) |
| 30 | **Fast Power-Up** Without P1 pins 29 and 30 shorted together, the |

| | |
|---|---|
| | servodrive has a 1 to 2 second startup delay to allow other system components to stabilize during system initialization. The Drive Ready signal will be asserted after the startup delay. When pins 29 and 30 are shorted together the startup delay is reduced to between 100 to 200 milliseconds**.** |
| N O T E S | **All Open Collector CMOS Outputs** have internal pull-up resistors to 12V and anti-parallel diodes. If higher voltage levels are required, an external pull-up resistor is needed. This output may be pulled up to 40VDC and may source up to 50 milliamperes.<br><br>**All Latched outputs** will permanently latch in their changed state if a momentary fault is sensed. Latched outputs can be reset by removing and then reapplying logic power, or by asserting the Remote Fault Reset. |

## Control (P11)

This connector mirrors the functions of the Control Connectors on the SP and SL Series Axis Servodrives and is provided here simply as a different connector style by which the following signals may be accessed. The following table provides information about each pin on this connector:

| Pin # | Function |
|---|---|
| 1 | **Ground** |
| 2 | **Torque Command** (equivalent). Scaling is 10 volts equals servodrive peak current, or servomotor peak torque. |
| 3 | **Ground** - use as the ground for the encoder power and other digital signals. |
| 4 | **Encoder "Z" / reference -** index or marker channel compliment. |
| 5 | **Encoder "Z" reference** - index or marker channel. |
| 6 | **Encoder "B" / reference** - Encoder data channel B compliment. |
| 7 | **Encoder "B" reference** - Encoder data channel B. |
| 8 | **Encoder "A" / reference** - Encoder data channel A compliment. |
| 9 | **Encoder "A" reference** - Encoder data channel A. |
| 10 | **Remote Fault Reset/Disable Input** – Clear fault conditions by setting this pin high, and then back to low. Or disable the servodrive by holding this pin high. After this pin goes low, a half-second delay occurs before the servodrive is enabled. Internal pull-up resistors hold this pin high. |
| 11 | **Drive Power On -** This pin will be high when logic power has been applied to the servodrive. |
| 12 | **Fault Bit 0** - This signal is part of the four bit binary word to indicate the status of the servodrive. Refer to the Fault Bit Status chart below for a description of this pin. |
| 13 | **Fault Bit 1** - This signal is part of the four bit binary word to indicate the status of the servodrive. Refer to the Fault Bit Status chart below for a description of this pin. |
| 14 | **Fault Bit 2** - This signal is part of the four bit binary word to indicate the status of the servodrive. Refer to the Fault Bit Status chart below for a description of this pin. |
| 15 | **Fault Bit 3** - This signal is part of the four bit binary word to indicate the |

| Pin # | Function |
|---|---|
| | status of the servodrive. Refer to the Fault Bit Status chart below for a description of this pin. |

*P11 - Pins 12 through 15: Fault Bit Status Chart*

| BIT 3 | BIT 2 | BIT 1 | BIT 0 | | Status |
|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | | No Faults |
| 0 | 0 | 0 | 1 | | RMS Fault |
| 0 | 0 | 1 | 0 | | Surge Fault |
| 0 | 0 | 1 | 1 | | Ground Fault |
| 0 | 1 | 0 | 0 | | Logic Fault |
| 0 | 1 | 0 | 1 | | Servodrive Temp Fault |
| 0 | 1 | 1 | 0 | | Regen Fault |
| 0 | 1 | 1 | 1 | | Motor Temp Fault |
| 1 | 0 | 0 | 0 | | Feedback Fault |
| | | | | | |
| 1 | 0 | 0 | 1 | | reserved |
| 1 | 0 | 1 | 0 | | reserved |
| 1 | 0 | 1 | 1 | | reserved |
| 1 | 1 | 0 | 0 | | reserved |
| 1 | 1 | 0 | 1 | | reserved |
| 1 | 1 | 1 | 0 | | reserved |
| 1 | 1 | 1 | 1 | | reserved |

Note that the Fault Bit is a four bit binary word. Along with the Power On output, this 4 bit word can be used to indicate the status of the servodrive. The output data is open collector with internal pull-ups. Because of the internal pull-ups, the No Fault State will only be achieved when the servodrive is operating properly.

## Watchdog Port (P13)

The watchdog port brings out the function of the internal watchdog timer. The watchdog timer is a hardware timer that must be refreshed every servo interrupt by the digital signal processor. Failure to refresh the watchdog timer will result in a watchdog fault.

The watchdog signal is available on pin 10 of P13 and is referenced to pin 9. The watchdog signal is normally open and is closed when a watchdog fault exists.

## Axis 2 Port (P12)

This port provides access to all of the necessary signals for the second axis of motion (standard with the SP2k). Use this port's encoder inputs as the master in a single axis master/slave application.

This port also provides command signals for the second axis, or a multi-purpose analog output if the second axis is not used or is used for the master in a master/slave application.

The following table describes the function of each pin on the Axis 2 Port:

| Pin # | Description |
|---|---|
| 1 | Axis 2 Encoder Marker - |
| 2 | Axis 2 Encoder Marker + |
| 3 | Axis 2 Encoder B - |
| 4 | Axis 2 Encoder B + |
| 5 | Axis 2 Encoder A - |
| 6 | Axis 2 Encoder A + |
| 7 | Axis 2 Torque Signal (return) |
| 8 | Axis 2 Torque Signal + |
| 9 | Axis 2 Common |
| 10 | Axis 2 Remote Fault Reset / Disable |

## Axis 3 Port (P14)

This port provides access to all of the necessary signals for the third axis of motion (optional). Use this port's encoder inputs as the master in a two axis master/slave application.

This port also provides command signals for the third axis, or a multi-purpose analog output if the third axis is not used or is used for the master in a master/slave application.

The following table describes the function of each pin on the Axis 3 Port:

| Pin # | Description |
|---|---|
| 1 | Axis 3 Encoder Marker - |
| 2 | Axis 3 Encoder Marker + |
| 3 | Axis 3 Encoder B - |
| 4 | Axis 3 Encoder B + |

| Pin # | Description |
|---|---|
| 5 | Axis 3 Encoder A - |
| 6 | Axis 3 Encoder A + |
| 7 | Axis 3 Torque Signal (return) |
| 8 | Axis 3 Torque Signal + |
| 9 | Axis 3 Common |
| 10 | Axis 3 Remote Fault Reset / Disable |

## Axis 4 Port (P15)

This port provides access to all of the necessary signals for the fourth axis of motion (optional). Use this port's encoder inputs as the master in a three axis master/slave application.

This port also provides command signals for the fourth axis, or a multi-purpose analog output if the fourth axis is not used or is used for the master in a master/slave application.

The following table describes the function of each pin on the Axis 4 Port:

| Pin # | Description |
|---|---|
| 1 | Axis 4 Encoder Marker - |
| 2 | Axis 4 Encoder Marker + |
| 3 | Axis 4 Encoder B - |
| 4 | Axis 4 Encoder B + |
| 5 | Axis 4 Encoder A - |
| 6 | Axis 4 Encoder A + |
| 7 | Axis 4 Torque Signal (return) |
| 8 | Axis 4 Torque Signal + |
| 9 | Axis 4 Common |
| 10 | Axis 4 Remote Fault Reset / Disable |

## COM1 Port (P16)

This port is used to communicate with external system devices and with a PC during programming and startup. The port is software selectable for either RS232 (factory default), RS422 or multi-drop RS485 communications. The port includes an auto baud detect feature—which detects the baud rate of incoming data after receiving two successive CR+LFs—as long as one of the following settings are used:

| Protocol | Baud Rate |
|---|---|

| | |
|---|---|
| 7, Odd, 1 | 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 bps |
| 8, None, 1 | 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 bps |
| 7, Even, 1 | 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 bps |

The following table includes specific details on each pin:

| Pin # | Description |
|---|---|
| 1 | RXD |
| 2 | TXD |
| 3 | GND |
| 4 | MUX |
| 5 | TXDA |
| 6 | TXDB |
| 7 | RXDA |
| 8 | RXDB |

### Connecting the SP2k to a PC

Westamp's *MotionObjects*™ for Windows 95 and Windows NT 4.0 includes a cable for communication. If you need to make additional cables, use the following table as a guideline:

| SP2k Pin # | Description | PC DB9 Pin # | PC DB25 Pin # |
|---|---|---|---|
| 1 | RXD | 3 | 3 |
| 2 | TXD | 2 | 2 |
| 3 | GND | 5 | 7 |
| 4 | MUX | | |
| 5 | TXDA | | |
| 6 | TXDB | | |
| 7 | RXDA | | |
| 8 | RXDB | | |

## COM2 Port (P17)

See COM1 Port (P16)

## Analog Inputs (P18)

This port provides access to optional 12-bit Analog to Digital Converters that may be ordered with the SP2k. Mating connectors will not be provided for this port if you did not order this option.

The following table provides information about the analog inputs:

| Pin # | Description | Value Address | Gain Address | Offset Address |
|---|---|---|---|---|
| 1 | Analog Input #1 | P6408 | P6410 | P6411 |
| 2 | Analog Input #2 | P6424 | P6426 | P6427 |
| 3 | Analog Input #3 | P6440 | P6442 | P6443 |
| 4 | Analog Input #4 | P6456 | P6458 | P6459 |
| 5 | Analog Input #5 | P6472 | P6474 | P6475 |
| 6 | Analog Input #6 | P6488 | P6490 | P6491 |
| 7 | Analog Input #7 | P6504 | P6506 | P6507 |
| 8 | Analog Input #8 | P6520 | P6522 | P6523 |

## Digital Inputs (P19)

This connector allows access to the 16, 24-volt isolated digital inputs onboard the standard SP2k. These inputs may be accessed in any program area and used within PLC program areas to control 2-state machine functions.

### Input/Output Types

The SP2k may be configured for either NPN (sinking) or PNP (sourcing) inputs and outputs. This **must** identified at time of order and may not be altered in the field.

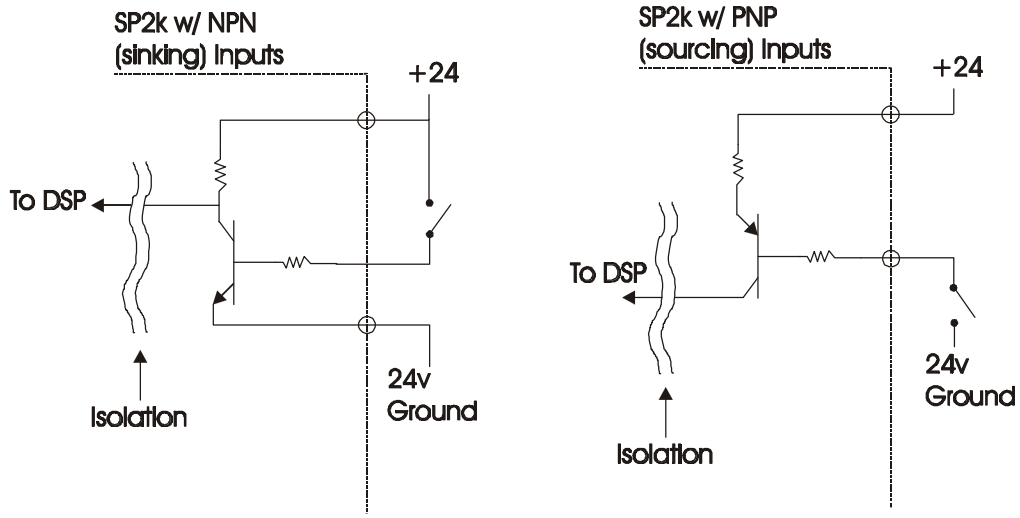
The 5th digit in the SP2k part number determines whether you have NPN or PNP I/O. If the 5th digit is even, you have NPN I/O. If the 5th digit is odd, you have PNP I/O. For example, SP22**1**0-xxx-xxx indicates that 16 inputs and 16 outputs—all PNP—were ordered.

### I/O Fusing

There is a 2 ampere fuse (F1) located on the face of the SP2k. This fuse provides protection from overloads in the outputs. Replace only with same type fuse.

### Digital Input Schematic

The following schematic of the I/O section of the SP2k should prove helpful in making the appropriate connections.




# Digital Outputs (P20)

This connector allows access to the 16, 24-volt isolated digital outputs onboard the standard SP2k. These outputs may be accessed in any program area and used within PLC program areas to control 2-state machine functions.

## Input/Output Types

The SP2k may be configured for either NPN (sinking) or PNP (sourcing) inputs and outputs. This **must** identified at time of order and may not be altered in the field.

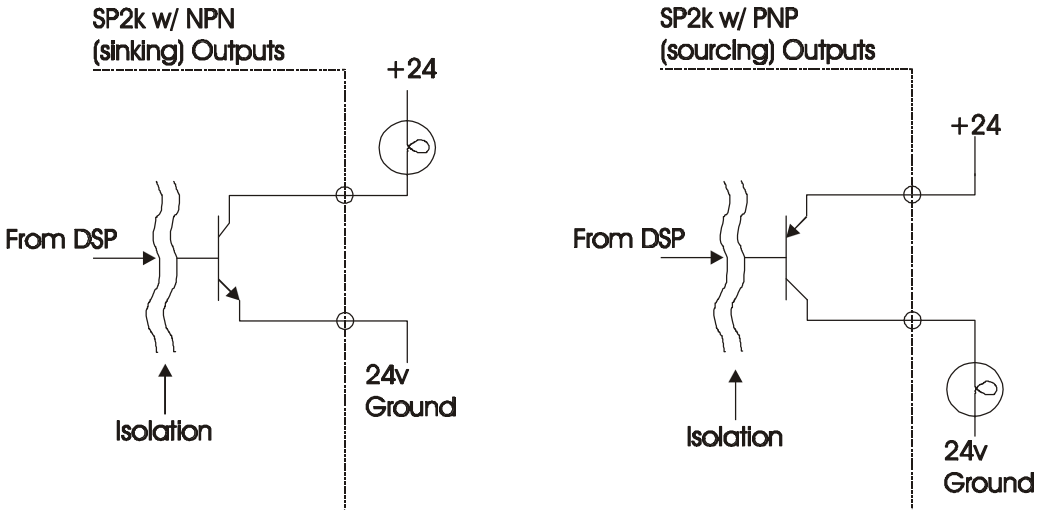
The 5th digit in the SP2k part number determines whether you have NPN or PNP I/O. If the 5th digit is even, you have NPN I/O. If the 5th digit is odd, you have PNP I/O. For example, SP22**1**0-xxx-xxx indicates that 16 inputs and 16 outputs—all PNP—were ordered.

## I/O Fusing

There is a 2 ampere fuse (F1) located on the face of the SP2k. This fuse provides protection from overloads in the outputs. Replace only with same type fuse.

### Digital Output Schematic

The following schematic of the I/O section of the SP2k should prove helpful in making the appropriate connections.




## External Shunt (TB403)

This terminal block provides access to the servodrive's DC bus. This is used by external shunt regulator or "regen" modules to absorb kinetic energy during deceleration of high mass, low-friction loads.

### Connecting Shunt Regulators

Connections to the servodrive for all three models of the SP2k shunt regulator are the same. The SP2k shunt regulator requires connections to the DC bus of the servodrive. It also requires logic voltage connections of +12 volts, -12 volts, and logic common. These connections are made from 3 flying leads (yellow, green, and blue) for the logic voltage connections, and two larger flying leads (gray and red) for the DC Bus connections.

*Making Bus Connections*

There are two flying leads on the shunt regulator for the bus connections. The Gray lead is for **-** (minus) Bus and should be connected to the **-** terminal of the Shunt/DC Power "HIGH VOLTAGE" connector on the servodrive. The red lead is for **+**

bus. It should be connected to the **+** terminal of the Shunt/DC Power “HIGH VOLTAGE” connector on the servodrive.

If you are connecting the Shunt Regulator to the SP2k servodrive, or to an SP series Axis Servodrive the connections are:

| Function | Wire Color | SP2k TB403 Connector Pin |
|---|---|---|
| - Bus | Gray | **-** Terminal |
| + Bus | Red | **+** Terminal |

*Making Logic Power Connections*

The SP2k shunt regulator requires externally-supplied logic voltage of +12 volts, **-**12 volts and logic common. Although an external logic supply may be used, it is recommended that this voltage be obtained from the servodrive P1 connector. The logic connections on the P1 connector will be the same for all servodrives (the SP2k digital positioning servodrive, and both the SP and SL series Axis Servodrives). There are three flying leads on the shunt regulator for the logic connections. The yellow wire is for the +12 volts, the green wire is for logic common, and the blue wire is for **-**12 volts. They should be connected to the P1 connector as follows:

| Function | Wire Color | SP2k P1 Connector Pin # |
|---|---|---|
| +12 volts | Yellow | P1 pin 10 |
| Logic Common | Green | P1 pin 11 |
| -12 volts | Blue | P1 pin 12 |

## Operation

The operation of the SP2k shunt regulator requires the application of the logic voltage before it will begin to monitor the DC bus. Once logic voltage is applied, there is a delay of approximately 0.5 seconds while the shunt electronics initialize. During this time, the shunt is disabled and the output IGBT transistors are turned off. At the end of this time, the “logic on” LED will illuminate. The shunt is now monitoring the bus voltage.

Although the shunt requires both bus and logic voltage to operate, it does not matter in which order bus and logic voltages are applied to the shunt. The bus may be turned on after, at the same time, or before the logic voltage is applied. Also, it does not matter in which order the bus and logic voltages are removed from the shunt.

Any time the bus voltage reaches or exceeds the preset level (approximately 375 VDC) the “REGEN” LED on the shunt will illuminate, indicating the shunt is active. At this point, the IGBT power transistor(s) will begin to conduct and dissipate the regenerative energy through the high power resistors that are in series with the power transistor(s).

# CABLES

Cables are the number one technical support issue during the startup of a machine. Servodrives and servomotors are no exception. There are many different types of cables in a servo and motion-control system. The purpose of this section is to define these types of cables, explain their purpose and clearly define their connections.

The SP2k was designed to simplify many of the cabling "nightmares" associated with motion control systems. This was accomplished by integrating as many functions as possible over singular wires and cables.

## Terms & Definitions

Let's start by defining a few basic terms. When we refer to the word "wire," we are referring to a singular piece of wire. The word "cable" indicates a group of wires within a jacket or sleeve.

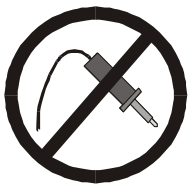
**What about Mating Connectors?**
The SP2k is shipped with all mating connectors required for connection to the outside world. To save you money, however, we do **not** ship mating connectors for headers that provide access to optional features that are not ordered. For example, you will not receive mating connectors for the P18 connector (Analog Inputs) unless your SP2k came equipped with the Analog Input option.

The SP2k and associated axis servodrives utilize a few different connector types. For the most part there are 3 different types of connections, each with varying sizes, on the SP2k.

For most connections, detachable Phoenix-style connectors are used to improve connection reliability and ease startup and maintenance. If you ordered Axis Control Cables, then you will also find shrouded Phoenix connectors.

For high power connections, screw connecting terminal blocks are used due to their rugged, high current designs. These connections are not quick-disconnect in nature.

Finally, Westamp axis servodrives utilize high-density HD15 connectors for all interfacing to the SP2k, so you will also note the use of these connectors in your SP2k system.



Not to worry, Westamp supplies you with all of the necessary cables and mating connectors—most often attached at the ends of our cables—so that all you have to do is plug things in and start things up. We apologize in advance to those who looked forward to using their soldering irons.

# Cable Types

## Motor Power and Feedback Cables

There are single-cable and two-cable configurations for interfacing the feedback and power connections on the SP2k to the servomotor. This section outlines both cable configurations.

*Single-Cable Configurations*

Single-cable configurations are used for any 66 mm or 2-inch frame size servomotor. This is because these servomotors use only one circular MS connector on the servomotor. This singular connector provides pins for both servomotor power and feedback functions. Thus, SP2k-PC-**1**-xxx power cables incorporate both power and feedback signals and wires into a singular cable for both functions. Sufficient lead length and separation is provided on the servodrive end to connect to both the feedback and power connectors.

The Table below shows the pin relationship between the servomotor's singular connector for both Feedback and Power and the SP2k's Feedback and Power connections for the Westamp BR3-25 to BR8-40 2-inch (66 mm) frame servomotors.

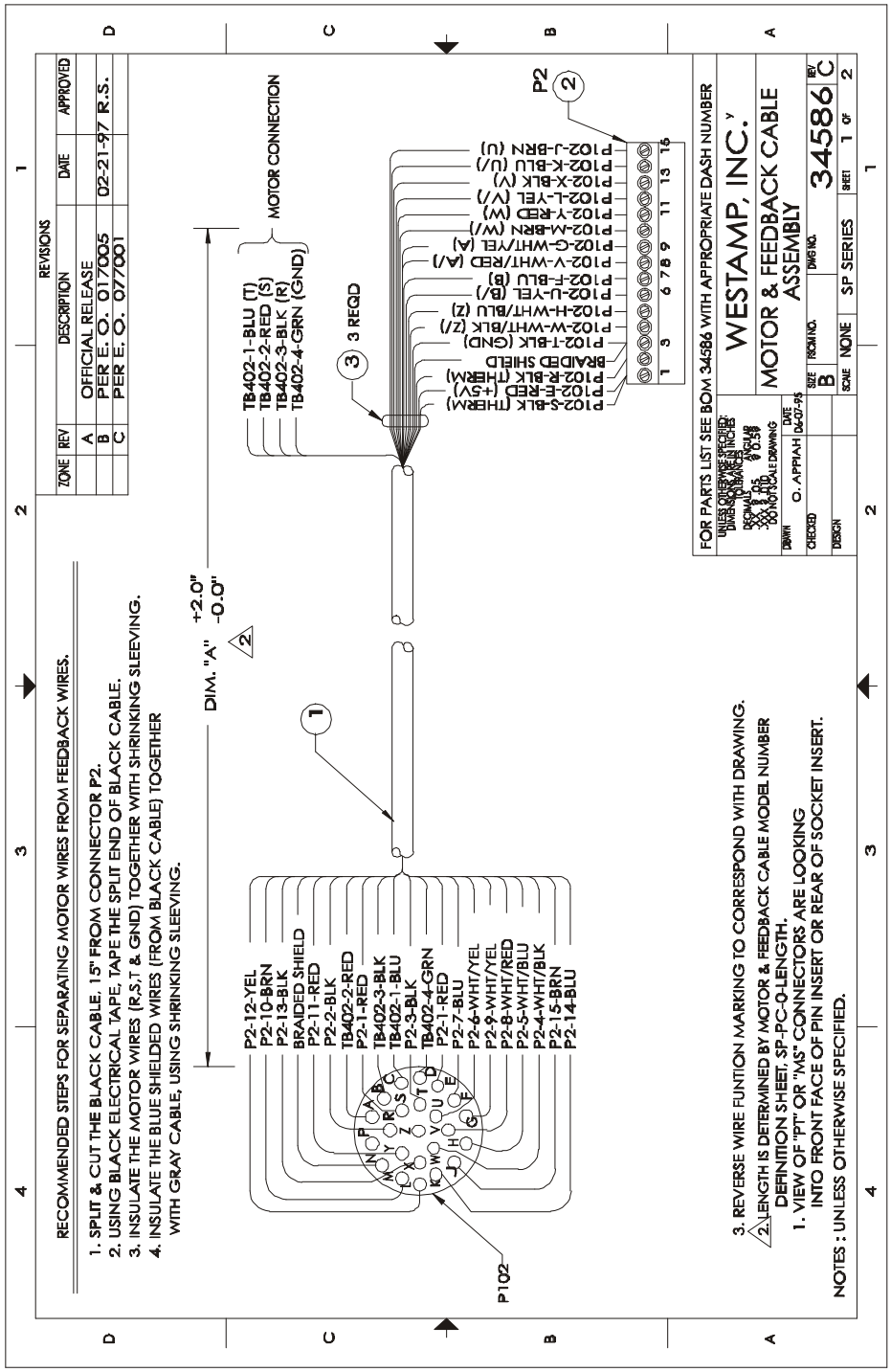
| SP2k P2 Pin # | SP2k Designation | Motor Pin Designator | Signal Description | (Westamp Cable Wire Color) |
|---|---|---|---|---|
| 1 | + 5 volts | E & S | +5 Volts | (BLK & RED wires) |
| 2 | Normally-Closed Symbol | R | Motor Thermal Switch | (BLK) |
| 3 | Ground | Cable Shield & T | Signal Shield & Encoder Ground | (Shield & BLK wire) |
| 4 | Z/ | W | Encoder Marker- | (WHT/BLK) |

| SP2k P2 Pin # | SP2k Designation | Motor Pin Designator | Signal Description | (Westamp Cable Wire Color) |
|---|---|---|---|---|
| 5 | Z | H | Encoder Marker + | (WHT/BLU) |
| 6 | B/ | U | Encoder Channel B- | (YEL) |
| 7 | B | F | Encoder Channel B+ | (BLU) |
| 8 | A/ | V | Encoder Channel A- | (WHT/RED) |
| 9 | A | G | Encoder Channel A+ | (WHT/YEL) |
| 10 | W/ | M | Commutation Track Channel W- | (BRN) |
| 11 | W | Y | Commutation Track Channel W+ | (RED) |
| 12 | V/ | L | Commutation Track Channel V- | (YEL) |
| 13 | V | X | Commutation Track Channel V+ | (BLK) |
| 14 | U/ | K | Commutation Track Channel U- | (BLU) |
| 15 | U | J | Commutation Track Channel U+ | (BRN) |

| SP2k TB402 Pin # | SP2k Designator | Motor Pin Designator | Westamp Cable Wire Color |
|---|---|---|---|
| 1 | “T” | C | BLU |
| 2 | “S” | A | RED |
| 3 | “R” | B | BLK |
| 4 | Ground Symbol | D | GRN |

The drawing on the next page is provided as further documentation of the single-cable configuration.

*Single-Cable configuration for the BR3-40 through BR8-30 Servomotors*



## Two-Cable Configurations

Two-cable configurations are used for any 89 mm (3-inch), 114 mm (4-inch), 142 mm (6-inch) or 190 mm (8-inch) servomotor. As the configuration name would imply, two cables are used, one for the feedback function and one for the power function.

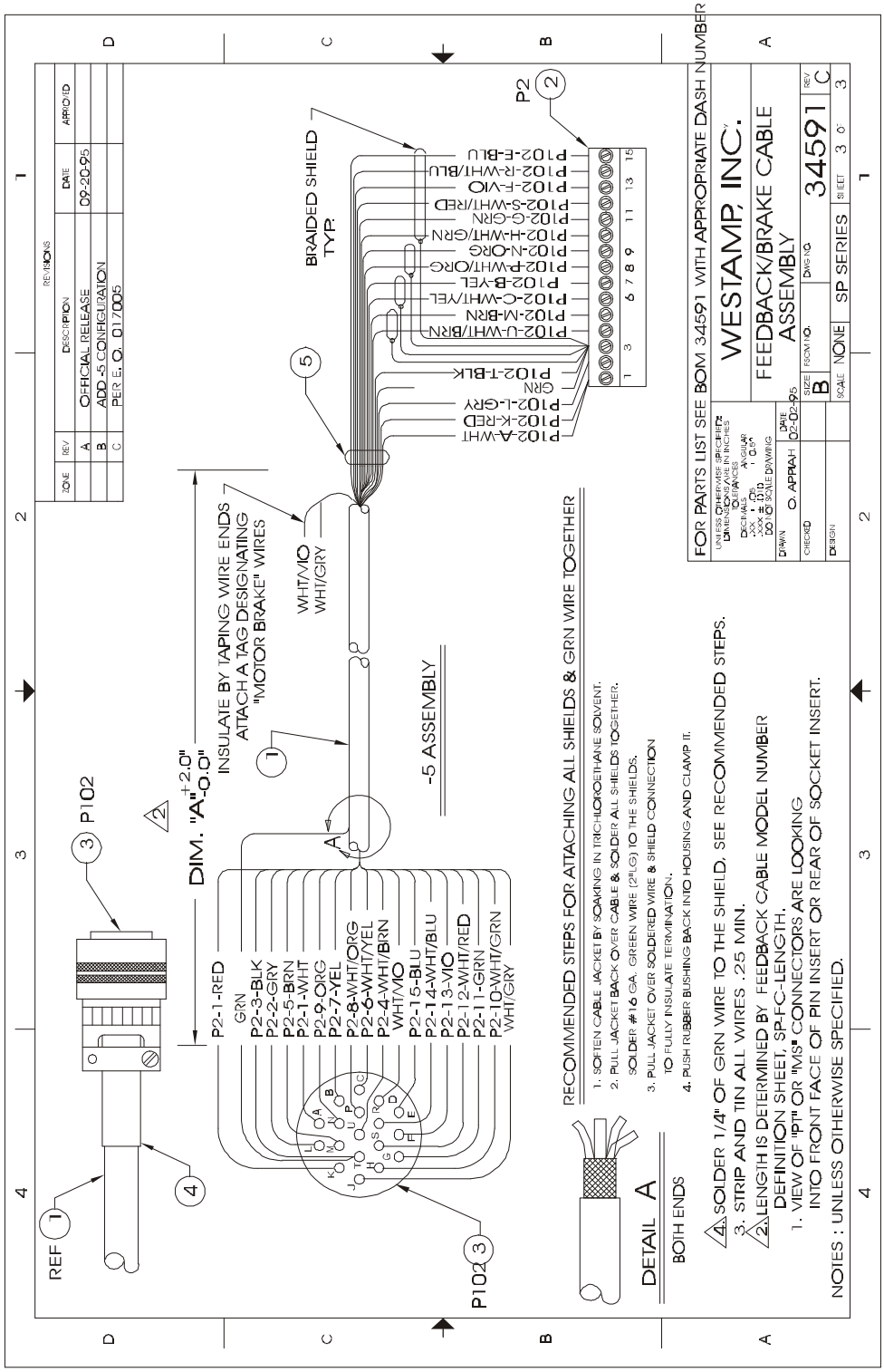
*Feedback Cables*

The following table shows the pin to pin relationship between the servomotor feedback cable for the BR13-40 through the BR344-24 servomotors:

| SP2k P2 Pin # | SP2k Designation | Motor Pin Designator | Signal Description | (Westamp Cable Wire Color) |
|---|---|---|---|---|
| 1 | + 5 volts | K & L | +5 Volts | (WHT & RED wires) |
| 2 | Normally-Closed Symbol | A | Motor Thermal Switch | (GRY) |
| 3 | Ground | Cable Shield & T | Signal Shield and Encoder Ground | (GRN & BLK wires & Shield) |
| 4 | Z/ | U | Encoder Marker - | (WHT/BRN) |
| 5 | Z | M | Encoder Marker + | (BRN) |
| 6 | B/ | C | Encoder Channel B- | (WHT/YEL) |
| 7 | B | B | Encoder Channel B+ | (YEL) |
| 8 | A/ | P | Encoder Channel A- | (WHT/ORG) |
| 9 | A | N | Encoder Channel A+ | (ORG) |
| 10 | W/ | H | Commutation Track Channel W- | (WHT/GRN) |
| 11 | W | G | Commutation Track Channel W+ | (GRN) |
| 12 | V/ | S | Commutation Track Channel V- | (WHT/RED) |
| 13 | V | F | Commutation Track Channel V+ | (VIO) |
| 14 | U/ | R | Commutation Track Channel U- | (WHT/BLU) |
| 15 | U | E | Commutation Track Channel U+ | (BLU) |

The drawing on the next page outlines the standard Westamp feedback cable for the BR13-40 through BR939-24 servomotors (2-cable configurations).

*Feedback Cable Assembly -- BR13-40 through BR344-24 servomotors*



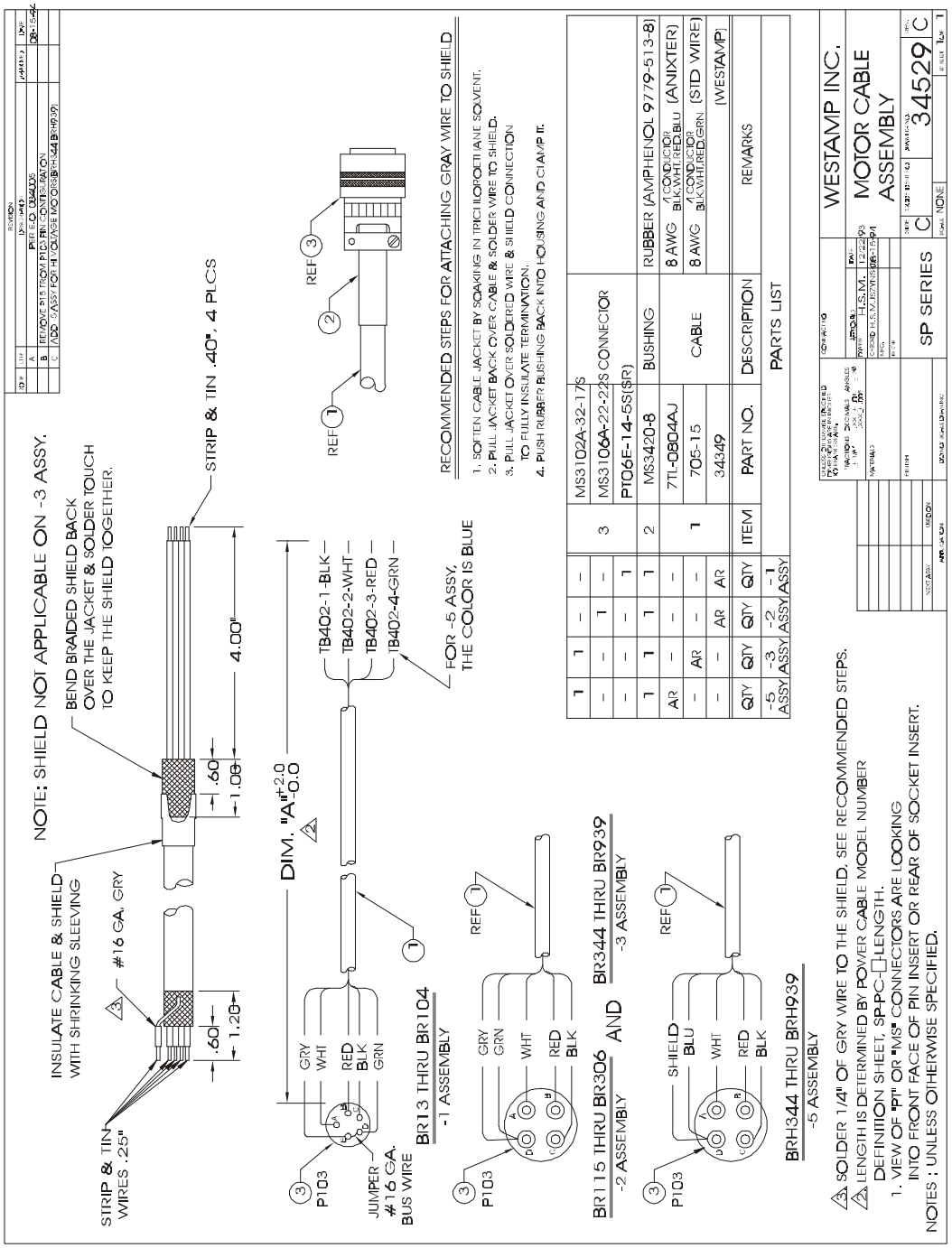
*Power Cables*

The following table outlines the motor power cable connections to the servodrive for the BR13-40 through BR344-24 servomotors.

| SP2k TB402 Pin # | SP2k Designator | Motor Pin Designator | Westamp Cable Wire Color |
|---|---|---|---|
| 1 | “T” | C | BLK |
| 2 | “S” | A | WHT |
| 3 | “R” | B | RED |
| 4 | Ground Symbol | D | GRN |

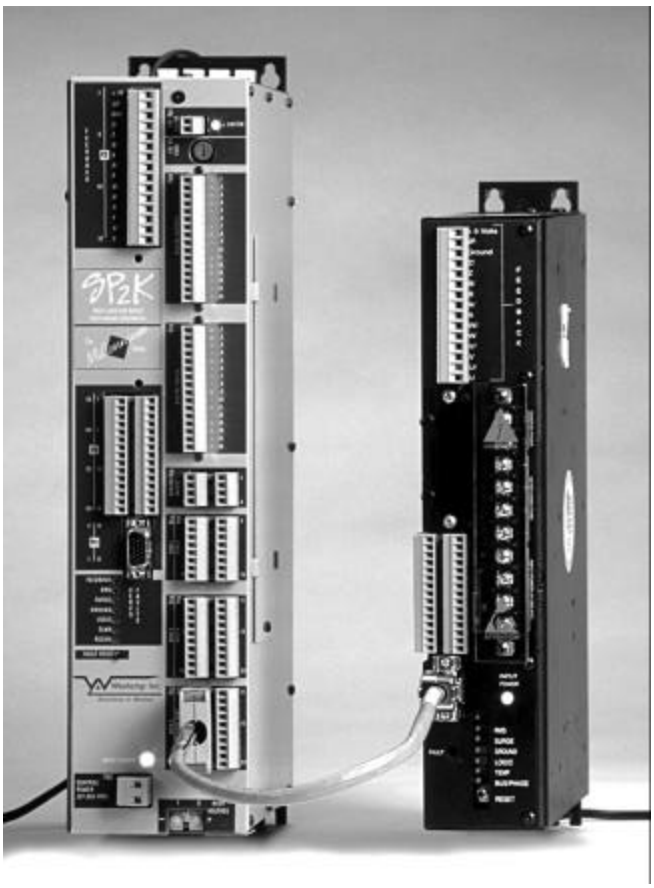
The drawing on the next page outlines the standard Westamp power cable for the BR13-40 through BR939-24 servomotors (2-cable configurations).

*Power Cable for the BR13-40 through BR939-24 Servomotors*



## Connecting Axis Servodrives

Westamp Axis Control Cables easily, efficiently and quickly connect the SP2k to additional Westamp servodrives to be controlled by the SP2k. Westamp Axis Servodrives incorporate a *Control Port* on the face of each SP or SL Series AC Brushless Servodrive. The *Control Port* on these axis servodrives gives the SP2k all of the necessary signals to control the axis. This significantly reduces the amount of time spent figuring out complex wiring diagrams and other hieroglyphics.



See the complex illustration at left to better understand the process of connecting Axis Servodrives to the SP2k.

Text Instructions:

1) Connect shrouded end of Axis Control Cable to Axis Port # for the Axis to be controlled (Axis 2 port shown here).
2) Connect HD15 end to *Control Port* on Axis Servodrive.
3) Have Lunch – You've earned it.
4) Apply power.
5) Repeat as necessary—and hungry.

If you did not order Westamp Axis Control Cables and you would like to now, use the following part numbers:

**Please do NOT try and figure out our complex ordering scheme at right. We are professionals.**

- SP2k-ACC-0005 ½ foot cable
- SP2k-ACC-0010 1 foot cable
- SP2k-ACC-0020 2 foot cable
- SP2k-ACC-0050 5 foot cable

If you did not order Westamp Axis Control Cables and you wish to build your own cables, please contact your nearest psychiatric care facility after reviewing the connection table below:

| SP2k P12, P14 or P15 Pin # | SP or SL Control Connector Pin # | Pin Description |
|---|---|---|
| 1 | 4 | Encoder Marker - |
| 2 | 5 | Encoder Marker + |
| 3 | 6 | Encoder B - |
| 4 | 7 | Encoder B + |
| 5 | 8 | Encoder A - |
| 6 | 9 | Encoder A + |
| 7 | 1 | Command Reference |
| 8 | 2 | Command Signal |
| 9 | 3 | Ground |
| 10 | 10 | Remote Fault Reset / Disable |

# STARTING THE SYSTEM UP

## Before Applying Power...

### De-couple the Servomotor

To minimize the risk of damage to the machine during the startup phase, de-coupling of the motor and load is highly recommended. This will prevent a motor runaway from damaging the machine or injury to personnel.

**If you have previously tuned the system with a load do not de-couple the load from the servomotor and do NOT run the servomotor without the load connected. Running the servomotor without the load once the system has been tuned may result in severe instability and the motor may shake and vibrate violently!**

## Applying Power

Go through the following checklist as a final check before application of power

- Ensure that the voltage and frequency of the power lines are correct.
  - All AC voltages should be no greater than 265 VAC, 50/60 Hertz.
  - The I/O power input should be 24 VDC +/- 10%.
- Ensure the Shunt Regulator Module wires are connected properly. **Failure to connect the Shunt Regulator properly could cause irreversible damage to the Shunt Regulator and/or Servodrive!**

Apply Control Power to the SP2k and check the status of the following LEDs:

- The green *Input Power* LED should be illuminated
- All red *Servodrive Fault* LEDs should be off

Turn the Control Power off and move on to the next section.

## Setting Up with *MotionObjects*™

It's time to install the software used to communicate with the SP2k Digital Positioning Servodrive. *MotionObjects*™ will allow you to directly "talk" with the servodrive, save and upload programs, plot data using *MotionScope*™ and many other important features.

➢Minimum Requirements for *MotionObjects*™

Windows 95 or Windows NT 4.0 Operating Systems with at least 16 megabytes (32 megabytes recommended) of RAM and 10 megabytes of hard disk space.

➢Installing *MotionObjects*™ *for Windows*

Insert the floppy disk labeled Disk 1 of 3 into your A: drive or place the MotionObjects CD ROM into your CD ROM drive. Click on the *Run* option of the *Start* menu.

At the *Open* prompt type "A:\SETUP.EXE" (floppy version), or "D:\MotionObjects\Setup.exe" (CD ROM version, use your own CD ROM drive letter if it's not D:). Then press Enter.

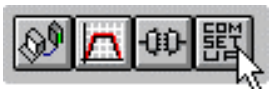
Follow the prompts to install the *MotionObjects*™ files onto your hard drive.

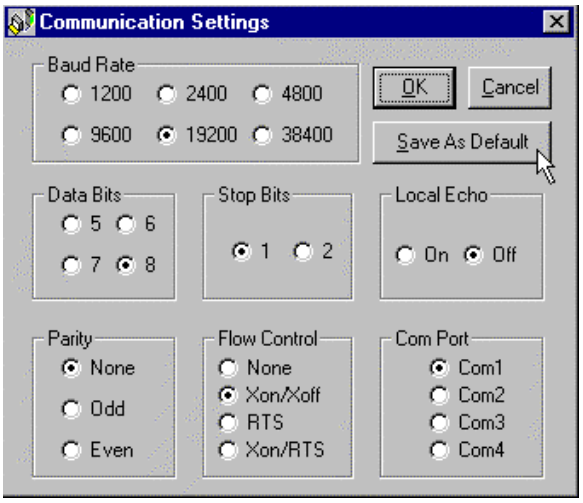
## Sample System Setups

To speed up the setup process for you, some sample code has been provided below to initialize the system and get you

up and running quickly. This code is provided only as a quick start tool and is not a substitute for understanding the software commands found in the *SP2k Developer's Manual.*

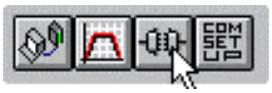
A. Connect the DB9 end of the COM cable supplied with *MotionObjects*™ to your PC and the shrouded Phoenix connector end (green connector) to either the COM1 or COM2 port of the SP2k.
B. Load *MotionObjects*™.
C. Click on the COM Setup Toolbar Button.



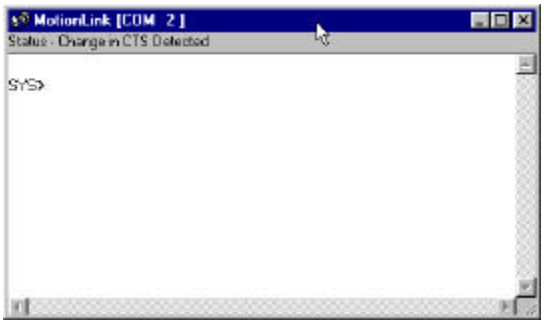




D. Select the COM port that the SP2k COM cable is connected to **on your PC**. All other settings are nominal and should be fine. Normal settings are 19200 Baud, 8 Data Bits, 1 Stop Bit, Local Echo Off, Parity None, and Xon/Xoff Flow Control.
E. Click on the Save As Default button if you are happy with these settings.

F. Apply Control Power to the SP2k.
G. **Carefully and observantly** apply power to the AC Power Mains. If the servomotors move, turn the system off and check all connections.
H. Click on the COM Port *Connect* Toolbar Button.




I. Press the Enter key a couple of times




You should now have a "SYS>" prompt in the *MotionLink*™ window. If you do not, check all connections, ensure the SP2k has proper control power and redo the steps above.

At the SYS prompt enter the following for the system you have:

## Single Axis Setup Example

```
SYS>DIM PROG0(20000)
SYS>PROG0
P00>ATTACH MASTER0
P00>ATTACH SLAVE0 AXIS0 “X”
P00>MULT X4
P00>ESAVE ALL
```

You have now set up a single axis system and it is ready for some limited motion (we have not tuned it). To move the “X” axis, use the following command:

```
P00>X/8000
```

The motor’s shaft should have rotated clockwise 1 revolution (based on a 2000 line encoder with 4x multiplication on Axis X per MULT X4). Since this is a relative move, you may enter this command over and over again to get the same motion.

The VEL, ACC and STP commands may be used to alter the velocity, acceleration and the ending deceleration ramps, respectively. Since the MASTER has been defined in Program area 0, these commands must be entered from program area 0. See the *SP2k Developer’s Manual* for more information on manipulating Masters from other program areas.

## Two-axis Independent Motion Setup Example

If you have set up your system using any of the previous examples, start this setup by clearing them with the following code:

From anywhere in the system, type “SYS” and press enter to move back to the system level. Now type:

```
SYS>HALT ALL
SYS>NEW ALL
SYS>DETACH ALL
```

```
SYS>CLEAR
SYS>ERASE
```

Now turn the Control Power off and then on again. The system is cleared and is ready for our next example.

For a 2-axis independent motion system, enter the following code:

```
SYS>DIM PROG0(20000)
SYS>DIM PROG1(20000)
SYS>PROG0
P00>ATTACH MASTER0
P00>ATTACH SLAVE0 AXIS0 “X”
P00>MULT X4
P00>PROG1
P01>ATTACH MASTER1
P01>ATTACH SLAVE0 AXIS1 “Y”
P01>MULT Y4
P01>ESAVE ALL
```

Your 2-axis system is now set up and ready to do simple motion. We still need to tune the system, however, and we will address this in the section on Tuning. For now, simple moves may be entered as follows:

```
P01>PROG0
P00>X/8000
```

This should have rotated the X axis servomotor clockwise 1 revolution (based on a 2000 line encoder with 4x multiplication on Axis X per MULT X4). Since this is a relative move, the command may be entered over and over again.

The VEL, ACC and STP commands may be used to alter the velocity, acceleration and deceleration ramps, respectively. Since the MASTER has been defined in Program area 0, these commands must be entered from program area 0. See the *SP2k Developer’s Manual* for more information on manipulating Masters from other program areas.

To move the Y axis:

```
P00>PROG1
P01>Y/8000
```

This should have rotated the y axis servomotor clockwise.

## Three-axis Independent Motion Setup Example

If you have set up your system using any of the previous examples, start this setup by clearing them with the following code:

From anywhere in the system, type “SYS” and press enter to move back to the system level. Now type:

```
SYS>HALT ALL
SYS>NEW ALL
SYS>DETACH ALL
SYS>CLEAR
SYS>ERASE
```

Now turn the Control Power off and then on again. The system is cleared and is ready for our next example.

For a 3-axis independent motion system, enter the following code:

```
SYS>DIM PROG0(20000)
SYS>DIM PROG1(20000)
SYS>DIM PROG2(20000)
SYS>PROG0
P00>ATTACH MASTER0
P00>ATTACH SLAVE0 AXIS0 “X”
P00>MULT X4
P00>PROG1
P01>ATTACH MASTER1
P01>ATTACH SLAVE0 AXIS1 “Y”
P01>MULT Y4
P01>PROG2
P02>ATTACH MASTER2
P02>ATTACH SLAVE0 AXIS2 “Z”
P02>MULT Z4
P02>ESAVE ALL
```

Your 3-axis system is now set up and ready to do simple motion. We still need to tune the system, however, and we will address this in the section on Tuning. For now, simple moves may be entered as follows:

P01>PROG0
P00>X/8000

This should have rotated the X axis servomotor clockwise 1 revolution (based on a 2000 line encoder with 4x multiplication on Axis X per MULT X4). Since this is a relative move, the command may be entered over and over again.

The VEL, ACC and STP commands may be used to alter the velocity, acceleration and deceleration ramps, respectively. Since the MASTER has been defined in Program area 0, these commands must be entered from program area 0. See the *SP2k Developer's Manual* for more information on manipulating Masters from other program areas.

To move the Y axis:

P00>PROG1
P01>Y/8000

This should have rotated the Y axis servomotor clockwise.

To move the Z axis:

P01>PROG2
P02>Z/8000

This should have rotated the Z axis servomotor clockwise.

## Four-axis Independent Motion Setup Code

If you have set up your system using any of the previous examples, start this setup by clearing them with the following code:

From anywhere in the system, type "SYS" and press enter to move back to the system level. Now type:

```
SYS>HALT ALL
SYS>NEW ALL
SYS>DETACH ALL
SYS>CLEAR
SYS>ERASE
```

Now turn the Control Power off and then on again. The system is cleared and is ready for our next example.

For a 4-axis independent motion system, enter the following code:

```
SYS>DIM PROG0(20000)
SYS>DIM PROG1(20000)
SYS>DIM PROG2(20000)
SYS>DIM PROG3(20000)
SYS>PROG0
P00>ATTACH MASTER0
P00>ATTACH SLAVE0 AXIS0 “X”
P00>MULT X4
P00>PROG1
P01>ATTACH MASTER1
P01>ATTACH SLAVE0 AXIS1 “Y”
P01>MULT Y4
P01>PROG2
P02>ATTACH MASTER2
P02>ATTACH SLAVE0 AXIS2 “Z”
P02>MULT Z4
P02>PROG3
P03>ATTACH MASTER3
P03>ATTACH SLAVE0 AXIS3 “A”
P03>MULT A4
P03>ESAVE ALL
```

Your 4-axis system is now set up and ready to do simple motion. We still need to tune the system, however, and we will address this in the section on Tuning. For now, simple moves may be entered as follows:

```
P01>PROG0
P00>X/8000
```

This should have rotated the X axis servomotor clockwise 1 revolution (based on a 2000 line encoder with 4x multiplication on Axis X per MULT X4). Since this is a relative move, the command may be entered over and over again.

The VEL, ACC and STP commands may be used to alter the velocity, acceleration and deceleration ramps, respectively. Since the MASTER has been defined in Program area 0, these commands must be entered from program area 0. See the *SP2k Developer's Manual* for more information on manipulating Masters from other program areas.

To move the Y axis:

P00>PROG1
P01>Y/8000

This should have rotated the Y axis servomotor clockwise.

To move the Z axis:

P01>PROG2
P02>Z/8000

This should have rotated the Z axis servomotor clockwise.

To move the A axis:

P02>PROG3
P03>A/8000

This should have rotated the A axis servomotor clockwise.

## Two-axis Coordinated Motion Setup Code

If you have set up your system using any of the previous examples, start this setup by clearing them with the following code:

From anywhere in the system, type "SYS" and press enter to move back to the system level. Now type:

SYS>HALT ALL

```
SYS>NEW ALL
SYS>DETACH ALL
SYS>CLEAR
SYS>ERASE
```

Now turn the Control Power off and then on again. The system is cleared and is ready for our next example.

For a 2-axis coordinated motion system, enter the following code:

```
SYS>DIM PROG0(20000)
SYS>PROG0
P00>ATTACH MASTER0
P00>ATTACH SLAVE0 AXIS0 “X”
P00>ATTACH SLAVE1 AXIS1 “Y”
P00>MULT X4
P00>MULT Y4
P00>ESAVE ALL
```

Your 2-axis coordinated motion system is now set up and ready to do simple motion. We still need to tune the system, however, and we will address this in the section on Tuning. For now, simple moves may be entered as follows:

```
P00>X/8000 Y/4000
```

Both axes should have rotated clockwise, and arrived at their final destination together. Remember, we haven’t tuned anything yet, so if they were slightly out of synch, don’t worry about it right now.

In a coordinated motion system, such as the one we just set up, two axes reside in one program area under one Master. This master automatically computes the required motion and velocity trajectories to get both axes to their end positions at the same time. By entering both move commands on one line together, we tell the Master to compute these trajectories together. If we want an axis to move without the other, you would enter the following code:

```
P00>X/8000
```

The X axis servomotor should move here by itself without the Y axis. This is independent motion, but both axes cannot move independently of each other at the same time in this configuration. For example,

P00>X/100000
P00>Y/100000

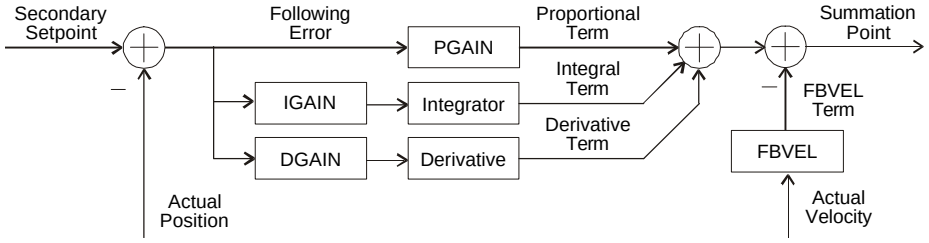
The above commands will generated movement in the X axis first. When the X axis has completed its motion, the Y axis will begin its move. This is because there is only 1 Master profiler allowed in a single program area. If you need 2 axes to move independent of each other simultaneously, you must set them up under separate program areas and Masters.

# TUNING YOUR SERVO

## PID Basics

In order to tune the SP2k, it is necessary to have at least a fundamental understanding of the PID algorithm and each term's impact on your servo system. PID is an acronym for *Proportional, Integral and Derivative.* Each of these terms is an independent gain in the closed loop system.

The diagram below shows the relationship between the PID terms. As the diagram shows, all of these gains work on the same source, the difference between the Secondary Setpoint (the commanded position) and the Actual Position. This is known as the following error.




### Proportional Gain

Proportional gain is simply an amplifier. It multiplies the amount of following error sampled each servo interrupt period by a fixed gain called PGAIN. This is a simple first order, linear function. It is expressed in volts of command per encoder count of following error, or Volts/Pulse.

The SP2k is shipped with a PGAIN of 0.00244141 volts per encoder count of following error. This yields a maximum command of 10 volts with 4096 counts of following error.

The factory default values for IGAIN, DGAIN and all other gains is 0. These must be set up in the application to optimize performance.

## Integral Gain

The Integral gain takes the sum of the previous servo period's following errors multiplied by IGAIN and adds that to the current period's following error multiplied by IGAIN. In so doing, the output of the integrator will increase over time if the following error remains.

This serves to eliminate constant errors, such as errors due to static friction at low speed or while at rest. Integral may also be used to eliminate constant errors at speed, but there is another gain called FFVEL that is a better choice for this and it will be discussed later.

IGAIN is expressed in volts/second/pulse. The anti-windup feature ILIMIT must first be set for IGAIN to work.

Integral should be left at 0 until proportional and derivative gains have been set up.

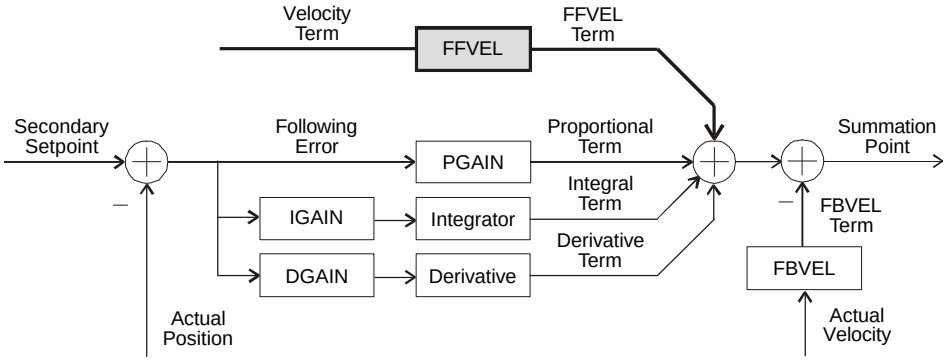
## Derivative Gain

Derivative gain works on the following error difference from period to period. The higher the difference in the following error this period when compared to the last period, the higher the output of the derivative function. Derivative helps stabilize systems with torque disturbances, such as slot lock in the servomotor or cutting or other intermittent forces applied to the servomotor.

## Velocity Feed-forward Gain

The FFVEL gain helps to eliminate following error while the servomotor is running at a given speed. The system does this by evaluating the velocity term—developed from the difference of positions or 1/T registers—and multiplying it by the FFVEL gain constant. Thus, the higher the velocity term, the greater the output from the FFVEL gain.

This gain is used because it is not possible to add enough proportional gain “PGAIN” to the system to eliminate steady-state following errors while running, and still maintain stability while not running.




While integral gain “IGAIN” will also eliminate steady-state following errors, it also introduces lags that can cause overshoots. It is recommended that FFVEL gain be used to eliminate following errors during motion, and only a small amount of IGAIN should be used to eliminate following errors due to static friction while the axis is at rest. This is accomplished by setting the “IDELAY” to a value of perhaps .001 or .010, which will cause the integral gain to occur 1 msec or 10 msec after the completion of the move, but not during the move. Remember to set “ILIMIT” to a non-zero value like 1 volt, or integral gain will not be activated.

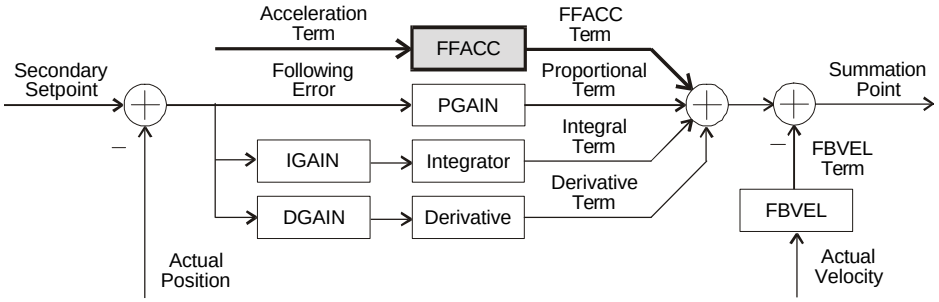
To determine the correct amount of FFVEL gain, use the following equation:

FFVEL = PGAIN * FollowingError / VELOC

You may use this equation at any velocity and the FFVEL gain should be accurate for all velocities.

## Acceleration Feed-forward Gain

The FFACC gain adds gain proportional to the difference in the setpoint (commanded position) from one servo interrupt period to the next. By doing so, additional gain is produced for higher acceleration and deceleration profiles, reducing the following error during acceleration and deceleration.




The system does this by multiplying the Acceleration Term--the difference in the setpoint from one servo interrupt to the next—by the FFACC gain constant. Adding FFACC gain is very similar to adding derivative gain, but derivative gain will cause instability at times other than acceleration or deceleration if it is too high. FFACC gain is like applying additional derivative only during the acceleration and deceleration parts of the motion profile. Failure to have enough gain during a given acceleration or deceleration profile will generate excessive following errors that may cause overshoots at the end of the profile.

To calculate the amount of FFACC gain required, use the following equation:

FFACC = PGAIN * FollowingError / ACCEL

## Recommended Tuning Procedure

Start by leaving the PGAIN at the factory default of **.**00244141 volts/pulse. Typically, the derivative gain "DGAIN" should be about 2 orders of magnitude less than the proportional gain "PGAIN", or about **.**0000244. This is just a guideline and systems vary, but it will generally yield stability.

Next, run the system using MotionScope to plot the actual and commanded velocity profiles, and increase PGAIN and DGAIN in tandem until the actual velocity closely follows the commanded velocity (stiffen the system). Don't worry about following errors at constant speed or other things right now.

Once you have your system fairly stiff, plot the following error and you will find that it is quite large during acceleration and during constant speed.

At this point, add a small amount of integral gain to eliminate any following error at zero speed caused by static friction. An IGAIN of **.**1 would be a good start. Set your IDELAY to **.**005 for a 5 msec delay. Increase the integral limit "ILIMIT" from its default of zero to perhaps 1 volt, or IGAIN will have no affect.

Then add velocity feed-forward gain to reduce the following error to near zero during constant speed. Note that this will **not** affect the following error observed during acceleration or deceleration.

Next, add some acceleration feed-forward gain to reduce the following errors observed during acceleration and deceleration to an acceptable value. Remember, that following error during acceleration and deceleration is generally acceptable as long as it is not so large that it produces overshoots at the end of the acceleration or deceleration portion of the motion profile.

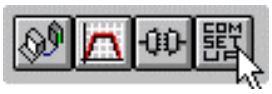
Your system should now be optimized and ready to run. ESave the results and record your gain values in a safe place.

# USING MOTIONSCOPE™

MotionScope™ provides an intuitive interface for exercising the servomotor and the servodrive and checking the performance. Move commands are issued and monitored with up to 8 data acquisition channels onboard the SP2k. This means that you may select and simultaneously monitor 8 pieces of data during a move. Each channel is sampled at the servo interrupt rate.

This section will help you install and use the MotionObjects tools for tuning your servo system. If it isn't running already, load *MotionObjects*™ and go through the steps to set up and initialize communication with the SP2k. You remember,

A. Load *MotionObjects*™.
B. Click on the COM Setup Toolbar Button.





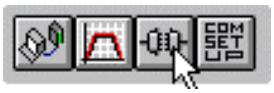
C. Select the COM port that the SP2k COM cable is connected to **on your PC**. All other settings are nominal and should be fine. Normal settings are 19200 baud, 8 data bits, 1 stop bit, Local Echo Off, Parity None, and Xon/Xoff handshaking.

D. Click on the Save As Default button if you are happy with these settings.

E. Apply Control Power to the SP2k.

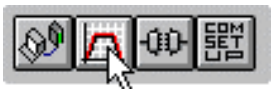
F. **Carefully and observantly** apply power to the AC Power Mains. If the servomotors move, turn the system off and check all connections.

G. Click on the COM Port *Connect* Toolbar Button… You're Connected!

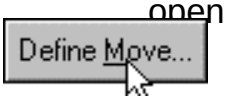


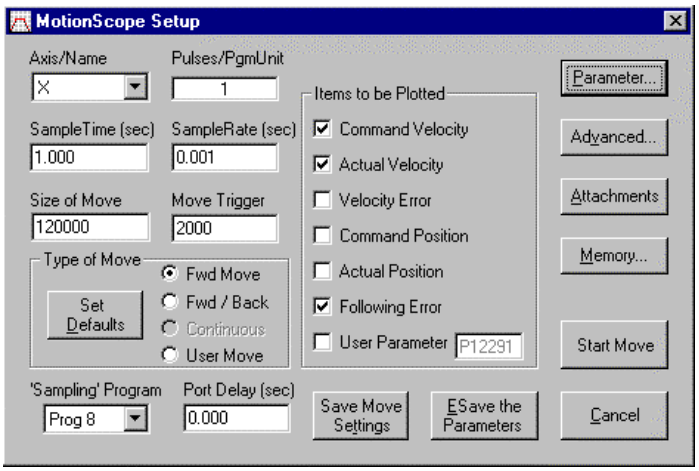
Now, to help you tune your system, load the MotionScope™ window as follows:

A. Click on the MotionScope Toolbar Button. The MotionScope graphics window should now be open.



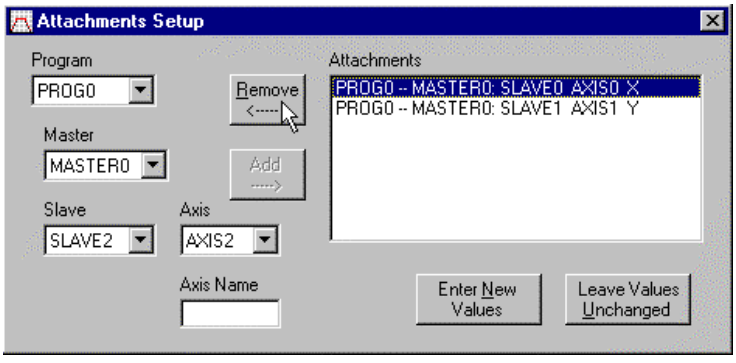
B. Click on the Define Move function button.




The MotionScope Setup Dialog appears.

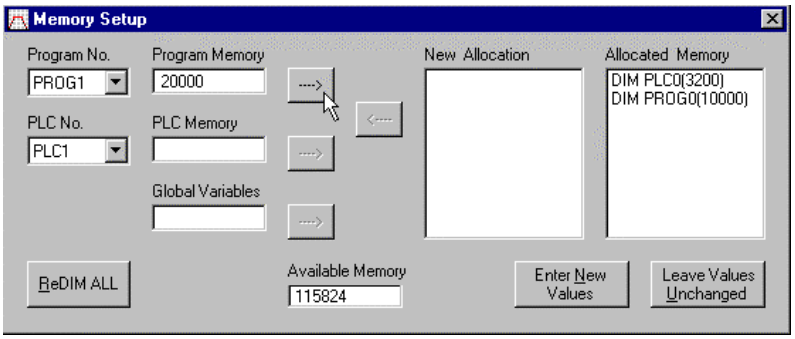
C. To clear system memory of the example setups that were done earlier in this chapter, click the Memory… button and select ReDIM ALL from the Memory Setup Dialog. Return to MotionScope Setup by clicking on Enter New Values.




D. Click the Attachments button from the MotionScope Setup dialog and click on the first attachment in the Attachments Setup window and click on the Remove button to remove that attachment. Repeat this for any other attachments in the Attachments Setup window.

E. Once all attachments have been removed, return to the MotionScope Setup dialog by clicking on the Enter New Values button.

F. Click on the Memory… button to set up the system memory as you want it. Allocate enough memory for system variables, tables, arrays and the program that will occupy this program area. If you are not sure about how much memory to use, just enter 20000, as the example shows.




G. Click on the Right Arrow button to transfer your new program area to the New Allocation list box.

H. Select any additional program areas from the "Program No." pulldown and repeat for as many programs as you require.

**Be sure to allocate one program area for the Sampling program to reside in and acquire your tuning data. This program should have at least 40k bytes of memory.**

I. Next, click on the Enter New Values button to return to the MotionScope Setup dialog and click on the Attachments button to make new system attachments.

J. Select any of the program areas you defined earlier and select a Master for that program area. The Slave number defaults to the next available slave, so there is no need to change this.

K. Select the Axis number for the program area and Slave and issue a Name in the Axis Name text box.

L. When all boxes are completed, click the Right Arrow button to complete the axis setup. The attachment will show in the Attachments list box.

M. Return to the MotionScope Setup dialog and click ESave the Parameters button to save all of your settings in Eprom.

Your system is now set up and ready for tuning. To start optimizing your system, follow these steps:

A. From the MotionScope Setup dialog, in the 'Sampling' program pulldown, select the program number that you planned to use for the tuning program earlier.

B. Select the axis to tune in the Axis/Name pulldown list.

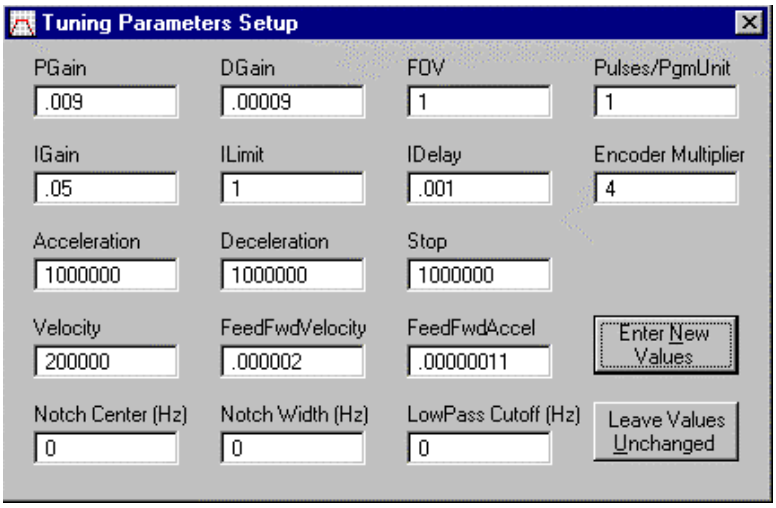
C. Using the Parameter… button in MotionScope Setup, set your desired acceleration, deceleration, stop deceleration, and velocity. These values should represent the move that your application will be making. They will characterize the nature of the test motion analyzed by MotionScope.
D. Enter a reasonable move distance in the Size of Move field. This is how far the axis will move for the tuning move, expressed in the current PPU units for the axis selected. Be careful of any end of travel limits of your machinery!
E. Click the Start Move button to make the move and plot the data.

The Sample Time normally should be set to contain the entire Sampling move. The default Sample Rate of .001 seconds is usually good, but you can change it as well. Clicking the Set Defaults button will set the size of move to contain a move based on your previous velocity setting, etc.

A special User Parameter may be plotted by checking the box and entering the parameter in the textbox.

## Changing Gains

The gains, velocity, deceleration, acceleration and other values can be manipulated from the Tuning Parameter Setup dialog. To access this dialog, click the Parameter button from the MotionScope Setup dialog.




After changing gains, make sure you save them by clicking the Enter New Values button on this screen. After your tuning is done and you are sure the settings are what you like, use Esave the Settings on the MotionScope Setup dialog.

# TROUBLESHOOTING GUIDE

The maintenance procedures described in this manual should be attempted only by highly skilled technicians using proper test equipment. Before starting, read the warranty provisions to prevent voiding your warranty.

When any fault is detected by the servodrive, a qualified technician should determine that all external connections to the servodrive, all signals, and the load are in good working order. Failure to verify that the situation that caused the fault has been resolved before resetting the servodrive can permanently damage the servodrive, motors, and machinery, and may void your warranty!

⚠ **Do not remove any connectors, jumpers, wires, etc., unless the POWER IS OFF!**

## Fault Indications

The table below describes some of the possible causes for LED fault indications:

| LED | POSSIBLE CAUSES |
|---|---|
| (MTR) GROUND | 1 - One or more output wires between the motor and the servodrive is shorted to ground.<br>2 - Breakdown in voltage (dielectric strength) in the output cables (shorted to ground).<br>3 - High parasitic capacitance in the output cables (particularly for long runs).<br>4 - Defective motor.<br>5 - Defective servodrive. |
| SURGE | 1 - One or more output wires shorted together.<br>2 - Breakdown in voltage (dielectric strength) in the output cables (shorted together).<br>3 - High parasitic capacitance in the output cables (particularly for long runs).<br>4 - Defective motor.<br>5 - Defective servodrive. |
| RMS<br><br><br>RMS (cont.) | 1 - Excessive load current caused by mechanical binding or friction.<br>2 - Defective or miswired feedback cable.<br>3 - Defective or miswired power cable.<br>4 - Wrong Personality Module or EPROM installed for the motor being driven. |

| LED | POSSIBLE CAUSES |
|---|---|
| | 5 - Defective motor.<br>6 - Defective servodrive. |
| REGEN with Green power LED ON | 1 - Excessive regenerative energy from decelerating load.<br>2 - Defective shunt regulator or no shunt regulator installed. |
| REGEN with green power LED OFF | 1 - One of the phases of the 3 phase AC input has failed.<br>2- Excessive noise on the AC input lines (see *Input Line Filters* in this manual).<br>3 - Defective servodrive. |
| TEMP | 1 - Excessive ambient temperature (servodrive is rated for 50 deg. C)<br>2 - Defective internal fan in servodrive.<br>3- Motor Over Temp. J-3 on the Personality Module must be removed to allow a motor overtemp to create a latched fault condition - See J2 -Feedback connector Motor Temp Fault and Personality Module jumper definitions (JP-3) and specifications. |
| LOGIC | 1 - Input voltage out of range (servodrive is rated for 97-265 VAC, 47-63Hz).<br>2 - Defective servodrive. |
| FEEDBACK FAULT | 1 - Feedback Fault - Loss of an encoder signal. |

# Troubleshooting Procedures

This section provides additional details about troubleshooting the servodrive and its components. It is intended to assist the trained technician or engineer in identifying defective system components. It is NOT intended to assist in the repair of any failed components.

| Symptom | Conditions | Possible Causes |
|---|---|---|
| No Output<br>No fault lights | Input power LED NOT ON | Check three phase power input TB401 for proper AC input power. If single phase, insure that the single phase AC inputs are connected to TB401 pins 1, 3, and 4 (ground), and that pin 2 is jumpered to pin 1 or pin3. |
| | Input power LED ON | Insure that the motor feedback and power cables are properly connected to the servomotor and servodrive. |
| | | Check J1 for the following voltages:<br>J1-5 = +5V<br>J1-10 = +12V<br>J1-12 = -12V<br>And Check J2 for the following voltage:<br>J2-1 = +5V<br>If any voltages are missing, remove all connectors, and after reapplying power, see if the voltages return. If they return, check for shorts in the cable/wiring. |
| | | Check to insure that the servodrive is not being disabled from an external condition. J1 pin 8 and J1 pin 13 must not be pulled low, or output will be disabled. Also, J1 pin 26 must be pulled low (either by the factory installed jumper from J1 pin 26 to common, or by an external condition if the jumper is removed).<br>Also, if J1 pin 24 is not pulled low, it will limit motion with negative input commands, and if J1 pin 25 is not pulled low, it will limit motion with positive input commands. Refer to Servo-drive Connection Definitions & Specifications for J1 Connector. |
| | | Disconnect the motor power connector and manually turn the motor while observing the encoder position registers. If any of these are not moving, check the cables and connections for proper wiring. |
| | | Replace motor. |
| | | Replace servodrive. |
| Erratic Movement motor jumps and kicks | No fault LEDs on | Insure that the motor feedback and power cables are properly connected to the motor and servodrive. |
| | | Check for loose or broken wires on the J2 Feedback connector |
| | | Check and insure that the servodrive is properly grounded. The AC input voltage connector pin TB401 pin 4 should be tied to earth ground. The servodrive output (Motor Stator) terminal |

| Symptom | Conditions | Possible Causes |
|---|---|---|
| | | TB402 pin 4 should be tied to the motor case ground. (This is the green wire on the Westamp cable). |
| | | It is recommended that shielded wire is used for the command signals and that differential input is used if your controller supports it. Terminate the shield for the encoder signals at the servodrive (feedback connector) end. Terminate the shield for the Command signals at the controller's end. |
| | | Observe the incremental encoder signals: "A" channel encoder signals are present on P2 pins 8 and 9, "B" channel encoder signals are present on P2 pins 6 and 7. Refer to the P2 Feedback connector description. There should be a 90 degree phase shift between the A and B encoder signals. The A NOT should be opposite the A (180 degree out of phase). Likewise, the B NOT should be opposite the B. |
| | | Observe the Hall signals on the J2 connector: U Hall = J2 pins 15 and 14, V Hall = J2 pins 13 and 12, W Hall = pins 11 and 10. (refer to the J2 Feedback connector description). There should be a 120 degree phase difference between the U, V, and W Hall (six step) signals. The U NOT Hall should be opposite the U Hall (180 degree out of phase). Likewise the V NOT and W NOT Hall should be opposite the V and W Hall respectively.<br><br>If any of the above signals are missing, recheck the cables for proper wiring. |
| | | Disconnect the motor power connector and manually turn the motor while observing the Hall signals at U Hall, (pins 15 and 14), V Hall (pins 13 and 12) and W Hall (pins 11 and 10). (see the J2-Feedback connector definitions and specifications)<br><br>There should be 120 degree phase differences between the three Hall signals. The frequency of the Hall signals should be 3 HZ per motor revolution for a six pole motor, and 2 Hz per motor revolution for a four pole motor. If Differential Hall inputs are used, the Not (/) input should be opposite (180 degree out of phase) the logical input. (U NOT opposite U, V NOT opposite V , W NOT opposite W) |
| | | If the motor configuration being used is different than the factory defaults, insure that the Control Board jumpers are properly configured. Factory default settings are for Differential Inputs on both Hall and encoder inputs to the J2 Feedback connector. If a different configuration is used refer to the Control Board Jumpers chart under the Connectors and Configuration Jumpers section. |
| | | Temporarily convert the servodrive to the six step mode by removing the left side cover and installing the control board's JP-8 jumper on pins 2 and 3. If the problem clears when the servodrive is in the six step position, the problem is in the encoder/feedback cable/circuitry. Re-inspect/repair the feedback cable. Substitute the motor if one is available. If additional noise immunity is required, an external logic supply may be used for the encoder feedback circuitry. (Refer to the procedure on Using an External Power Supply for the Encoder). |

| Symptom | Conditions | Possible Causes |
|---|---|---|
| | | Placing the servodrive in the six step position should be for troubleshooting only. In most circumstances, you will not want to leave the servodrive in six step mode. This will cause poor performance at lower speeds. |
| RMS Fault | RMS LED light is on. | An RMS fault indicates that the servodrive has supplied a current above the RMS rated current of the system for an extended period of time. The RMS fault occurs to protect the servodrive/motor and mechanical system. |
| | | Insure that the load is not oversized. (The load is larger than the servodrive/motor combination can safely handle.) |
| | | Insure that the motion profile does not have an extreme duty cycle. (The servodrive is pulling current above the RMS level for an excessive period of time.) |
| | | Insure there is no binding or defective mechanical components causing an increase in machine friction. (The servodrive is requested to supply more than normal current because of a mechanical bind. |
| | | The servodrive may not be properly compensated for the load. Recheck the Set - Up Procedure for the tach loop (refer to Set-Up Procedure in this manual). |
| | | The motor could be defective. Replace the motor. |
| | | Replace the servodrive. |
| SURGE Fault | SURGE LED is on | Turn power off and disconnect the motor cable at the servodrive. (TB402 pins 1, 2, 3 and 4). |
| | | If the SURGE fault light continues to illuminate after the motor cable has been disconnected at the servodrive end (TB402)and power reapplied, replace the servodrive. |
| | | If the SURGE fault clears when the cable has been disconnected at the motor end (TB402) and power reapplied, reconnect the cable at the motor end and disconnect the motor armature cable at the motor connector. |
| | | If the SURGE fault continues to illuminate after the motor cable has been disconnected at the motor end, the problem is probably the motor cable. Inspect and/or replace the motor cable. |
| | | If the SURGE fault clears when the motor cable has been disconnected at the motor end, but illuminates when the cable is connected to the motor, there is an internal short in the motor. Replace the motor. |
| GROUND Fault | GROUND LED is on | Turn power off and disconnect the motor cable at the servodrive (TB402 pins 1, 2, 3 and 4). |
| | | If the GROUND fault light continues to illuminate after the motor cable has been disconnected at the servodrive end (TB402) , and power reapplied, replace the servodrive. |
| GROUND (cont.) | | If the GROUND fault clears when the cable has been disconnected at the motor end (TB402) and power reapplied, reconnect the cable at the motor end, and disconnect the motor armature cable at the motor connector. |
| | | If the GROUND fault continues to illuminate after the motor cable has been disconnected at the motor end, the problem is probably the motor cable. Inspect and/or replace the motor |

| Symptom | Conditions | Possible Causes |
|---|---|---|
| | | cable. |
| | | If the GROUND fault clears when the motor cable has been disconnected at the motor end, but illuminates when the cable is connected to the motor, there is an grounded armature in the motor. Replace the motor. |
| LOGIC Fault | LOGIC fault LED is on | LOGIC fault indicates that the + 5V, -12V, or +12V logic voltage has dropped below the level required to reliably operate the logic circuits of the servodrive. |
| | | Check J1 for the following voltages:<br>J1-5 = +5V<br>J1-10 = +12V<br>J1-12 = -12V<br>And check J2 for the following voltage:<br>J2-1 = +5V<br>If any voltages are missing remove the J1 and J2 connectors, and after reapplying power, see if the voltages return. If they return, check for shorts in the cable/wiring. |
| TEMP Fault | TEMP fault LED is on | A TEMP fault indicates that either the motor or the heat sink temperature (and thus the output transistor temperature) has risen beyond the safe operating range of the servodrive. |
| | | Insure that the ambient temperature (the temperature directly outside of the servodrive) is below 50 degrees C. The drive is rated to pull RMS current at 50 degrees C. If the temperature is above this, the ambient temperature must be lowered. |
| | | If the servodrive uses a fan, insure that the fan is working properly. |
| | | Insure that there is room to allow proper ventilation of the servodrive. Do not obstruct the intake or exhaust outlets near the top or the bottom of the servodrive. The module should be mounted vertically, so that air naturally passes through the heatsink from the bottom of the module to the top of the module. |
| | | Insure that the motor temperature is not excessive. If the motor temperature becomes too high the internal thermal switch inside the motor will open, creating a temperature fault and disabling the servodrive.<br>If a motor temperature fault has occurred, the Motor Temp Fault outputs at J1 pin 16 and J1 pin 17 will become asserted. Refer to the Servodrive Connection Definitions and Specifications for the J1-Input / Output commands. |
| FEEDBACK Fault | FEEDBACK LED is on | Check that the feedback cable is properly connected at P2. Check the feedback cable wiring per the applicable drawing. |
| REGEN Fault (BUS/PHASE) | REGEN LED is on | If a BUS overvoltage fault occurs when the servodrive is first turned on, check three phase power input TB401 for proper AC input voltage. Insure that there is power on all three phases. In-sure that the voltage is within the range listed for the servodrive. |
| REGEN Fault (cont.) | | If the overvoltage fault occurs during a move, the system may be producing regenerative energy that is being returned to the servodrive. The fault circuitry may be protecting the servodrive by shutting it off to prevent higher regeneration. |
| | | If there is no shunt regulator with the servodrive, it may be necessary to add one. If there is a shunt regulator, check to insure that the fuse has not blown. |

| Symptom | Conditions | Possible Causes |
|---|---|---|
| Motor Slowly rotates With no input command | Controller position loop open or no position loop. | Insure that there is no input signal command at the J1 connector (J1-1 and J1-2). Adjust the offset pot (R23) on the Personality Module until the motor stops rotating. |
| Motor Runs Away | Controller Position loop may be opened or closed. | Check (preferably with an oscilloscope) the signal levels at J1-3, the Tachometer signal monitor, with respect to J1-4, the signal command common (Refer to the J1 connector description). This reference voltage should be proportional to the speed of the motor. (normally scaled to either 0.5V or 1V / 1000 rpm.) If there is no signal at this point insure that the JP-12 jumper is installed on the Personality Module.<br><br>If there is a jumper on JP-12 inspect/repair the feedback connector as listed above. |
| | | If there is a voltage at J1-3, insure that the Tach Pot (R12) on the Personality Module is not misadjusted. If the Tach Pot is turned too far counter-clockwise, the servodrive may loose tach feedback. Slowly turn the Tach Pot clockwise to see if the problem clears. |
| Motor Runs one direction only | No fault LEDs illuminated | Insure that the servodrive is receiving the proper command. Factory default settings require a positive input signal at J1 pin 2 with respect to J1 pin 1 for the motor to turn in a clockwise direction. A negative command will cause the motor to turn in a counter-clockwise direction. The command signal level and polarity may be checked at the J1 connector (J1 pin 1 and J1 pin2). Refer to the Servodrive Connection Definitions and Specifications for more information. |
| | | Insure that the servodrive is not limited in one direction by an external condition. J1 pin 6 and J1 pin 7, the signal limit input / pins, must not be pulled low or the servodrive will be limited in one direction.<br><br>Also: J1 pin 24 and J1 pin 25, the Normally Closed Limit inputs, must be tied to common, or pulled low or the servodrive will be limited in one direction. Refer to Servodrive Connection Definitions and Specifications for more information. |