SL™ Series
AC Brushless
Servo Amplifier
Instruction Manual

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P/N MNLSL-1.0

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Solutions in Motion

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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 SL Series Servo System.

Typographical 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 amplifier 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 amplifiers, motors and machinery.

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SYSTEM COMPONENTS & OPTIONS

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

SL Series Power/Drive Modules

Key Components

The SL Series Power/Drive Modules are the heart of your servo system. Each module consists of the following key elements (refer to picture on next page):

1. Control/Drive Electronics - This is the heart of the motor controller and includes all electronics for controlling and driving the servo motor in either the torque or velocity modes.
2. Output Power IGBT Transistor - This component is controlled by the Control/Drive Electronics to drive the motor with the appropriate current and voltage.
3. Input Power Electronics (Optional) - This section rectifies the single or three phase AC input supplied to the Power/Drive module. Some of the electronics on this board include bus capacitors and soft-start control.
4. Logic Power Supply Electronics - This component provides the Control/Drive Electronics with the control voltages necessary to operate.
5. Personality Module - Provides for all user-configurable, motor- and load-specific configuration and compensation components. It also provides all user and application specific adjustments. Note that in the unlikely event a drive should need replacement in the field, the Personality Module can be removed from the old drive and placed in the new drive. No adjustments are necessary as all previous adjustments are retained on the Personality Modules.

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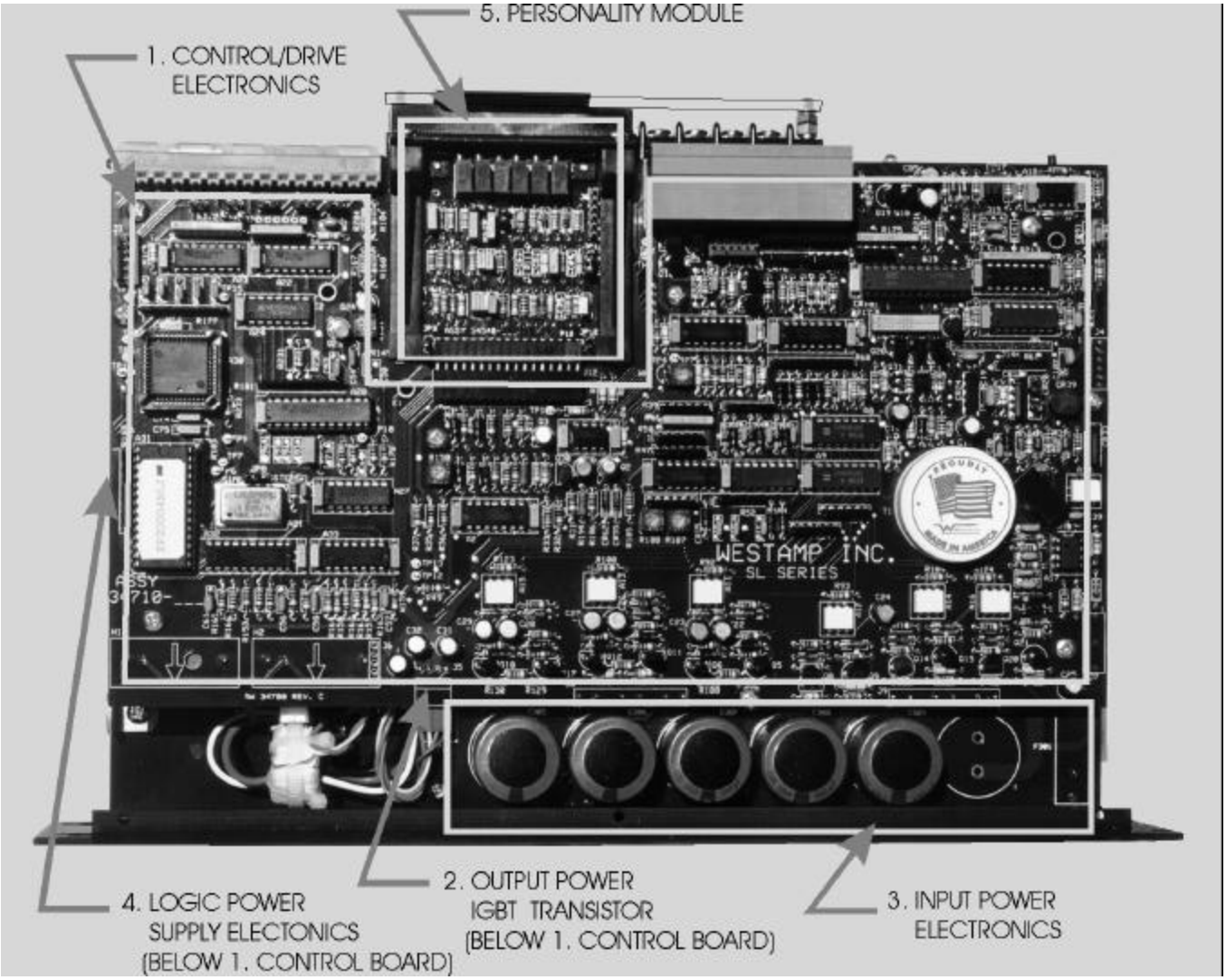

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Connections for the 97 to 265 VAC SL Series

The SL series products have an input voltage range from 97 to 265 VAC. Note that the motor's achievable top speed is directly related to the AC input voltage. Unless otherwise specified, all SL Series speed versus torque curves were generated based on a 240 VAC, three phase main. Lower than published top speeds can be expected with input voltage mains below 240 VAC or use of single phase power.

DC Power Input/Shunt Connector	TB401 (pins 1 and 2)
Motor Output Power Connector	TB401 (pins 3,4,5 and 6)
Input Power Connector (AC)	TB401 (pins 7,8,9,and 10)
Drive Input Commands Connector	J1
Motor Feedback Connector	J2

Adjustments

There are no user adjustments on the Power/Drive Module. All adjustments are made on the Personality Module housed in the Power/Drive Module.

There are, however, configuration jumpers that may need to be considered in certain circumstances. If you are using a Westamp BR Series Brushless Servo motor and Westamp cabling, then the standard settings for these configuration jumpers from the factory are optimum.

If, however, you are using a different motor or cabling, a review of the section entitled *Connectors and Configuration Jumpers* is suggested.

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Fault Indicator Board Option

The Fault Indicator Board provides individual fault indications for all servo faults. In addition, a RESET push-button is provided to reset the drive manually after a servo fault has been cleared.

The purchase of this board is strongly recommended for at least the first commissioning of a system. Later production runs may omit this option, if desired.

The "1" in the part number indicates the presence of the fault board. For example, *SLXXX-X**1*** would specify a fault indicator board, while a "0" in this position would not specify this option.

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SL Series Personality Modules

Personality Modules in the SL Series house all user-configurable, motor-specific and load-dependent configuration and compensation components. There are two types of Personality Modules available: Adjustable and Fixed compensation.

Adjustments

The adjustable compensation "A" modules include adjustments for the following:

CMD adjustment	CoMmanD signal input DC gain
TACH adjustment	TACHometer feedback DC gain
C. COMP adjustment	Course Compensation -- Velocity loop AC gain
F. COMP adjustment	Fine Compensation -- Velocity loop AC gain
I - LIMIT adjustment	Current Limit -- Clamps the peak output current of the drive
OFFSET	Nulls input offsets up to 50 millivolts

For fixed compensation Personality Modules, only the *Offset* adjustment is present.

Drive Replacement

In the event a drive should need replacement in the field, the Personality Module can be removed from the old drive and placed in the new drive. No adjustments are necessary as all previous adjustments are retained on the Personality Modules.

This eliminates the need to send a field service technician to the customer's site to install the replacement drive.

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Load-to-Motor Inertia Mismatches

With low-inertia, high-performance brushless servo motors, such as the Westamp BR Series, it is inevitable that the load inertia will often exceed that of the motor driving them. In an ideal world where shafts and couplings have no spring constants (absolute stiffness), this would not be a problem. Since "absolute stiffness" is not a reality, it is indeed a problem.

As the load is accelerated to, or decelerated from speed, the mechanisms between the motor and the load flex. As the motor accelerates, for example, part of the motor's shaft, coupling and the load actually lags behind the accelerating motor. When the motor reaches the desired speed these mechanisms "spring" back and overshoot the desired speed. If the velocity loop in the drive has sufficient bandwidth to respond to this overshoot, as seen in the tachometer feedback signal, it will attempt to correct it by driving the motor's speed down. This creates another lag between the motor and the load. This process is repeated over and over again, and instability is the result.

Westamp has provided a means for dealing with this problem. The part number for the Personality Modules includes two (2) digits for specifying inertia mismatches. For example, the "05" in *SL-MPM-XXX**05**-X* indicates a 5:1 load to motor inertia mismatch. Specifying the inertia mismatch in this manner provides Westamp with minimum application data that, in most cases, is sufficient enough for us to provide a Personality Module critically damped for your application.

Westamp does this by assuming that the component with the lowest natural resonant frequency is the motor's shaft, and then rolling-off the velocity loop at a frequency lower than this resonance. In most applications, this works exceptionally well. However, there are system components that can undermine this philosophy. If a coupling is used between the motor and load, it is critical that high-grade servo couplings are specified. These couplings are designed to provide high natural resonant frequencies, usually much higher than most other drive

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mechanisms.

What is more important than knowing the inertia mismatch, however, is knowing the frequency of lowest resonance in the drive train. This can be accomplished by using an oscilloscope to observe the tachometer signal on J1, pin 3 with respect to pin 4. This issue will be further discussed in the section entitled *Tuning,* later in this manual.

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User-Configurable Jumpers

Personality Module Jumpers

There are configuration jumpers on the Personality Module to provide flexibility for a wide variety of applications. The following table details these jumpers and their purpose:

Jumper#	Function
JP-1	**Differential / Single-ended Command Input Jumper -** This jumper is used in conjunction with the J1 connector Signal inputs. **For Single-ended Non- Inverted Input** : (normal configuration) The JP-1 shorting jumper is placed on positions 2 and 3 (bottom two pins). **For Single-ended Inverted Input** : The JP-1 shorting jumper is placed on positions 1 and 2 (top two pins). **For Differential Input** : The JP-1 shorting jumper should be removed. Refer to the J1 connector for explanations on the signal input modes.
JP-2	**High / Low Gain Jumper -** **For velocity control mode:** remove the JP-2 jumper. **For torque (current) mode:** install the JP-2 jumper. Normal Westamp Configuration is velocity control mode (JP-2 removed)
JP-3	**MTR Temperature Fault Disable**. If an amplifier fault/shutdown is NOT desired when a motor overtemperature condition occurs, the JP-3 jumper on the Personality Module must be installed. When this jumper is installed, a Motor Temperature Fault condition will be sensed by the MTR Temp Fault Out pins (J1-16 and J1-17), but it will not disable the amplifier. If the JP-3 Jumper is not installed, the MTR Temp Fault condition will disable the amplifier, creating an amplifier temperature fault. Normal Westamp Configuration is JP-3 removed (Motor Temp Fault will cause an amplifier fault).
JP-11	**Velocity Loop Integrator Jumper:** **For highest bandwidth:** (lowest value integrator) Install the JP-11 Jumper on pins 1 & 2 **For lowest bandwidth:** (highest value integrator) Install the JP-11 Jumper on pins 2 & 3 Normal Westamp Configuration is for lowest bandwidth (JP-11 on pins 2 and 3) Refer to the chapter on tuning for more information.
JP-12	**Internal Tach Jumper**. To use the internal electronically derived tachometer (Normal Westamp Configuration), the JP-12 jumper should be installed. If an external tach is used (refer to J1-3, Command Input connector), or if the amplifier is configured for torque (current) mode, the internal tach may be disabled by removing JP-12

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Control Board Jumpers.

For most applications, the jumpers on the control board will not need to be changed. If you are using a Westamp BR Series Brushless Servo motor and Westamp cabling, then the standard settings for these configuration jumpers from the factory are optimum.

If, however, you are using a different motor or cabling, a review of the section entitled Connectors and Configuration Jumpers is suggested.

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Shunt Regulators

What is it?

A shunt regulator is a dissipative device used to regulate the bus voltage of the servo amplifier. 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 rotating load back to the amplifier. Since the input rectifiers on the amplifier will not allow the excessive voltage to be returned to the AC line, the bus voltage will increase to unsafe levels, if left uncontrolled.

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 on the 230 volt series SL Amplifiers. The power transistor is in series with high power resistors (often supplied by the customer) that dissipate the regenerative energy in the form of the heat they generate.

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You need a shunt regulator if...

There are some "rules of thumb" that can be used to determine if a shunt will be required for a system. These are not absolutes, however.

If your system has one or more 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.
- ⇒ Your system does not have a shunt and the drive shuts down with a "BUS" fault during deceleration cycle of the motor.

Shunt Regulator Specifications

There are three shunt regulators available for the SL Series drives. The table below outlines specifications for each.

Part Number	Peak Power (kWatts)	Cont Power (kWatts)	Trigger ON Voltage	Protective Fuses
34312-1	1	0.1	390-410 VDC	1 x 3-2/10A Slow Blow
34312-2	1.8	0.18	390-410 VDC	2 x 3-2/10A Slow Blow
34312-3	2.6	0.26	390-410 VDC	3 x 3-2/10A Slow Blow

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Alternatives to Shunt Regulators

➢Additional Bus Capacitance

It is possible for some applications of the 230 volt SL series products that marginally require a shunt regulator to use additional bus capacitors to absorb the energy. If drive faults occur occasionally during some deceleration cycles, then this may indicate that only a small amount of energy is tripping the drive. Just enough to cause a problem sometimes. Experimentation is the best way to determine if additional capacitors will work in your application. For example, adding a 1000-4000 microfarad capacitor to the bus just might do the trick.

Be careful, though! You'll need to use a capacitor with sufficient voltage for the drive. That means an electrolytic capacitor with a working voltage of no less than 450 VDC at 85^{o}C ambient. Using a capacitor rated for anything less could cause irreversible damage to the drive and is a significant fire hazard.

Once a capacitor of sufficient voltage and capacitance has been obtained, simply connect the positive terminal of the capacitor to the "+" terminal of the Shunt connector (TB401 pin 2) and the negative terminal of the capacitor to the "-" terminal of the Shunt connector (TB401 pin 1).

WARNING! The capacitor terminals should be covered preventing personnel from touching the dangerous voltages present when the drive is on and for several minutes after it has been turned off.

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➢Tying multiple drives together in multi-axis systems

If your system includes more than one axis, you're in luck! One way to avoid the added expense of shunt regulators is to connect the buses of each drive together as one. This is similar to adding bus capacitors with an added benefit: If one axis is decelerating (returning energy to the drives) while another axis is accelerating or driving the load (drawing energy from the drives), then the energy of the decelerating drive will be used by the accelerating drive.

Note that if this configuration is to be used, then input power MUST be applied to each drive simultaneously!

Make absolutely certain that the positive terminal of the shunt connector (TB401 pin 2) on each drive is connected together and the negative terminal of the shunt connector (TB401 pin 1) is connected to other negative terminals. Miswiring these terminals will cause irreversible damage to the drive.

Using a Shunt Regulator

There are two flying leads on the shunt regulator assembly. One wire is red and the other gray. The red wire is connected to the shunt connector "+" terminal (TB 401 pin 2) and the gray wire is connected to the shunt connector "-" terminal (TB401 pin 1).

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

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

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POSSIBLE DRIVE CONFIGURATIONS

Due to the modular design of the SL Series products, there are many possible drive configurations. This is particularly true in multi-axis applications using multiple SL Series drives and servo motors.

The purpose of this section is to detail some of the drive configurations that may be useful in setting up your system.

Multi-axis System Sharing Power Supply

As discussed earlier in this chapter in the section on *Alternatives to Shunt Regulators*, many SL drive buses may be tied together for the purposes of obviating the need for a shunt regulator. In SL10, SL20, and SL30 multiple axis applications, it is possible to specify some drives with internal bus supplies and some without bus supplies. In this configuration, the drives without bus supplies get their bus from the TB401 DC Power Input/Shunt connector on the drive with a bus supply.

Let's take a three (3) axis application, for example. Axis 1 is an SL30-B1 drive with a BR34-362000M servo motor. Axes 2 and 3 are SL20C1 drives and BR13-402000M servo motors. The "C" in the SL20 part number indicates a *common bus* configuration and does not include AC rectifiers for AC input.

The *Shunt/DC Power* connector of axes 2 and 3 are tied together and connected to the Shunt/DC Power connector of axis 1 (TB401 pins 1 and 2 on every axis). In this configuration, the bus power supply in axis 1 is supplying bus power to all axes in the system.

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When evaluating such a configuration, consideration must be given to the power supply's rating. The table below offers some insight to the rating of the power supplies and the output power of each drive in the SL series. All specifications are based on three (3) phase, 240 VAC mains.

Drive & Motor	Power Supply Rating (kWatts)	Output Power (kWatts)
SL30-BX and BR34-362000M	4.2	1.76
SL20-BX and BR13-402000M		0.81
SL20-BX and BR13-402000M		0.81

Using the table above and the example given above, you can see that the SL30-B1 and the BR34-362000M provides 4.2 kilowatts in the bus power supply. Of that, it consumes 1.76 kilowatts to drive the BR34-362000M servo motor if the motor is driven at its rating. The SL20--B1 and the BR13-402000M servo motors require 0.81 kilowatts each for a total of 1.62 kilowatts (2 axes X 0.81kW = 1.62kW). The total dissipation is, therefore, 1.62kW + 1.76kW = 3.38kW. This is within the 4.2kW rating of the SL30--B1 drive's supply.

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Sharing Shunt Regulators

Previously in this chapter, we demonstrated that it is possible to connect the bus connectors of drives together for multi-axis systems for the purposes of obviating the need for a shunt regulator. In some multi-axis applications, however, this may not work due to the excessive energy returned during motor deceleration, or if multiple axes are decelerating simultaneously. The obvious solution is to put a shunt regulator on each axis that is faulting on BUS over-voltage. Another possibility is to tie all buses together and use one shunt regulator for all drives in the system.

When tying multiple axes together and using only one shunt regulator, you must consider the total energy returned to the amplifier. The application may call for two separate 100 Watt shunt regulators on two separate axes, or one (1) 160 Watt shunt regulator tied to both axes.

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GETTING STARTED

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

⚠ **WARNING: The following procedures detail working with the drive 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!**

Mounting Instructions

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

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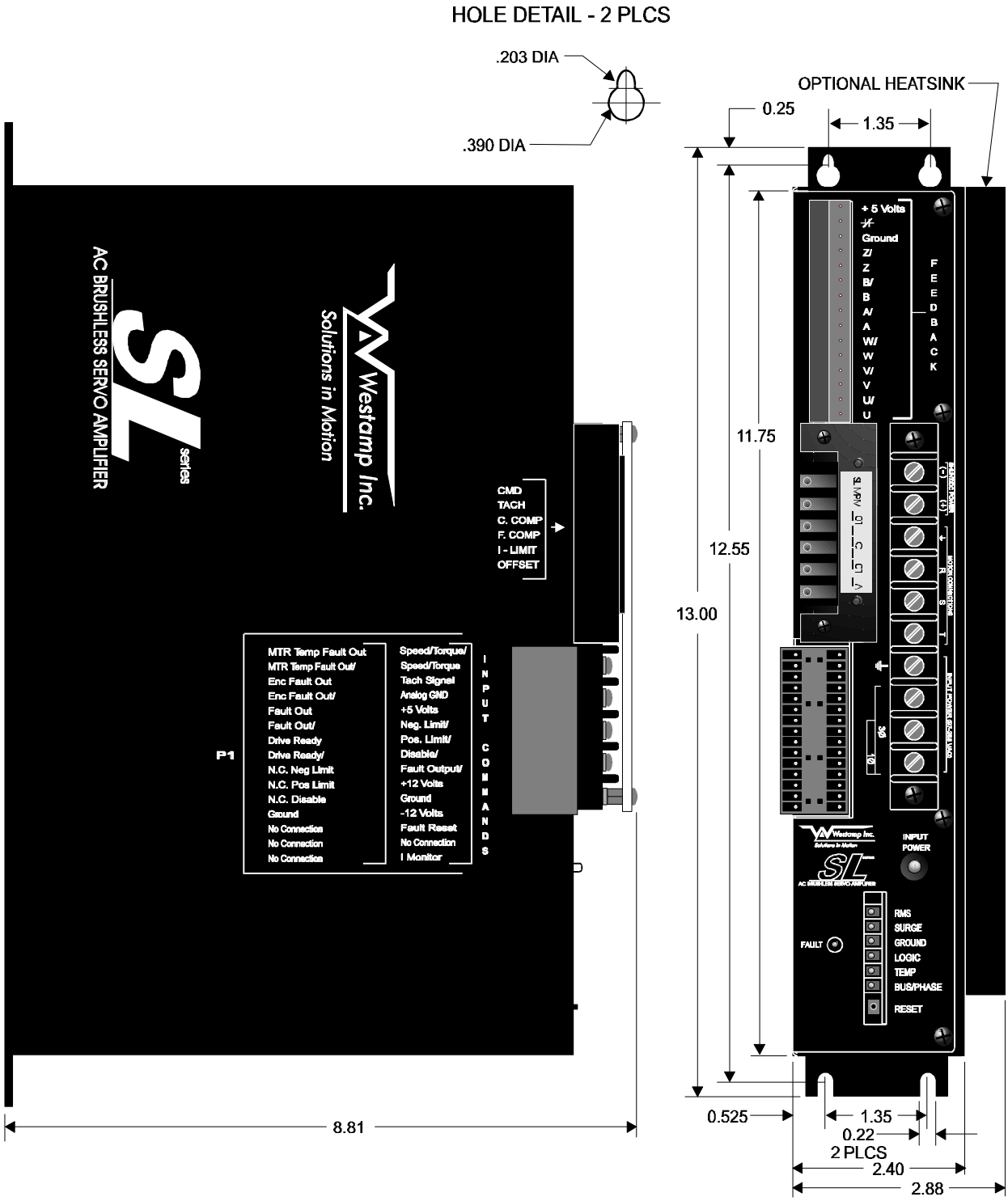
Mounting Dimensions



All dimensions are in inches

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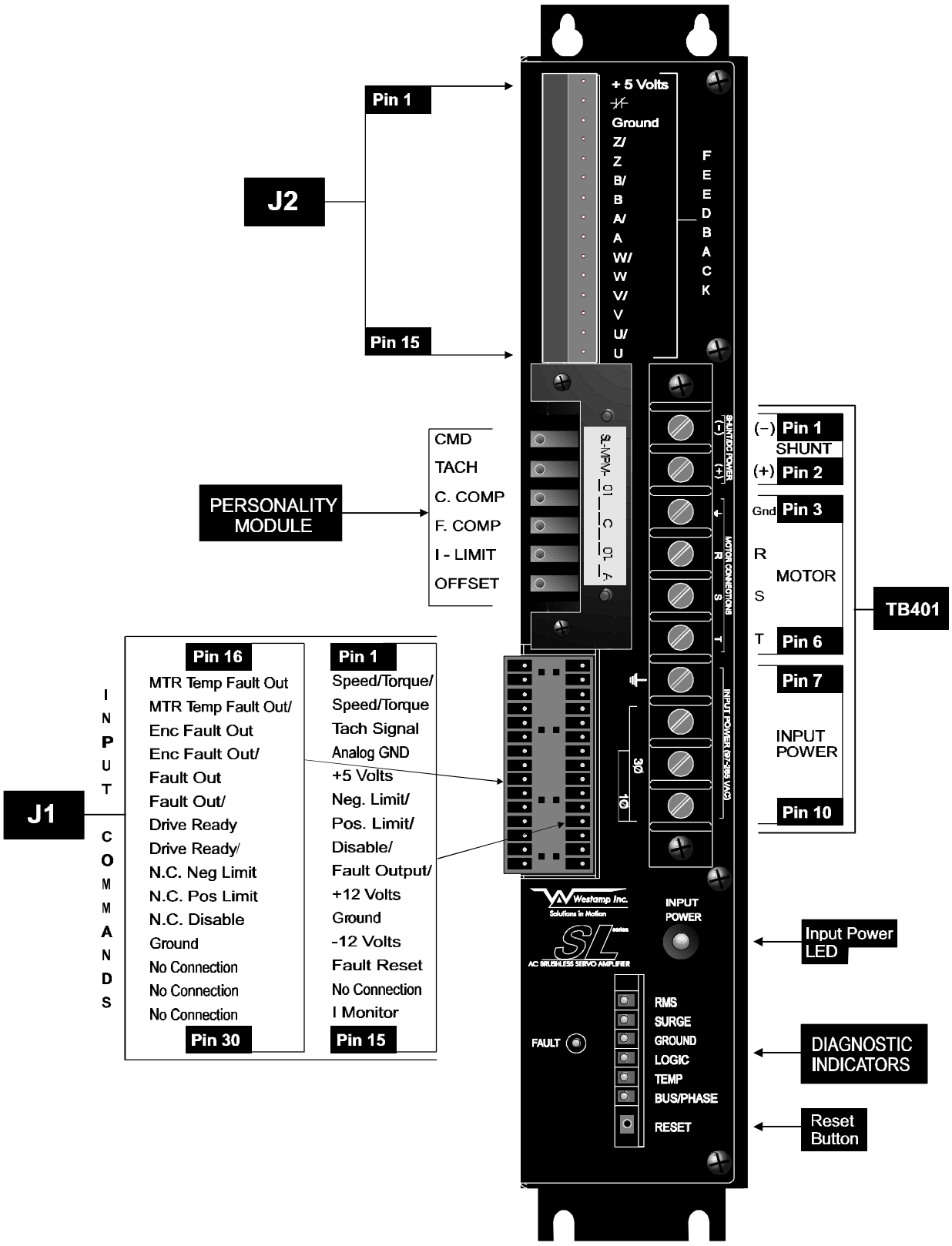
Making Drive Connections



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Input Power

Before connecting the power mains to the drive, insure that the voltage and frequency are within the allowable range. The table below shows the allowable ranges for the SL 230 Volt products:

Drive Series	AC Voltage Range min-max	Frequency (Hz) min-max
SL 230 volt products Mains & Control	97-265	47-63

➢SL 230 Volt Product Input Power Connections

The 230 volt SL series combines both the main and the control power on one connector, TB401. Use the illustration below to locate the connector.

Use the following table for main and control power connections:

	PIN 10	PIN 9	PIN 8	PIN 7
TB401	Phase A 97-265 VAC Line-Line Single phase input A	Phase B 97-265 VAC Line-Line Single phase input B	Phase C 97-265 VAC Line-Line	Earth Ground

➢Single Phase Operation

For single phase operation, only phase A and phase B are needed: apply power to Pins 10 and 9 on TB401. Do not apply power to pin 8.

Single phase AC operation requires special consideration to the single phase current capability of the drive, which is lower than the three phase current capability. Due to the differences in the power supply ampacities and the drive output power, this affects only some drives in the SL Series.

➢ Derating For Single Phase Operation

The table below details the effect of single phase operation for each drive and motor combination.

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Drive & Motor	Cont. Power Derating
SL10-2-BX-X (all)	0
SL20-2-BX-X and BR13-402000M	0
SL30-2-BX-X and BR25-402000M	10%
SL30-2-BX-X and BR34-362000M	10%

Input Power Filtering

Input power quality varies from site to site and from region to region. Westamp drives are designed to tolerate most transients and noise present on power mains. In certain applications, however, it may be necessary to use an input line filter.

➢When You Need One

There are certain symptoms that indicate that an input power filter may be useful. If any of the following symptoms persist, then it may be necessary to install an input power filter:

⇒ Intermittent Bus or Bus/Phase faults

⇒ Intermittent RMS faults when operating near zero speed

Attacking the source of the noise or transient is the best way to prevent the problem from affecting other equipment, including the servo amplifier and the motion controller. There are certain events on, around or near the machine to look for when searching for the source of power line transients and noise.

If any of the above symptoms occur, take note of what happened with other equipment or machinery on, around or near the machine just prior to or during the fault condition. For example, an AC motor starting or stopping, a clutch or brake firing, or power contactors opening or closing are excellent power line transient generators.

If the drive symptom can be tied to one of these events, then it may be possible to resolve the problem at the source. Usually, putting a Metal-Oxide Varistor "MOV" on the power

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line on or near the source will prevent any transients from transmitting all over the power lines.

➢How to Specify an Input Power Filter

When specifying an input power filter, the most important factor is the rated voltage and current of the drive. Other factors, such as filter FCC and TUV classifications are important, but really any input filter, irrespective of classification, will be significantly better than no input filter.

The voltage and current, however, are critical. The wrong voltage rating and a dangerous short could develop between the power lines or from the power line to the casing of the filter.

⚠ **ONLY SPECIFY A FILTER THAT IS ENCLOSED IN A CONDUCTIVE METAL CASING. TO REDUCE THE HAZARD OF DEATH BY ELECTROCUTION, THE CASING MUST BE CONNECTED SECURELY TO EARTH GROUND!**

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➢Minimum Filter Ratings

Use the below table to specify an input power filter's current ratings:

Drive & Motor	Minimum Filter Rating (amperes)*
SL20-2-BX and BR13-402000M	3
SL20-2-BX and BR13-402000M	3
SL30-2-BX and BR25-402000M	5
SL30-2-BX and BR34-362000M	5
SL30-2-BX and BR45-302000M	10
SL30-2-BX and BR69-302000M	10
SL30-2-BX and BR97-302000M	15

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

Motor Feedback

Before the drive will function properly, the motor feedback signals must be properly connected. Most startup problems have to do with the feedback signals. The following table shows the pin to pin relationship between the motor feedback connector and the amplifier feedback connector:

Amplifier J2 Pin Number	Motor Pin Designator	Signal Description
1	K & L	+5 Volts (To Encoder & Thermal Switch)
2	A	Motor Thermal Switch (normally closed)
3	Cable Shield & T	Signal Shield & Encoder Common (Ground)
4	U	Encoder Marker Z/
5	M	Encoder Marker Z
6	C	Encoder Channel B/
7	B	Encoder Channel B
8	P	Encoder Channel A/
9	N	Encoder Channel A
10	H	Commutation Track Channel W/
11	G	Commutation Track Channel W
12	S	Commutation Track Channel V/
13	F	Commutation Track Channel V
14	R	Commutation Track Channel U/
15	E	Commutation Track Channel U

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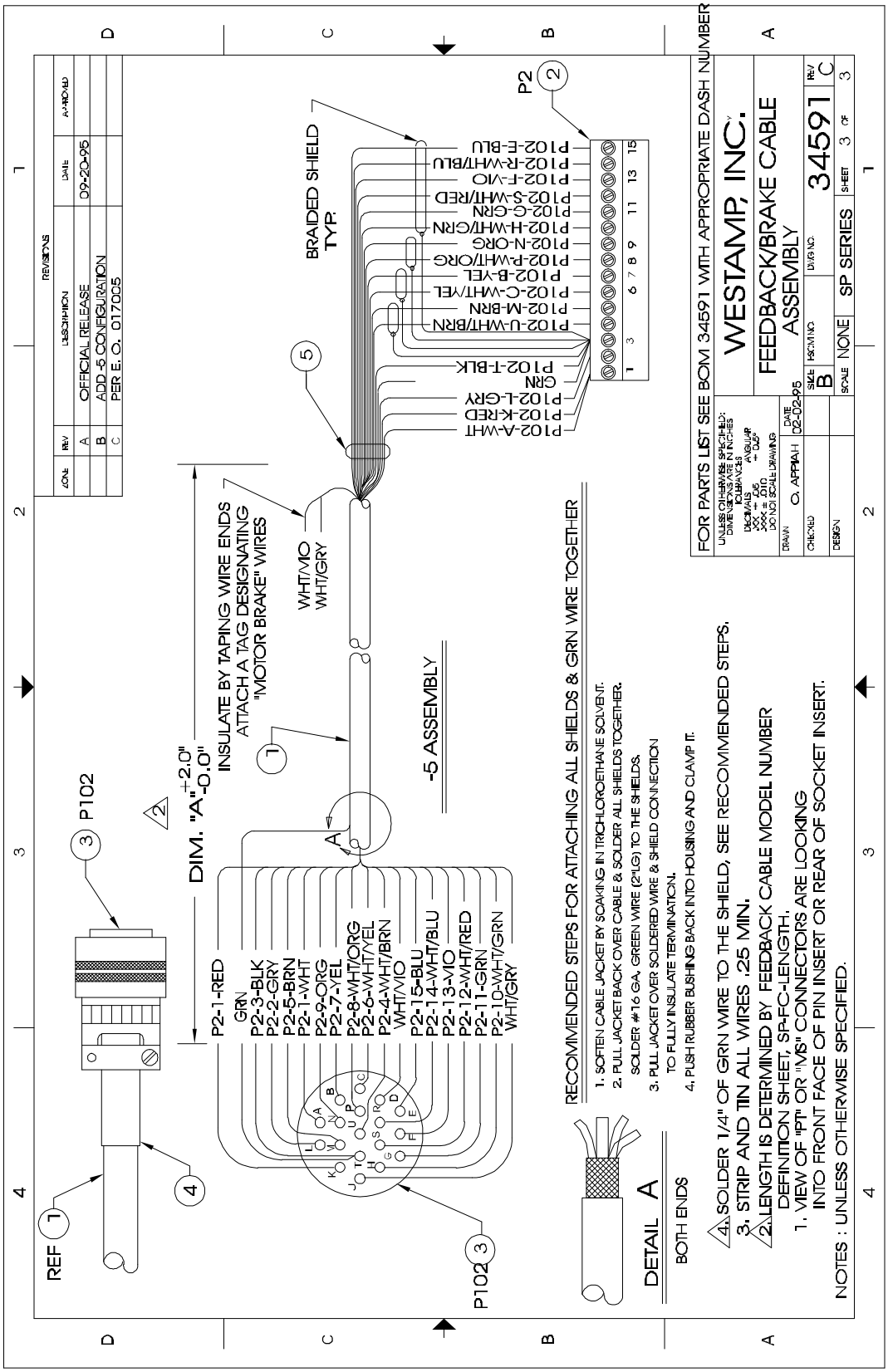

Please use the above drawing as an outline for the feedback cable.

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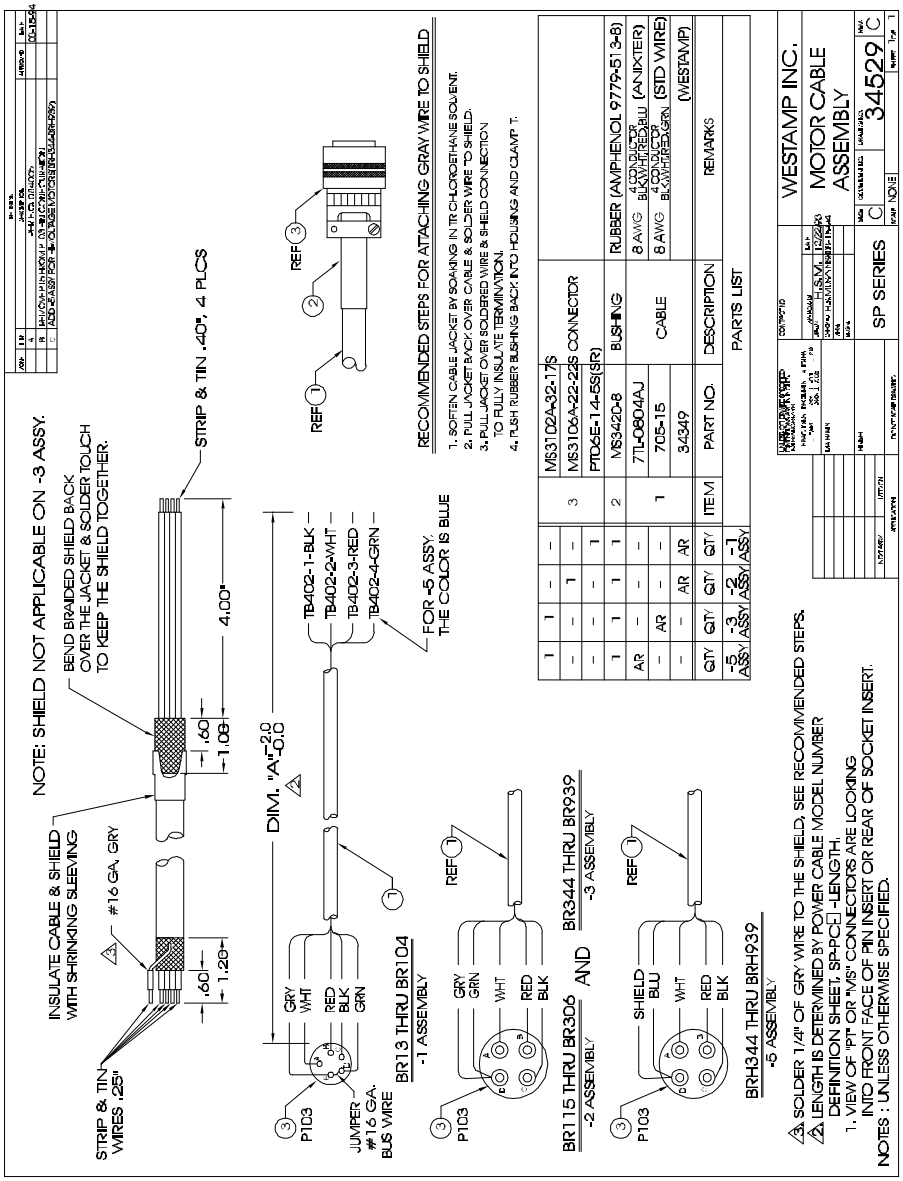
Motor Power

The following table outlines the motor power cable connections to the drive.

Amplifier TB401 Pin Number	Motor Pin Designator	Description
6	C	Amplifier T Output
5	A	Amplifier S Output
4	B	Amplifier R Output
3	D	Amplifier Case & Cable Shield



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Input Command Signals & I/O

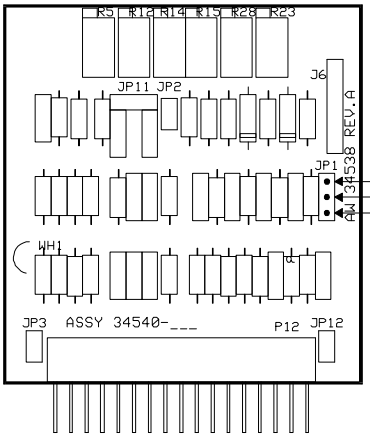
Velocity and Torque Mode Configuration

➢Velocity Mode Configuration

To connect a command for velocity to the drive, first identify the type of signal to be applied: Single-ended or Differential. Single-ended inputs are usually referenced to the system common and are subject to common mode noise, i.e., noise that changes the reference or common level. Differential input is not referenced to common. Instead, it is referenced to another signal that is also applied to the drive.

Use the following procedure to configure the drive for a command for velocity:

1) If a positive signal from the command wire is to achieve a clockwise rotation of the motor (from the drive end of the motor), then:
   A) If a Single-ended command is to be used:
      1) Connect the command wire to J1, pin 2
      2) Connect the reference wire to J1, pin 1.
   B) If a Differential command is to be used:
      1) Connect the command+ wire to J1, pin2.
      2) Connect the command- wire to J1, pin 1.
   C) Remove the Personality Module from the top of the drive by pulling up on the one or two locking tabs until they snap up about a 1/4 of an inch. Then remove the Personality Module by grasping the handle and slowly pulling it out of the drive. **DO NOT ATTEMPT TO PULL THE PERSONALITY MODULE OUT BY PULLING ON THE LOCKING TAB(S)!**



   D) If a Single-ended command is to be used:
      1) Place the shorting plug on JP1 of the Personality Module between pins 1 & 2. Move ahead to step 3.
   E) If a Differential command is to be used:
      1) Remove the shorting plug on JP1 of the Personality Module. Move ahead to step 3.

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2) If a positive signal from the command wire is to achieve a counter-clockwise rotation of the motor (from the drive end of the motor), then:

   A) If a Single-ended command is to be used:

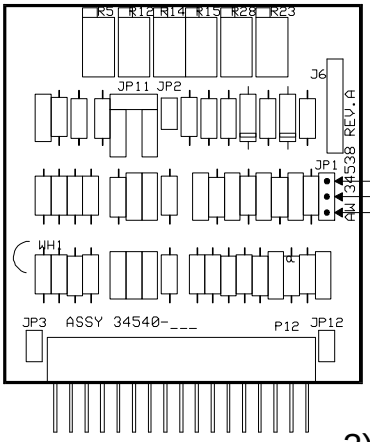
      1) Connect the command wire to J1, pin 1.

      2) Connect the reference wire to J1, pin 2.

   B) If a Differential command is to be used:

      1) Connect the command- wire to J1, pin 2.

   C) Remove the Personality Module from the top of the drive by pulling up on the locking tab(s) until they snap up about a 1/4 of an inch. Then remove the Personality Module by grasping the handle and slowly pulling it out of the drive. **DO NOT ATTEMPT TO PULL THE PERSONALITY MODULE OUT BY PULLING ON THE LOCKING TAB(S)!**



   D) If a Single-ended command is to be used:

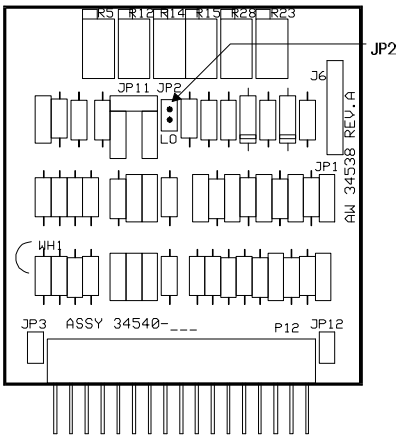
      1) Place the shorting plug on JP1 of the Personality Module between pins 2 & 3. Move ahead to step 3.

   E) If a Differential command is to be used:

      1) Remove the shorting plug on JP1 of the Personality Module. Move ahead to step 3.

3) Remove the shorting plug at JP2.

NOTE: For safekeeping, place the shorting plug on only one pin of JP2 for possible use in the future.



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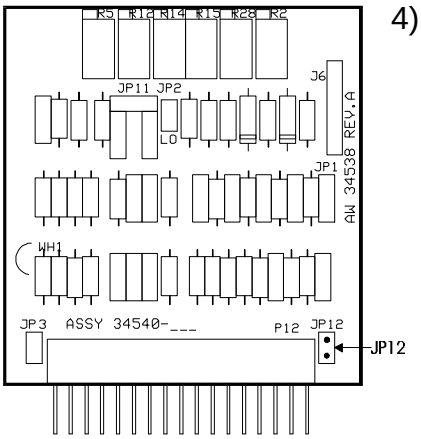
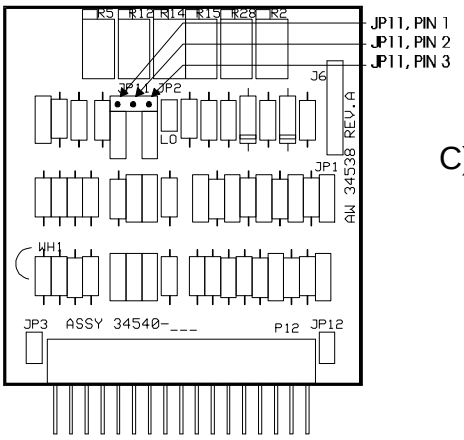


4) Place a jumper plug at JP12:

5) Configure the Velocity Loop Integrator:

   A) To select lowest value integrator (highest bandwidth), then place the shorting plug between pins 1 and 2 on JP11.

   B) To select the highest value integrator (lowest bandwidth), then place the shorting plug between pins 2 and 3 on JP11.



   NOTE: There will be further discussion on the integrator later in the chapter on Tuning.

   C) Place the Personality Module back in the drive:

      1) Slide the guide rails on the side of the Personality Module over both sides of the motherboard (back and front) until resistance is felt.

      2) Push slightly harder until Personality Module is fully seated into connector. Usually, you will hear it snap into place.

      3) Finally, push the locking tabs down until they are fully seated, locking the Personality Module into the drive.

The drive has been configured to accept a command for velocity!

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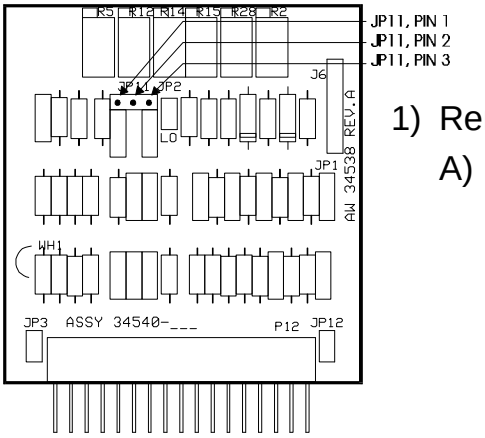
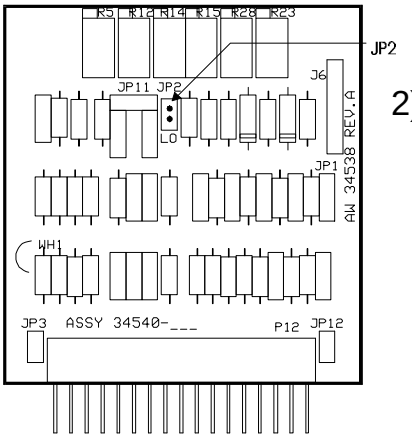
➢Torque Mode Configuration

A command for torque, also called a current command, configures the drive to convert the input signal into a command for current, not velocity. This mode is usually used with motion controllers that close the velocity loop in software.

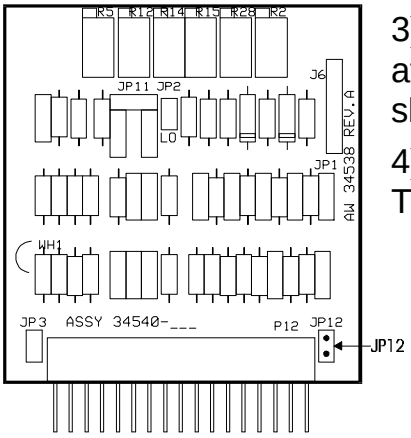
Follow the steps in the previous section and the procedure below to configure the drive for a command for torque:



1) Remove the shorting plug at JP11.
   A) For safekeeping, place the shorting plug on only one pin on JP11.



2) Place a shorting plug on JP2.



3) If use of the velocity signal developed by the drive and available on J1, pin 3 is not required then remove the shorting plug at JP12.

4) If use of the velocity signal is required, then turn the TACHometer potentiometer all the way counter-clockwise.

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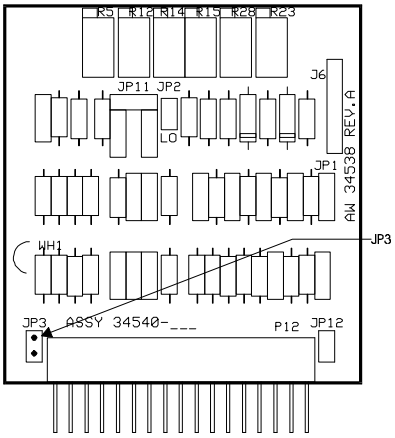
Motor Temperature Fault Configuration

The Motor Temp Fault Open Collector Output and its compliment on J1 pin 16 and 17 are asserted any time the Motor Temperature Fault input on the feedback connector (J2-2) is not pulled to a 5V logic high. Under Normal configuration this input is wired on the motor feedback cable to a normally closed temperature sensor within the motor that will open when the motor temperature is excessive. This input can be configured to create an amplifier temperature fault, disabling the amplifier, or to continue operation only asserting J1 pin 16 & 17.

Note: Motor operation while the motor temperature rating has been exceeded could damage the motor and void your warranty.



1) If it is desired for a Motor Temperature Fault to disable the amplifier:
   A) Remove the jumper from JP-3.
      1) For safekeeping, place the shorting plug on only one pin on JP-3.
2) If it is desirable for a Motor Temperature Fault **Not** to disable the amplifier:
   A) Install the jumper on JP-3.

Normal factory configuration is for the motor temperature fault to disable the amplifier (step 1). If this function is disabled (step 2) the motor temperature output (J1 pin 16 & 17) should be monitored by an external source. If a motor temperature fault occurs, the motor/amplifier should be shut down as quickly as possible to prevent damage to the motor.

The Motor Temperature Fault Normally Closed input (J2 pin 2) can be used with any normally closed contact or logic input that will hold this input at a logic high. If this input is used for something other than the Motor thermal switch, the motor temperature should be monitored elsewhere in the system.

Note: Failure to monitor the motor temperature outputs, or motor operation while the motor temperature rating has been exceeded could damage the motor and void your warranty.

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Limit and Enable/Disable Inputs

➢Limit Input Configurations

The J1 Input/Output Commands Connector on the SL Series amplifiers allow for both normally open and normally closed limit and enable inputs. The chart below lists the Limit and Enable inputs and their functions.

J-1 Limit Enable and Disable Input Commands

J1 Pin#	Function
6	**Negative Command Signal Input Limit / -** When this input is connected to J1 pin 11, or any other ground, or pulled to a CMOS logic low, all negative command inputs to the non-inverted input J1 pin 2, with respect to the inverted input J1 pin 1, are disabled. Internal pull-ups hold the normal condition of this input at a CMOS (12V) logic high. Note that this input disables all current in one direction only. The Drive Ready will remain asserted
7	**Positive Command Signal Input Limit /-** When this input is connected to J1 pin 11, or any other ground, or pulled to a CMOS logic low, all positive command inputs to the non-inverted input J1 pin 2, with respect to the inverted input J1 pin 1, are disabled. Internal pull-ups hold the normal condition of this input at a CMOS (12V) logic high. Note that this input disables all current in one direction only. The Drive Ready will remain asserted
8	**Amplifier Disable Input**./ - The signal present at this pin will be at +VCC (logical high) when the SL amplifier is operating normally, and at common (logical low) when the SL amplifier has disabled output as a result of a fault condition. Internal pull-ups hold the normal condition of this input as a CMOS (12V) logic high. Note that this input disables all output, and will place the amplifier in a "Not Ready" state when it is asserted (Drive Ready will go low, Drive Ready / will go high)
24	**N.C. Neg Limit Input -** When this input is at a CMOS logic high, or allowed to float, all negative command inputs to the non-inverted input J1 pin 2, with respect to the inverted input J1 pin 1, are clamped. This input must be forced low for normal operation. Internal pull-ups will hold this pin at a CMOS (12V) logic high if it is allowed to float. Internal diodes allow for voltages of up to 40V to be applied to this pin when in its high state. Note that this input disables all current in one direction only. The Drive Ready will remain asserted (Drive Ready will remain high, Drive Ready / will remain low).
25	**N.C. Pos Limit Input -** When this input is at a CMOS logic high, or allowed to float, all positive command inputs to the non-inverted input J1 pin 2, with respect to the inverted input J1 pin 1, are clamped. This input must be forced low for normal operation. Internal pull-ups hold the normal condition of this input at a CMOS (12V) logic high if it is allowed to float. Internal diodes allow for voltages of up to 40V to be applied to this pin when in its high state. Note that this input disables all current in one direction only the Drive Ready will remain asserted. (Drive Ready will remain high, Drive Ready / will remain low).
26	**N.C. Disable Input -** When this input is at a CMOS logic high ,or allowed to float, all amplifier output will be disabled. This output must be forced low for normal operation. Internal pull-ups will hold this pin at a CMOS (12V) logic high if allowed to float. Internal diodes allow for voltages of up to 40V to be applied to this pin when in its high state. Note that this input disables all output, and will place the amplifier in a "Not Ready" state when it is asserted.(Drive Ready will go Low, Drive Ready / will go high)

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The logical NOT inputs on pins 6, 7, and 8 of the J1 Connector are Normally Open inputs that will become asserted if they are pulled to ground or a logical low. Westamp's default configuration for these inputs is to allow them to float high (No connection).

The Logical Inputs on pins 24, 25, and 26 of the J1 Connector are Normally Closed inputs that will become asserted if they are allowed to float high. These inputs MUST be tied to ground or held at a CMOS logic low for normal amplifier operation. Westamp's default configuration for these inputs is to jumper them to logic common (J1 pin 27).

A complete listing of the J1 -Input/Output Commands Connector can be found in the SL Drive Connection Definitions & Specifications portion of this manual.

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Making External Positioner Connections

Feedback

➢With an External Motion Controller

If use of an external motion controller is required in the application, then encoder feedback connections to the motion controller should be made on J2, as well. The output signals from the encoder are shared by both the drive and the motion controller in this configuration.

There are terminating resistors in resistor packs R173 and R174 within the drive. These may be changed to different values if needed. Usually, this is not necessary. But in cases where the cables are over 50 feet in length these resistors may need to be changed to higher value.

As a general rule, about 100 ohms per 20 feet of cable should be added. This will help keep the signal levels up while providing adequate termination impedance for noise suppression.

Some motion controllers include termination resistors, as well. Make certain that the use of termination resistors on both the drive and the motion controller does not exceed the output capability of the encoder or reduce the signal levels to unreliable levels.

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Using an External Power Supply for the Encoder

In certain circumstances, it may be desirable to use a power supply other than the drive's internally-developed 5 volt supply. This may be required because encoder power is needed even when the drive is turned off or due to noise generated by the drive that has become apparent on the drive's internally-developed 5 volt power source.

In either case, using an external 5 volt supply is easily accomplished by simply removing the wires on the feedback connector at J2 for +5 volts and Ground on pins 15 and 13, respectively, and connecting them to an external 5 volt source.

The external 5 volt source must be capable of supplying a minimum of 200 milliamperes of current and should be regulated to within ±1% of 5 volts.

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Before Applying Power...

Initial Adjustments

This section describes the recommended initial potentiometer settings for "A" Personality Modules. If you have "B" Personality Modules then you may proceed to the next section.

"A" Personality Modules provide potentiometers for the following functions:

CMD adjustment	CoMmanD signal input DC gain
TACH adjustment	TACHometer feedback DC gain
C. COMP adjustment	Course Compensation -- Velocity loop AC gain
F. COMP adjustment	Fine Compensation -- Velocity loop AC gain
I - LIMIT adjustment	Current Limit -- Clamps the peak output current of the drive
OFFSET	Nulls input offsets up to 50 millivolts

To minimize the risk of instability during the startup, it is suggested that the following settings are used:

CMD adjustment	20 Turns CCW, then 10 Turns CW
TACH adjustment	20 Turns CCW, then 10 Turns CW
C. COMP adjustment	DO NOT ADJUST FROM FACTORY SETTING
F. COMP adjustment	20 Turns CCW
I - LIMIT adjustment *	20 Turns CCW, then 3 Turns CW
OFFSET	20 Turns CCW, then 10 Turns CW

* Note that the I - LIMIT severely limits the peak current and should be slowly increased to its nominal value (usually fully clockwise) once proper operation is obtained.

Decouple the Motor

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

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If the system includes a Personality Module with an inertia mismatch specified in the Personality Module part number, then do NOT decouple the load from the motor and do NOT run the motor without the load connected. Running the motor without the inertia that is specified in the Personality Module part number may result in severe instability in the velocity loop and the motor may shake and vibrate violently.

Applying Power

As a final check before application of power, insure that the voltage and frequency of the power lines are correct for the drive model.

Apply power to the drive and observe motor operation. If the motor moves quickly to a high speed or operates erratically, turn off the power and check power and feedback cabling (see Troubleshooting Guide).

If the motor moves slowly in one direction or the other, then turn the BALance potentiometer until the motor stops.

Moving the Motor

➢With an External Motion Controller

Enter a command to move the axis per the motion controller's instructions. If the motor runs away then change either the polarity of the input signal or the encoder feedback signals between the drive and motion controller.

To change the polarity of the input signal, see *Input Command Signals & I/O* in this manual. To change the encoder polarity switch the A and A Complement with the B and B Complement signals to the motion controller. **NOTE**: It is very important that the wiring from the encoder to the drive remain in compliance with the drawings located in this manual. Any swapping of the A, A Compliment and B, B Compliment must take place between the drive and the motion controller!

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If the motor moves under control then phasing between the encoders and input command is correct. If the motor moves erratically or runs away, see the *Troubleshooting Guide* in this manual.

If an external motion controller is used and the motor moves under control, but positive commands from the controller generate moves in a direction opposite the requirements of the application, then the feedback and command signals must be re-phased. This can be accomplished by switching the "A" and "B" encoder channels between the drive and the motion controller and switching the input command polarity. Remember, the encoder signals must NOT be swapped between the motor and the drive, so the above swap will have to take place between the drive and the motion controller.

Once proper operation is obtained, and before continuing with the tuning, the I - LIMIT should be increased to the nominal value (normally fully clockwise) to insure proper output current under load.

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TUNING

This section describes optimizing the servo loops through tuning. Many of the techniques described herein assume at least a knowledge of basic servo loop theory and application.

If the system appears stable and running it may not be necessary to optimize the system by further tuning. Only in the most critical of applications where high hit rates are required with minimal settling time is it necessary to "critically dampen" the velocity and/or position loops.

Furthermore, if you have the "B" Personality Modules, there are not potentiometers to adjust. These modules were designed to be critically damped with the customer-specified load information. If the system is not damped correctly using a "B" module, see your sales representative, distributor or Westamp regarding specifying a different module.

Note that if the system uses a "B" module and has an inertial mismatch specified in the Personality Module part number then the system may NOT appear stable without connecting the motor to the load considered when the inertia mismatch was specified.

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Using an Adjustable Personality Module

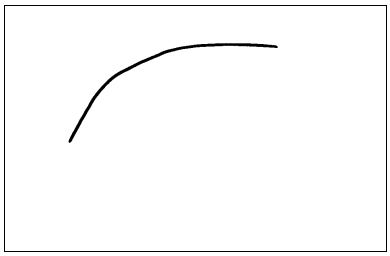
This section is intended for tuning adjustable Personality Modules (those with an "A" suffix) only.

➢Establishing a good feedback loop

The first step in tuning the velocity loop is establishing the proper gain in the feedback or tachometer loop. The SL generates a velocity signal from the quadrature encoder output signals using a high-performance Frequency-to-Voltage converter. The first pole of the F/V is at approximately 500kHz. The output of this circuit is very linear and responsive. There is no need for a DC tachometer.

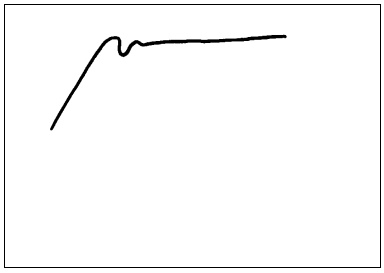
Using an oscilloscope, observe the velocity signal response to a step input signal. The velocity signal can be observed at pin 3 of J1 with respect to pin 4 of J1. Identify which of the following illustrations best matches what is observed.

A

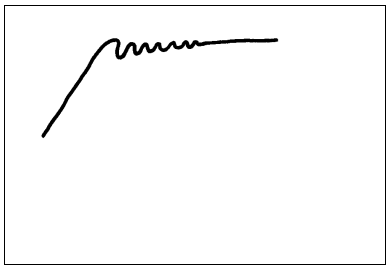


B

C



D



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➢A - Overdamped

The overdamped illustration indicates that more velocity loop DC gain is needed. Increase the DC gain by turning the TACH potentiometer clockwise until a waveform like B or C is observed.

➢B - Critically Damped

The critically damped velocity loop illustrated in B is ideal and needs no further attention.

➢C - Underdamped

The underdamped illustration in C indicates that more bandwidth is needed in the velocity loop integrator or there is too much DC gain in the velocity loop. Try increasing the bandwidth by turning the F. COMP potentiometer clockwise. **CAUTION: This may cause instability in the loop!**

Usually, you can use the F. COMP potentiometer to adjust out the undershoot that follows the first overshoot, but not the overshoot in its entirety. If an overshoot remains after the undershoot has been removed, it may be necessary to add some amount of derivative gain in the velocity feedback. A single overshoot, however, is not usually problematic in the position loop. If removal of the overshoot is required see the section on derivative gain later in this chapter.

➢D - Unstable

Instability may be the result of a variety of system ailments, including low system natural resonant frequencies and poor tuning. In either case, the loop can usually be stabilized by reducing the gains, unless the natural resonant frequencies in the system are extremely low (>100 Hz).

It is suggested that you start by reducing the DC feedback gain, or the TACHometer gain. This is done by turning the TACH potentiometer counter-clockwise.

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NOTE: Turning the TACH potentiometer too far clockwise may result in motor runaway. Insure on any machine that any hard machine limits are protected by the use of limit switches or soft stops. It is also advisable to reduce the amplifier's peak current output by turning the I-LIMIT counter-clockwise 20 turns, then clockwise 2 to 3 turns.

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SL DRIVE CONNECTION DEFINITIONS & SPECIFICATIONS

J1- Input / Output commands

Pin#	Function
1	**Command Signal Inverted Input** - Used in conjunction with pin 2. This input is the negative input of the Command signal input when connected differentially, or may be configured as either the Non- Inverted Command signal input return (common), or the Inverted Command Signal input when connected single-ended. The gain scaling for this input is achieved using the SIG potentiometer. Turning the potentiometer clockwise will increase the command signal gain. **Single-ended input:** For single-ended input, the signal is applied to J1-1 with respect to common (J1-2 or J1-4). J1-2 must be tied to common for single-ended input by placing the shorting jumper JP-1, on the Personality Module, between pins 1 and 2 (the bottom two pins). **Differential Input:** For differential input, the signal is applied between J1 pin 1 and J1 pin 2. This pin(J1-1) becomes the negative input of the differential input command. To allow differential input, both J1 pins 1 and 2 must be ungrounded by removing the shorting jumper on JP-1 from the Personality Module.
2	**Command Signal Non-Inverted Input** - Used in conjunction with pin 1, this input is the positive input of the command signal input when connected differentially, or either the Non-Inverted Command signal input, or the Inverted Command Signal input return (common) when connected single-ended. The gain scaling for this input is achieved using the SIG potentiometer. Turning the potentiometer clockwise increase the command signal gain non - Inverted Command Input: **Single-ended Input:** For single-ended input (Normal Westamp Configuration) the signal is applied to J1-2 with respect to common (J1-1 or J1-4). J1-1 must be tied to common for single-ended input by placing the shorting jumper JP-1, on the Personality Module, between pins 2 and 3 (the bottom two pins). **Differential Input:** For differential input the signal is applied between J1 pin 1 and J1 pin 2. This pin becomes the - input of the differential input command. To allow differential input, Both J1 pins 1 and 2 must be ungrounded by removing the shorting jumper on JP-1 from the Personality Module.

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3	**Tachometer reference signal output**. - (not an input).- under Normal configuration, this signal is a reference indication of the electronically derived tachometer used by the SL amplifier. It is normally scaled to 1 volt / 1000 rpm for the SL series amplifiers. This signal is internally generated. It may be used externally as a speed reference. **Tachometer input signal:** By removing the JP-12 jumper on the Personality Module, this pin becomes an external tachometer input. The gain scaling for this input is achieved using the TACH potentiometer. Turning the potentiometer clockwise increases the tach signal gain.
4.	**Signal Command Common -** This is a signal ground that may be used to reference only command signal input related circuits. DO NOT USE THIS AS A CURRENT SINK FOR ANY OTHER CIRCUIT.
5.	**+5V** - Up to 500ma is available for external use.
6	**Negative Command Signal Input Limit / -** When this input is connected to J1 pin 11, or any other ground, or pulled to a CMOS logic low, all negative command inputs to the non-inverted input J1 pin 2, with respect to the inverted input J1 pin 1, are disabled. Internal pull-ups hold the normal condition of this input at a CMOS (12V) logic high. Note that this input disables all current in one direction only. The Drive Ready will remain asserted.
7	**Positive Command Signal Input Limit /-** When this input is connected to J1 pin 11, or any other ground, or pulled to a CMOS logic low, all positive command inputs to the non-inverted input J1 pin 2, with respect to the inverted input J1 pin 1, are disabled. Internal pull-ups hold the normal condition of this input at a CMOS (12V) logic high. Note that this input disables all current in one direction only. The Drive Ready will remain asserted.
8	**Amplifier Disable Input**./ - The signal present at this pin will be at +VCC (logical high) when the SL amplifier is operating normally, and at common (logical low) when the SL amplifier has disabled output as a result of a fault condition. Internal pull-ups hold the normal condition of this input as a CMOS (12V) logic high. Note that this input disables all output, and will place the amplifier in a “Not Ready” state when it is asserted (Drive Ready will go low, Drive Ready / will go high).
9	**Fault output / (Latched output) -** The signal at this pin will be at a 12V logic high under normal operation, and will go to common (logic low) when a fault condition occurs.
10	**+VCC (+12VDC)** - Up to 50ma is available for external use.
11	**Logic Power Common.**
12	**-VCC (-12VDC)** - Up to 10ma is available for external use.
13	**Amplifier Fault Reset input** - On the SL amplifiers, a fault condition can be cleared by pulling this pin from its normal high (+12V) state to common or a logic low, then back to high. A half second delay will occur after this pin is allowed to go high, before the amplifier becomes enabled. Internal pull-ups hold the normal condition of this input at a CMOS (12V) logic 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 amplifier. 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 amplifier is saturated .
16	**MTR Temp Fault Open Collector Output - (Latched Output) -** The Latched output signal at this pin will be at a common (logic low) under normal operation, and will go to a CMOS logic high when a motor overtemperature condition occurs (The thermal switch within the motor opens). This requires that the motor's Normally Closed thermal switch be tied between pins 1 (+5V) and 2 (Motor Temp Input) of the J2 feedback connector. (see J2-Feedback Connector Definition & specifications). (cont.)

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	If an amplifier fault/shutdown is NOT desired when a motor overtemperature condition occurs, the JP-3 jumper on the Personality Module must be installed. If the JP-3 Jumper is not installed, the MTR Temp Fault condition will disable the amplifier, creating an amplifier temperature fault.
17	**MTR Temp Fault Open Collector Output / - (Latched Output) -** The Latched Output signal at this pin will be at a CMOS logic high under normal operation, and will go to common (logic low) when a motor overtemperature condition occurs (The thermal switch within the motor opens). This requires that the motors Normally Closed thermal switch be tied between pins 1 (+5V) and 2 (Motor Temp Input) of the J2 feedback connector. (see J2-Feedback Connector Definition & specifications). If an amplifier fault/shutdown is NOT desired when a motor overtemperature condition occurs, the JP-3 jumper on the Personality Module must be installed. If the JP-3 Jumper is not installed, the MTR Temp Fault condition will disable the amplifier, creating an amplifier temperature fault.
18	**Enc Fault Open Collector Output - (Latched Output) -** The Latched output signal at this pin will be at a common (logic low) under normal operation, and will go to a CMOS logic high when a loss of one or more encoder signals at the J2 feedback connector occurs. (see J2-Feedback Connector Definition & specifications). If an amplifier fault/shutdown is NOT desired when a Encoder Fault condition occurs, the JP-15 jumper on the Control Board must be installed. If the JP-15 Jumper is not installed, the Enc Fault condition will disable the amplifier, creating a combination of an amplifier logic and an amplifier temperature fault.
19	**Enc Fault Open Collector Output / - (Latched Output) -** The Latched Output signal at this pin will be at a CMOS logic high Under normal operation, and will go to common (logic low) when a Loss of one or more encoder signals at the J2 feedback connector occurs. (see J2-Feedback Connector Definition & specifications). If an amplifier fault/shutdown is NOT desired when an Encoder Fault condition occurs, the JP-15 jumper on the control board must be installed. If the JP-15 Jumper is not installed, the Enc Fault condition will disable the amplifier, creating a combination of an amplifier logic and an amplifier temperature fault.
20	**Fault Open Collector output - (Latched Output) -** The Latched Output signal at this pin will be at a signal common (logic low) under normal operation, and will go to a CMOS logic high when a fault condition occurs .
21	**Fault Open Collector output/ - (Latched Output) -** The Latched Output signal at this pin will be at a CMOS logic high under normal operation, and will go to common (logic low) when a fault condition occurs .
22	**Drive Ready Open Collector Output -** The signal at this pin will be at a signal common (logic low) when the amplifier output is disabled, and will go to a CMOS logic high when the amplifier is operating. Note that when a Negative or Positive Limit occurs, which blocks output in one direction only, the amplifier will stay in the “Drive Ready” condition. (This pin will remain high).
23	**Drive Ready Open Collector Output / -** The signal at this pin will be at a CMOS logic high when the amplifier output is disabled, and will go to a common (logic low) when the amplifier is operating. Note that when a Negative or Positive Limit occurs, which blocks output in one direction only, the amplifier will stay in the “Drive Ready” condition. (This pin will remain low).
24	**N.C. Neg Limit Input -** When this input is at a CMOS logic High, or allowed to float, all negative command inputs to the non-inverted input J1 pin 2, with respect to the inverted input J1 pin 1, are clamped. This input must be forced low for normal operation. Internal pull-ups will hold this pin at a CMOS (12V) logic high if it is allowed to float. Internal diodes allow for voltages of up to 40V to be applied to this pin when in its high state. Note that this input disables all current in one direction only. The Drive Ready will remain asserted (Drive Ready will remain high, Drive Ready / will remain low).
25	**N.C. Pos Limit Input -** When this input is at a CMOS logic High, or allowed to float, all positive command inputs to the non-inverted input J1 pin 2, with respect to the inverted input J1 pin 1, are clamped. This input must be forced low for normal operation. Internal pull-ups hold the normal condition of this input at a CMOS (12V) logic high if it is allowed to float. Internal diodes allow for voltages of up to 40V to be applied to this pin when in its high state.

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	Note that this input disables all current in one direction only. The Drive Ready will remain asserted. (Drive Ready will remain high, Drive Ready / will remain low).
26	**N.C. Disable Input -** When this input is at a CMOS logic high ,or allowed to float, all amplifier output will be disabled. This output must be forced low for normal operation. Internal pull-ups will hold this pin at a CMOS (12V) logic high if allowed to float. Internal diodes allow for voltages of up to 40V to be applied to this pin when in its high state. Note that this input disables all output, and will place the amplifier in a "Not Ready" state when it is asserted. (Drive Ready Will go Low, Drive Ready / will go high).
27	**Logic common -**
28	**No Connection**
29	**No Connection**
30	**No Connection**
N O T E S	**The Open Collector CMOS Outputs** have internal pull-up resistors to 12V, with blocking diodes. If higher voltage levels are required, an external pull-up resistor is needed. This output may be pulled up to 40VDC and source a current of 50 milliamps. **The Latched outputs** will permanently latch in the fault state if a momentary fault is sensed. The latched output will remain the fault condition even after the fault disappears. The Fault can be reset by removing and then reapplying logic power, or by creating a Reset. A Reset can be created by momentarily pulling J1-13 to a logic low, and then bringing it or allowing it to float high, or by pressing and releasing the reset button on the Fault Diagnostic Module.

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J2 -Feedback Connector

Pin#	Function
1	**+5V** - A maximum of 1V 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. The Motor Temperature Fault Normally Closed input (J2 pin 2) can be used with any normally closed contact, or logic input that will hold this input at a logic high. If this input is used for something other than the motor thermal switch, the motor temperature should be monitored elsewhere in the system. **Note**: Failure to monitor the motor temperature outputs or motor operation while the motor temperature rating has been exceeded 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.

TB401 - Power / Motor Connector:

Pin#	Function
1	**Shunt/power - (minus) -** Negative DC bus. Use this connector for the negative side of the shunt regulator, if needed. On a multi-axis amplifier, this would be the negative bus output for an amplifier with internal bus, or a negative bus input for amplifiers without a bus supply .
2	**Shunt/power + (Plus) -** Positive DC bus. Use this connector for the positive side of the shunt regulator, if needed. On a multi-axis amplifier, this would be the positive bus output for an amplifier with internal bus, or a positive bus input for amplifiers without a bus supply.
3	**Motor Case Ground**: - When using Westamp cables, this is the Green wire.
4	**Motor Terminal "R"** - When using Westamp cables, this is the Red wire.
5	**Motor Terminal "S**" - When using Westamp cables, this is the White wire.
6	**Motor Terminal "T"** - When using Westamp cables, this is the Black wire.
7	**Input Power GND -** Use this connector for the AC power input ground.
8	**Phase "C" 97-265VAC**. - Use this connector for 3 phase operation. This connector is not used on single phase operation.
9	**Phase "B" 97 - 265VAC**. - Use this connector for 3 phase or single phase operation.
10	**Phase "A" 97 - 265 VAC** - Use this connector for 3 phase or single phase operation.

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CONNECTORS & CONFIGURATION JUMPERS

Control Board Jumpers:

Jumper#	Function
JP-14 JP-4 JP-5	**A Hall Differential / Single-ended Jumper.** **B Hall Differential / Single-ended Jumper.** **C Hall Differential / Single-ended Jumper**. **For use with differential input** on the Halls (Normal Westamp operation), these jumpers are to be removed. **If single-ended input is needed** on the Halls, these three jumpers must be installed, and the differential load resistors must be removed from R172, pins 5-6, 7-8, 9-10. If pull-ups are needed for open collector single-ended Hall drivers, R171 may be installed (4.7 k ohms, parallel network resistors). For single-ended Hall operation, only the Hall inputs to the J2 connector , and not their compliments, will be used. (Refer to J2 Feedback). Differential input is the Normal Westamp Configuration. Due to the advantages of differential inputs, when connected to the outside world, it is recommended that whenever possible the differential inputs be used.
JP-6 JP-7	**A Encoder Differential / Single-ended Jumper.** **B Encoder Differential / Single-ended Jumper.** **For use with differential input** on the encoders (Normal Westamp operation) these jumpers are to be removed. **If single-ended input is needed** on the encoders, these two jumpers must be installed, and the differential load resistors must be removed from R172, pins 1-2, and 3-4. It is not recommended that open collector encoders be used. For single-ended encoder operation, the encoder inputs to the J2 connector , and not their compliments, will be used. (Refer to J2 Feedback). Differential input is the Normal Westamp Configuration. Due to the advantages of differential inputs when connected to the outside world, it is recommended that whenever possible the differential inputs be used.
JP-8	**Sin / Six Jumper** - For normal Sine Wave operation, this jumper is placed on positions 1 and 2. If Six-Step operation is desired, the jumper should be placed in positions 2 and 3. Westamp's Normal and recommended configuration is for the amplifier to be configured for Sine Wave Operation. (Jumper on pins 1 and 2).
JP-14	**A Hall Differential / Single-ended Jumper**. (see JP-4 and JP-5 above.)
JP-15	**Encoder Fault Disable Jumper-** If an amplifier fault/shutdown is NOT desired when an Enc Fault condition occurs, this jumper must be installed. With this jumper is installed, an Encoder Fault condition will be succeeded by the Enc Fault Out pins (J1-18 and J1-19), but it will not disable the amplifier. If the JP-15 jumper is not installed, the Enc Fault condition will disable the amplifier, creating a combination of an amplifier logic and an amplifier temperature fault. Normal Configuration is for the JP-15 jumper to be installed. (Encoder fault will not cause an amplifier fault.)

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Personality Module Jumpers

Jumper#	Function
JP-1	**Differential / Single-ended Command Input Jumper -** This jumper is used in conjunction with the J1 connector Signal inputs. **For single-ended Non- Inverted Input** : (Normal Configuration) The JP-1 shorting jumper is placed on positions 2 and 3 (bottom two pins). **For single-ended Inverted Input** : The JP-1 shorting jumper is placed on positions 1 and 2 (top two pins). **For Differential Input** : The JP-1 shorting jumper should be removed. Refer to the J1 connector for explanations on the signal input modes.
JP-2	**High / Low Gain Jumper -** **For velocity control mode:** remove the JP-2 jumper. **For torque (current) mode:** install the JP-2 jumper. Normal Westamp Configuration is velocity control mode (JP-2 removed)
JP-3	**Motor Temp Fault Disable** -If an amplifier fault/shutdown is NOT desired when a motor overtemperature condition occurs, the JP-3 jumper on the Personality Module must be installed. With this jumper is installed, a Motor Temperature Fault condition will be sensed by the MTR Temp Fault Out pins (J1-16 and J1-17), but will not disable the amplifier. If the JP-3 Jumper is not installed, the MTR Temp Fault condition will disable the amplifier, creating an amplifier temperature fault. Normal Westamp Configuration is JP-3 installed. (Motor Temp Fault will not cause an amplifier fault).
JP-11	**Velocity Loop Integrator Jumper: -** **for highest bandwidth:** (lowest value integrator) Install the JP-11 Jumper on pins 1 and 2. **for lowest bandwidth:** (highest value integrator) Install the JP-11 Jumper on pins 2 and 3. Normal Westamp Configuration is for lowest bandwidth (JP-11 on pins 2 and 3.) Refer to the chapter on tuning for more information.
JP-12	**Internal Tach Jumper**. To use the internal electronically derived tachometer (Normal Westamp Configuration) the JP-12 jumper should be installed. If an external tach is used (refer to J1-3, Command Input connector), or if the amplifier is configured for torque (current) mode, the internal tach may be disabled by removing JP-12.

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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 amplifier, a qualified technician should determine that all external connections to the amplifier, 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 amplifier can permanently damage the amplifier, 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 amplifier is shorted to ground. 2 - Breakdown in voltage (dielectric strength) in the output cables (shorted to ground). 3 - High parasitic capacitance in the output cables (particularly for long runs). 4 - Defective motor. 5 - Defective drive.
SURGE	1 - One or more output wires shorted together. 2 - Breakdown in voltage (dielectric strength) in the output cables (shorted together). 3 - High parasitic capacitance in the output cables (particularly for long runs). 4 - Defective motor. 5 - Defective drive.
RMS RMS (cont)	1 - Excessive load current caused by mechanical binding or friction. 2 - Defective or miswired feedback cable. 3 - Defective or miswired power cable. 4 - Wrong Personality Module or EPROM installed for the motor being driven. 5 - Defective motor.

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LED	POSSIBLE CAUSES
	6 - Defective drive.
BUS/PHASE with Green power LED ON	1 - Excessive regenerative energy from decelerating load. 2 - Defective shunt regulator or no shunt regulator installed.
BUS/ PHASE with green power LED OFF	1 - One of the phases of the 3 phase AC input has failed. 2- Excessive noise on the AC input lines (see *Input Line Filters* in this manual). 3 - Defective drive.
TEMP	1 - Excessive ambient temperature (drive is rated for 50 deg. 2 - C) 3- Defective internal fan in drive. 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 (drive is rated for 97-265 VAC, 47-63Hz). 2 - Defective drive.
LOGIC and TEMP	Encoder Fault - The combination LOGIC and TEMP fault lights are multiplexed together to indicate the loss of an encoder signal. JP-15 on the control board must be removed to allow a Encoder Fault to create a latched fault condition. See J2-Feedback connector Encoder Fault, And control board Jumper definitions (JP-15) definitions and specifications.

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Troubleshooting Procedures

This section provides additional details about troubleshooting the drive 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 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 pins TB401 pins 8 (ground), 9, and 10.
	Input power LED ON	Insure that the motor feedback and armature cables are properly connected to the motor and amplifier.
		Check J1 for the following voltages: J1-5 = +5V J1-10 = +12V J1-12 = -12V And Check J2 for the following voltage: J2-1 = +5V 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.
		Check to insure that the amplifier 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. 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). Refer to the SL Drive Connection Definitions & Specifications for the J1 Connector.
		Disconnect the motor power connector and manually turn the motor while observing the incremental encoder signals: A encoder signal = J2 pins 8 and 9, B encoder signal = J2 pins 6 and 7. (refer to the J2-Feedback connector description.) There should be a 90 degrees phase difference 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 . 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 A Hall, (pins 15 and 14), B Hall (pins 13 and 12) and C Hall (pins 11 and 10). (see the J2-Feedback connector definitions and specifications.) 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. (A Not opposite A, B Not opposite

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Symptom	Conditions	Possible Causes
		B, C Not opposite C.)
		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 & Configuration Jumpers section.
		Replace Motor.
		Replace Amplifier.
Erratic Movement motor jumps and kicks	No fault LEDs on	Insure that the motor feedback and armature cables are properly connected to the motor and amplifier.
		Check for loose or broken wires on the J2 Feedback connector
		Check and insure that the amplifier is properly grounded. The AC input Voltage connector pin TB401 pin 7 should be tied to Earth Ground. The amplifier output (Motor Armature) terminal TB401 pin 3 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 amplifier (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 J2 pins 8 and 9, "B" channel encoder signals are present on J2 pins 6 and 7. Refer to the J2 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: A Hall = J2 pins 15 and 14, B Hall = J2 pins 13 and 12, C Hall = pins 11 and 10. (refer to the J2 Feedback connector description). There should be a 120 degree phase difference between the A, B, and C Hall (six step) signals. The A Not Hall should be opposite the A Hall (180 degree out of phase). Likewise the B Not and C Not Hall should be opposite the B and C Hall respectively. 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 A Hall, (pins 15 and 14), B Hall (pins 13 and 12) and C Hall (pins 11 and 10). (see the J2-Feedback connector definitions and specifications) 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

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Symptom	Conditions	Possible Causes
		of phase) the logical input. (A Not opposite A, B Not opposite B , C Not opposite C)
		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 & Configuration Jumpers section.
		Temporarily convert the amplifier 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 amplifier 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 Logic Supply for the Encoder listed in the SL Manual). Placing the amplifier in the six step position should be for troubleshooting only. In most circumstances, you will not want to leave the amplifier in Six Step. This will cause poor performance at lower speeds.
RMS Fault	RMS LED light is on.	An RMS fault indicates that the amplifier 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 amplifier/motor and mechanical system.
		Insure that the load is not oversized. (The load is larger than the motor/amplifier combination can safely handle.)
		Insure that the motion profile does not have an extreme duty cycle. (The amplifier 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 amplifier is requested to supply more than normal current because of a mechanical bind.
		The amplifier 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 amplifier.
SURGE Fault	SURGE LED is on	Turn power off and disconnect the motor cable at the amplifier. (TB401 pins 3, 4, 5 and 6).
		If the SURGE fault light continues to illuminate after the motor cable has been disconnected at the amplifier end (TB401 pins 3, 4, 5 and 6), and power reapplied, replace the amplifier.
		If the SURGE fault clears when the cable has been disconnected at the motor end (TB401 pins 3, 4, 5, and 6) 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

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Symptom	Conditions	Possible Causes
		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 amplifier (TB401 pins 3,4,5 and 6).
		If the GROUND fault light continues to illuminate after the motor cable has been disconnected at the amplifier end (TB401 pins 3,4,5 and 6) , and power reapplied, replace the amplifier.
		If the GROUND fault clears when the cable has been disconnected at the motor end (TB401 pins 3, 4, 5 and 6) 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 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 amplifier.
		Check J1 for the following voltages: J1-5 = +5V J1-10 = +12V J1-12 = -12V And check J2 for the following voltage: J2-1 = +5V 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 the heat sink temperature, and thus the output transistor temperature has risen beyond the safe operating range of the amplifier.
		Insure that the ambient temperature (the temperature directly outside of the amplifier) is below 50 degrees C. The amplifier is rated to pull rms. current at 50 degrees C. If the temperature is above this, the ambient temperature must be lowered.
		If the amplifier uses a fan, insure that the fan is working properly.
		Insure that there is room to allow proper ventilation of the amplifier. Do not obstruct the intake or exhaust outlets near the top or the bottom of the amplifier. 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.
BUS/PHASE Fault	BUS/PHASE LED is on	If a BUS overvoltage fault occurs when the amplifier is first turned on, check three phase power input TB401 for proper AC input voltage. Insure that there is power on all three phases. Insure that the voltage is within the range listed for the

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Symptom	Conditions	Possible Causes
		amplifier.
		If the overvoltage fault occurs during a move, the system may be producing regenerative energy that is being returned to the amplifier. The fault circuitry may be protecting the amplifier by shutting it off to prevent higher regeneration.
		If there is no shunt regulator with the amplifier, it may be necessary to add one. If there is a shunt regulator, check to insure that the fuse has not blown.
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. 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 amplifier may loose tach feedback. Slowly turn the Tach Pot clockwise to see if the problem clears.

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DRAWINGS

This section includes all system drawings, such as schematics, assembly drawings and cable drawings.

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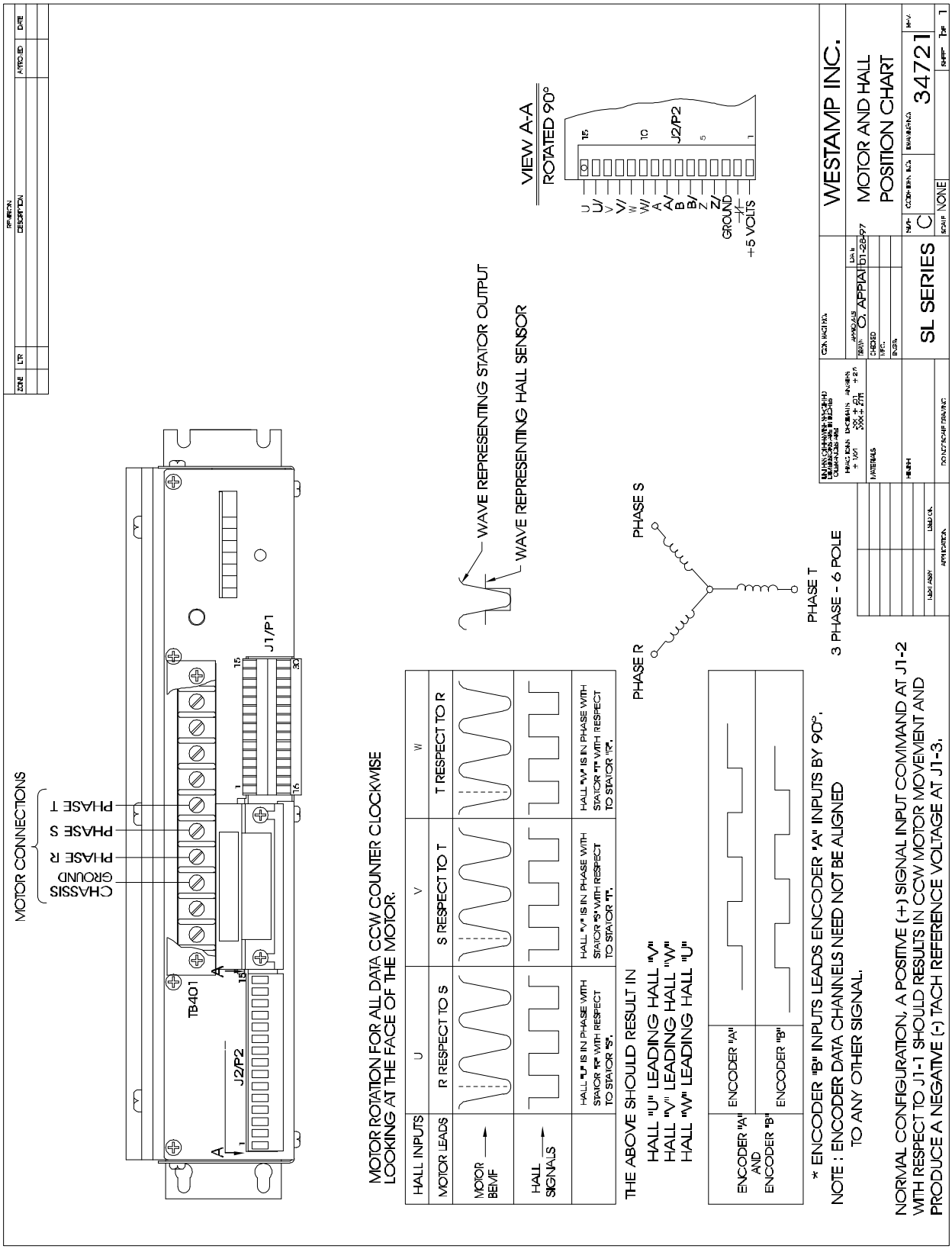
SL Installation Diagram



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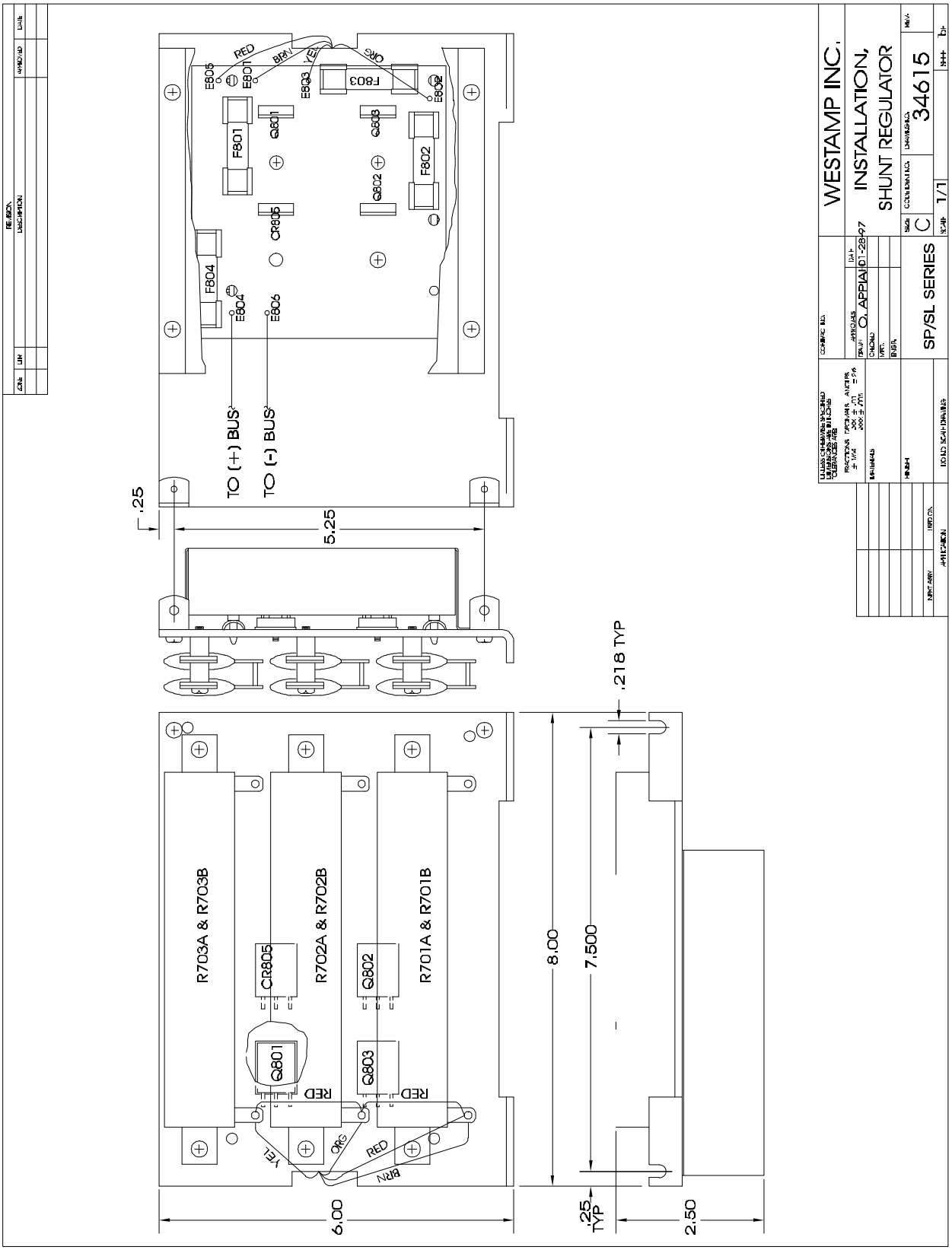
Shunt Regulator Module Outline



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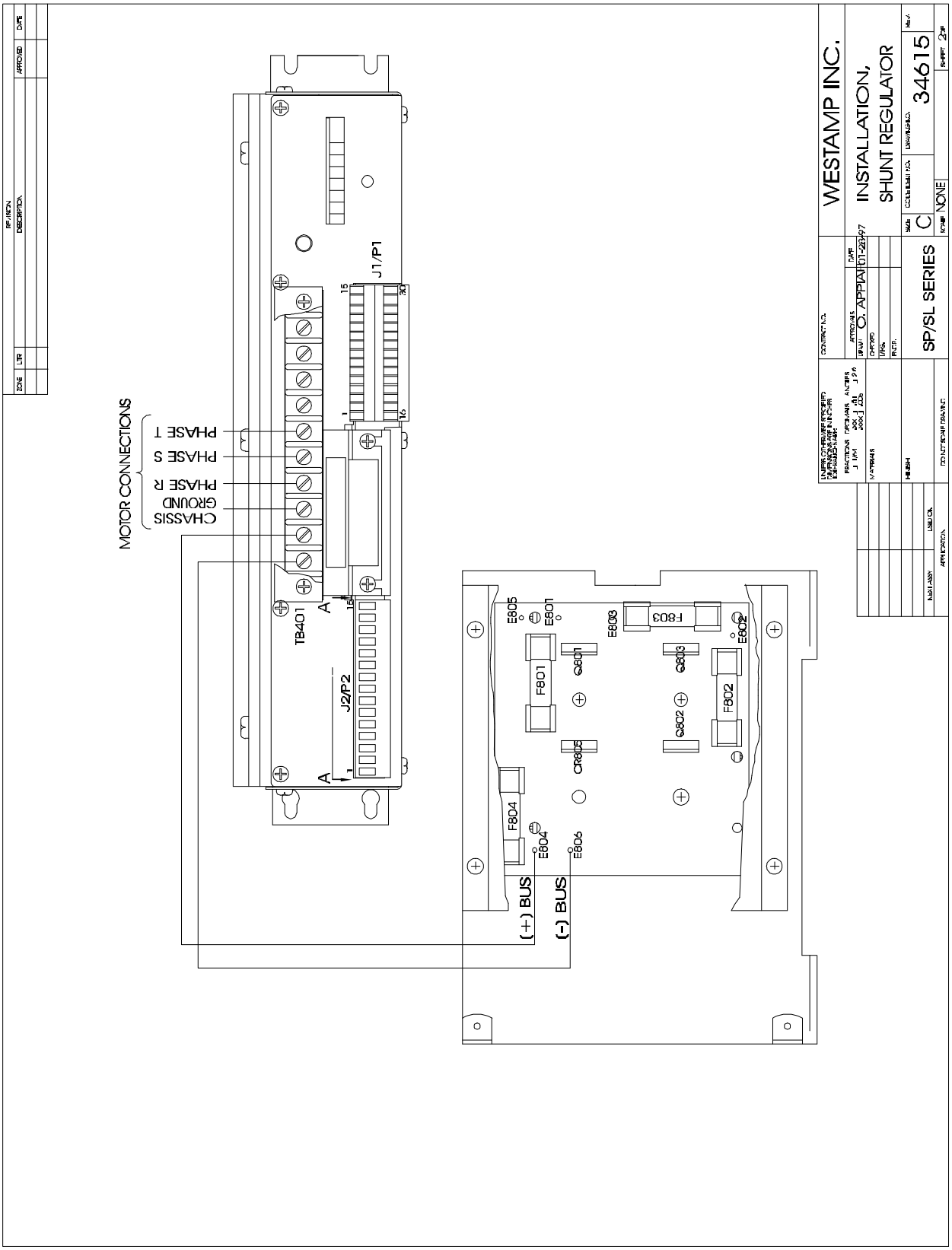
Shunt/SL Installation



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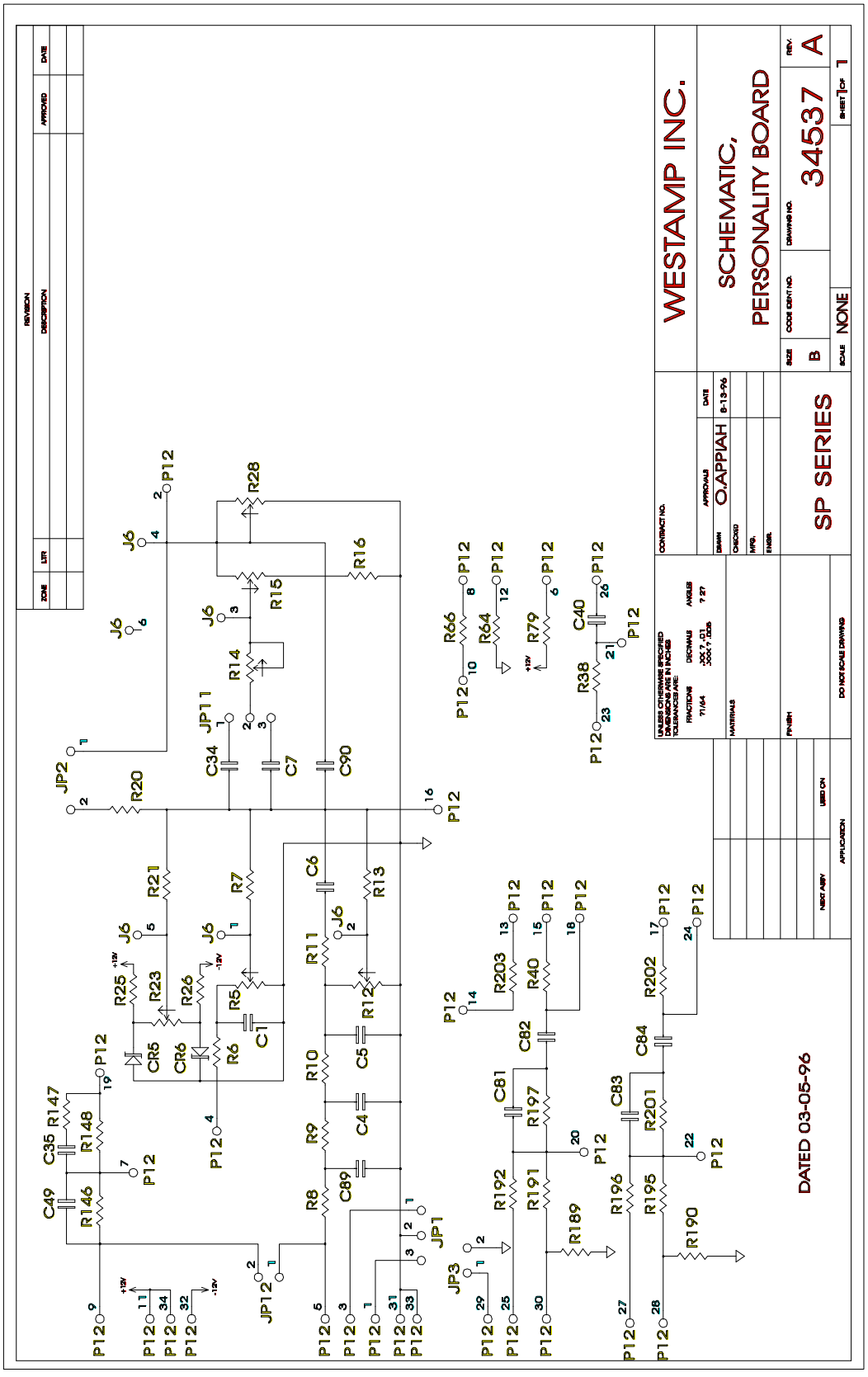
Personality Module Schematic



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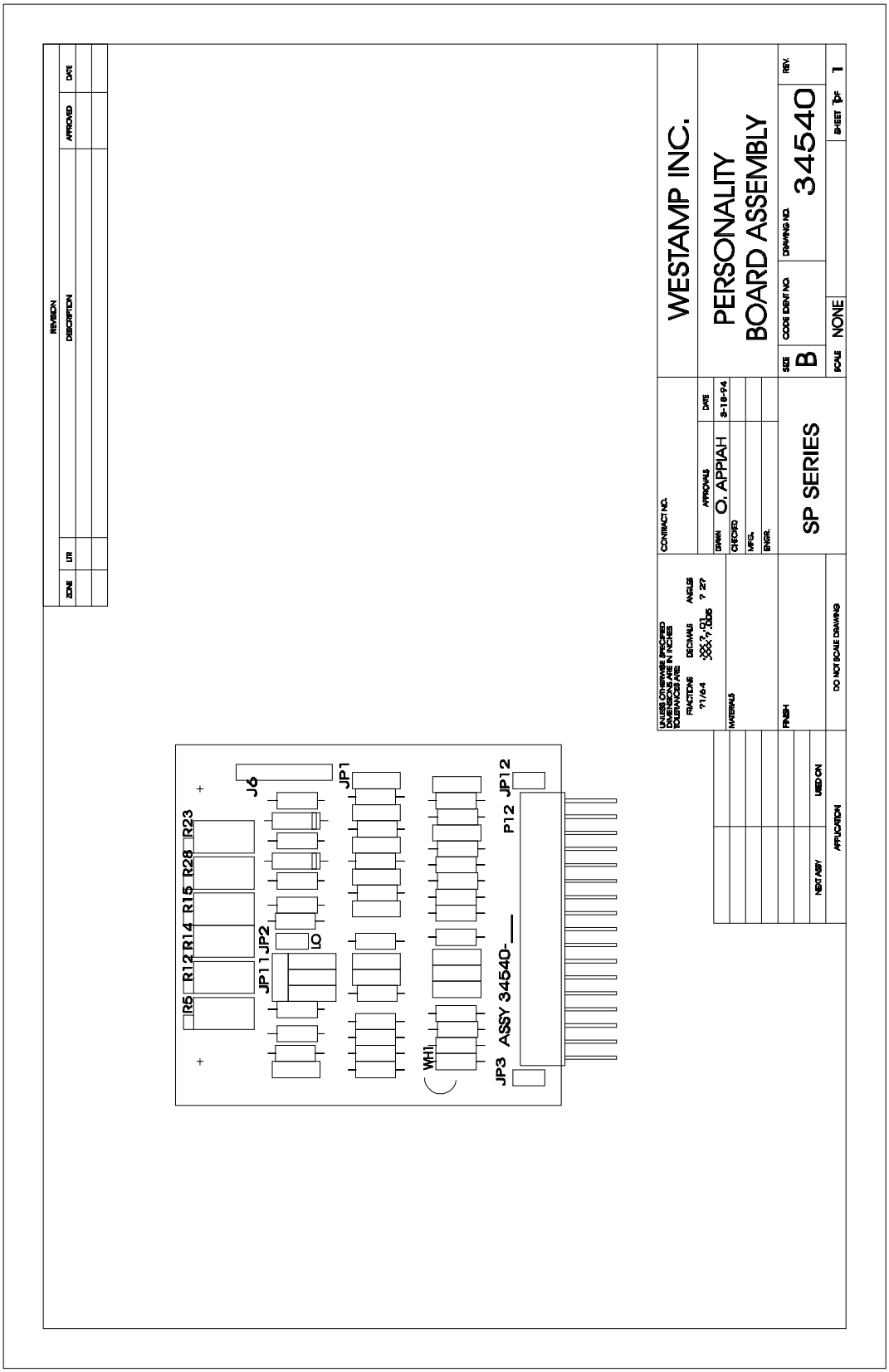
Personality Module Assembly



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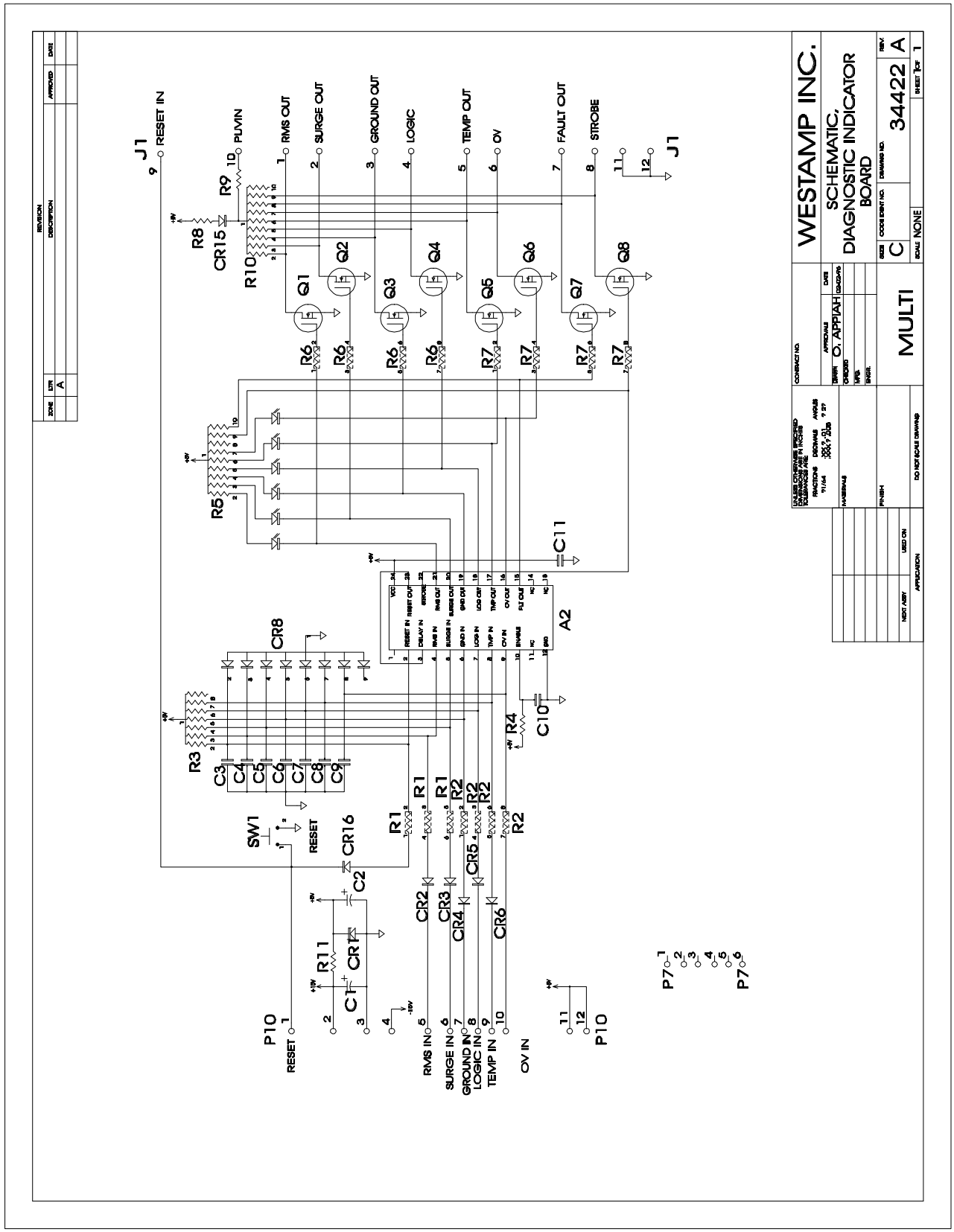
Fault/Diagnostic Board Schematic



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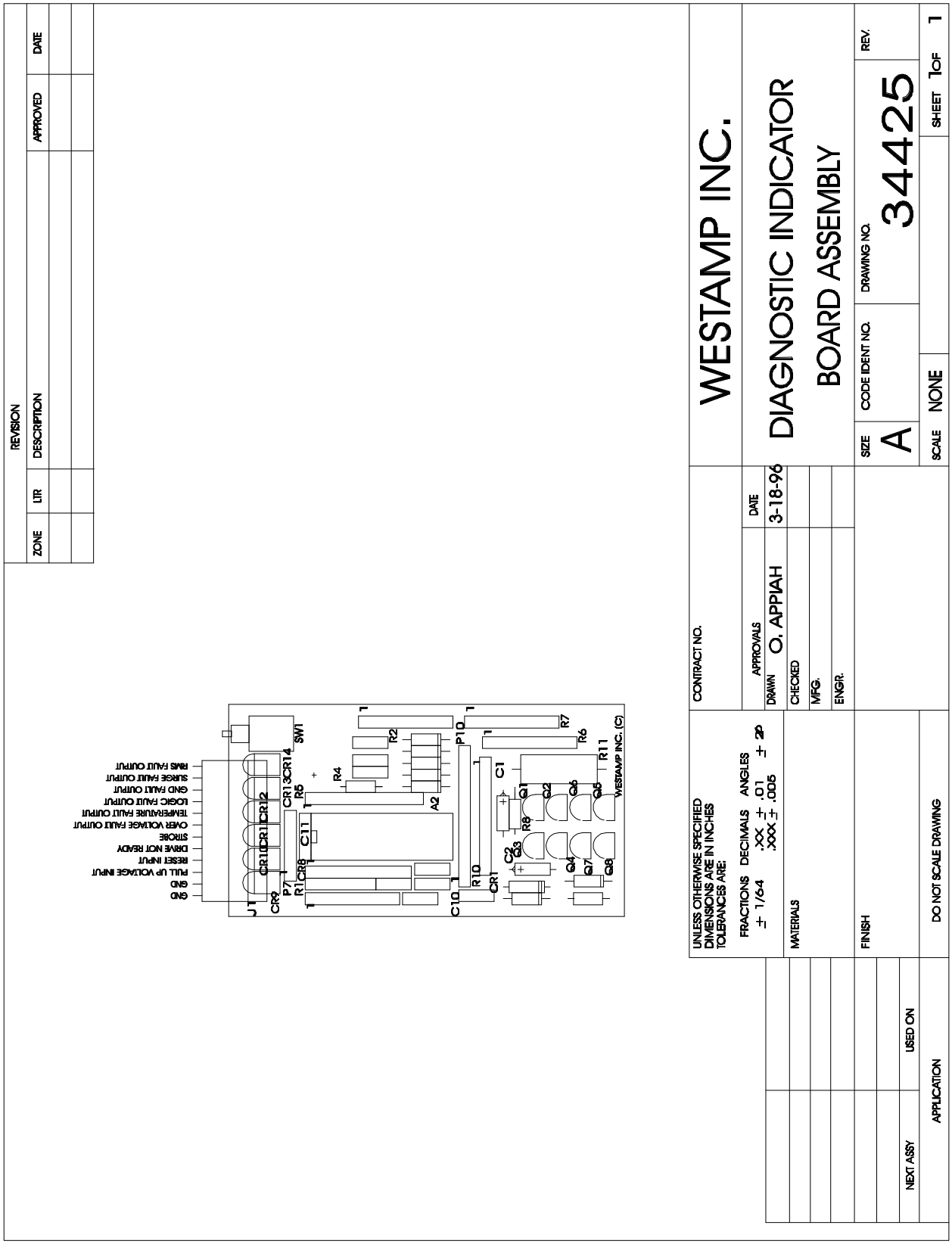
Fault/Diagnostic Board Assembly



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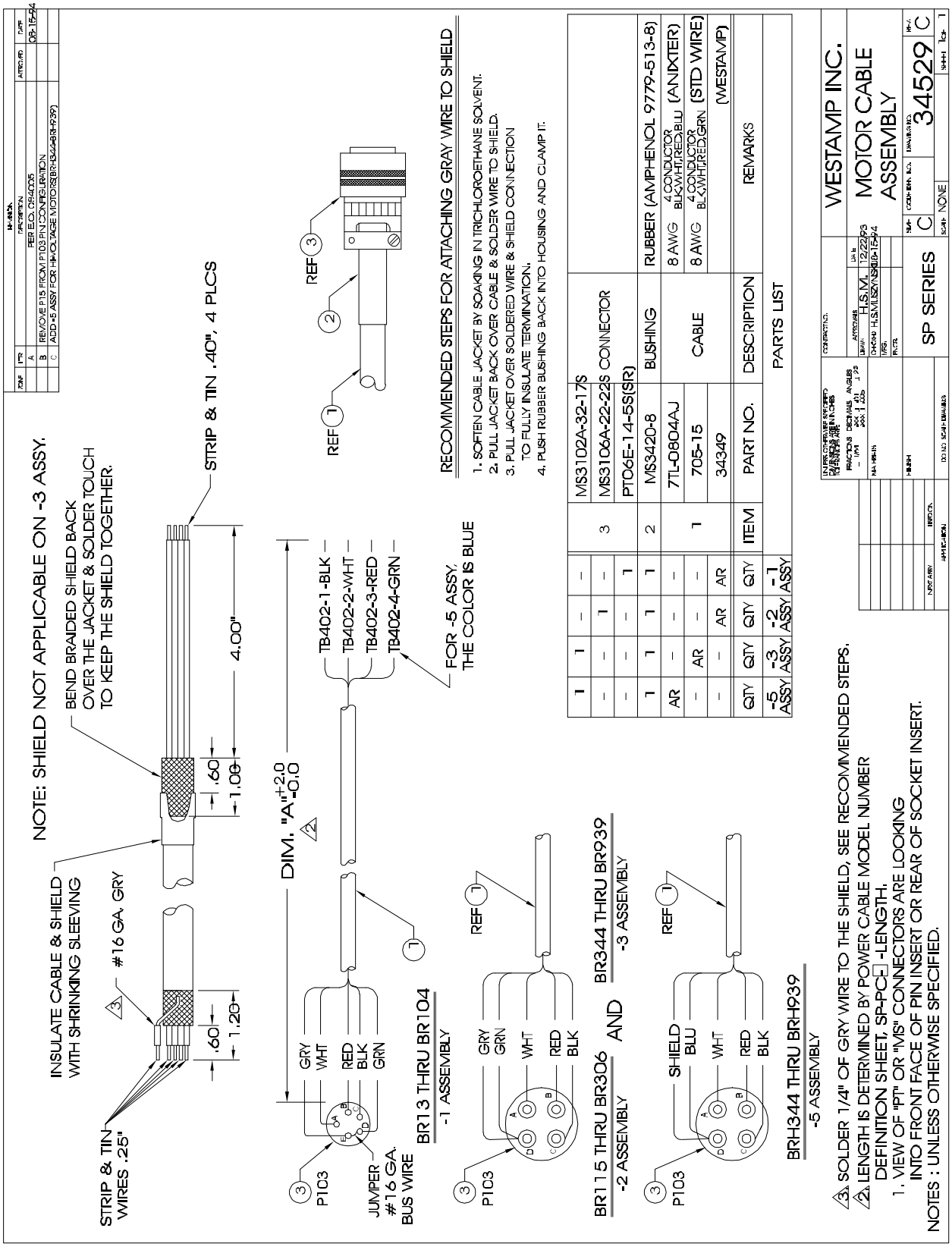
Motor Power Cable Assembly



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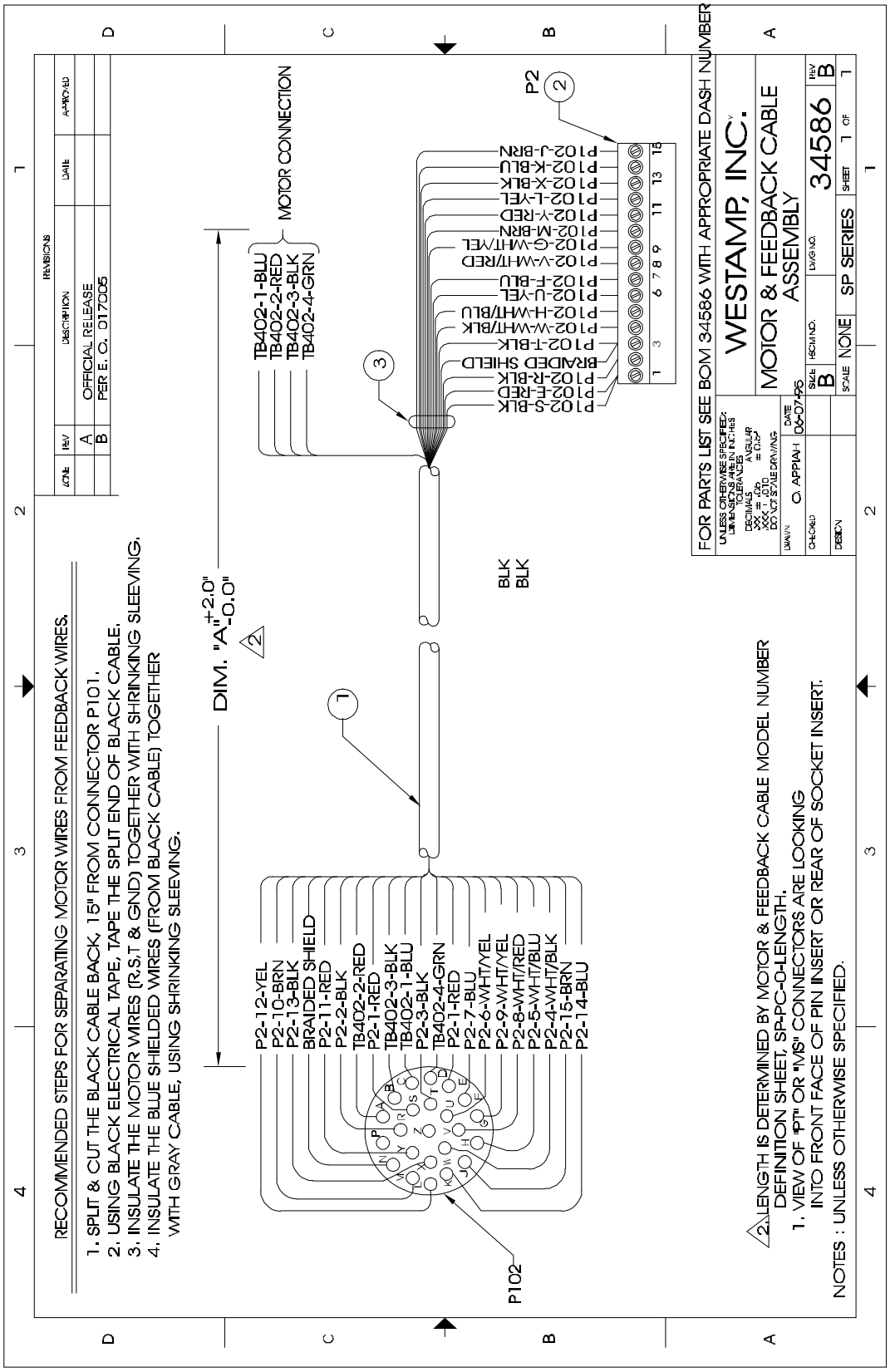
Motor Feedback Cable Assembly



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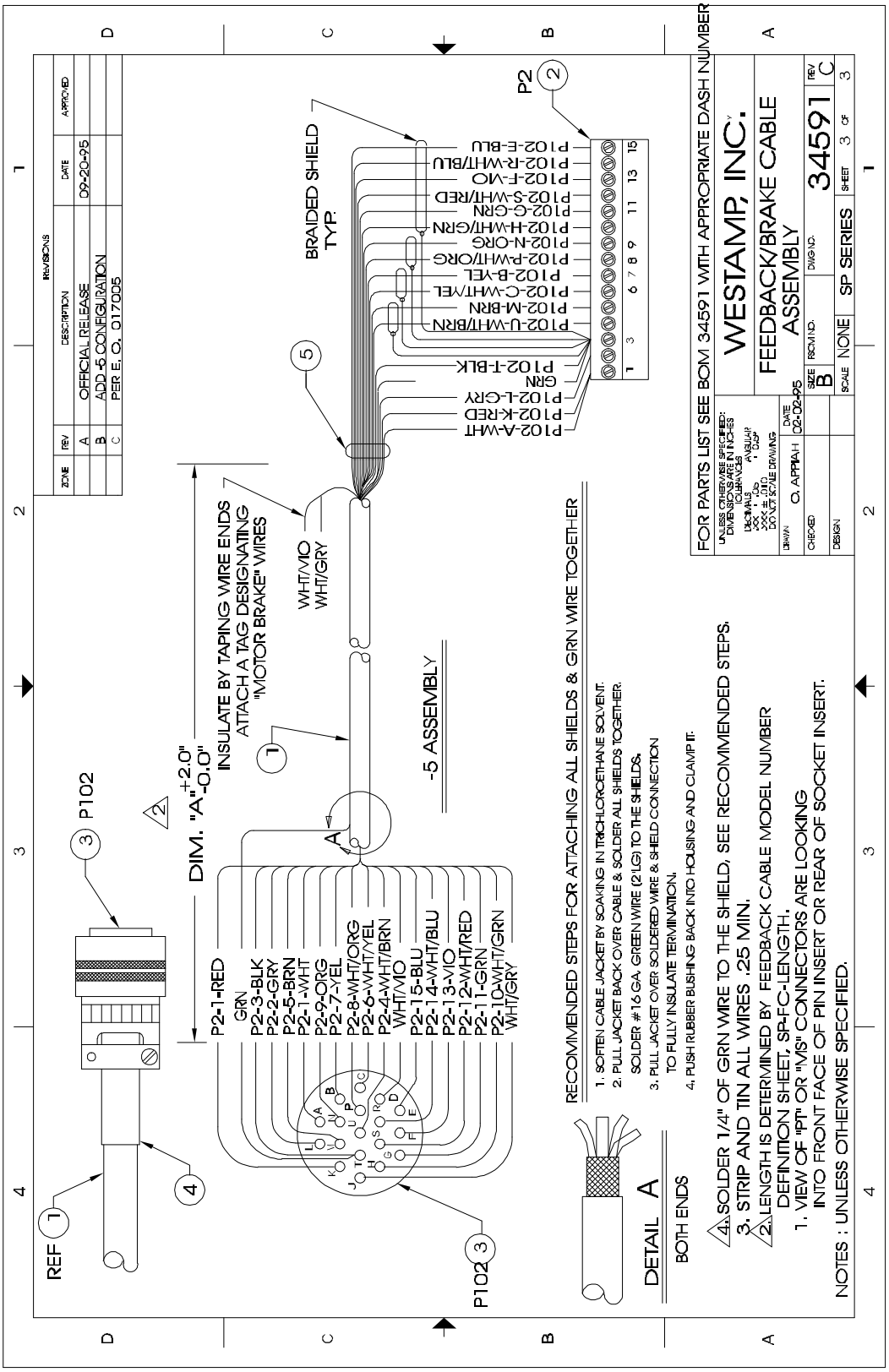
Motor Feedback w/Brake
Used Only w/SL-PC-2 Power Cables



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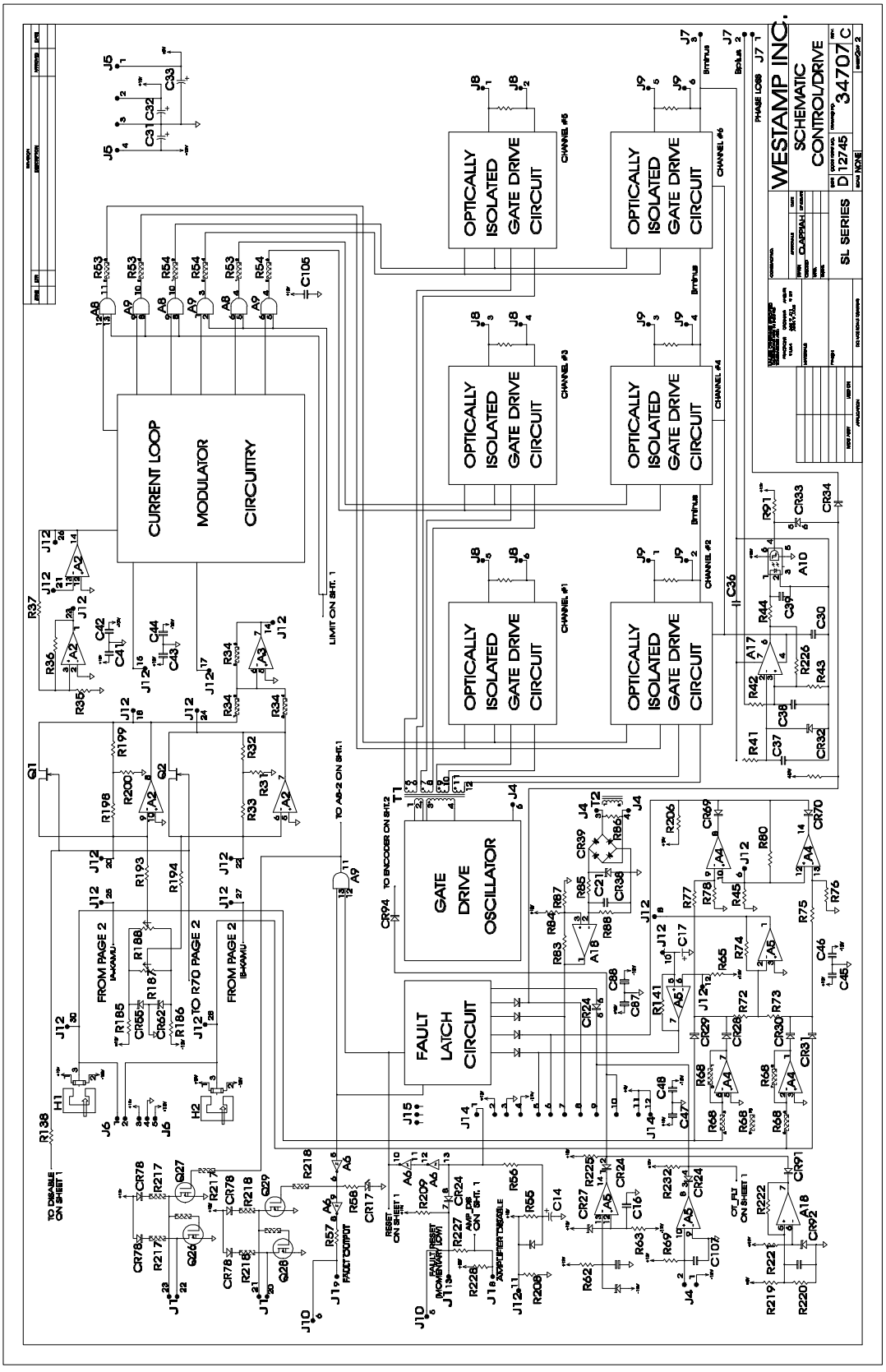
Servo Control Board Schematic 1 of 2



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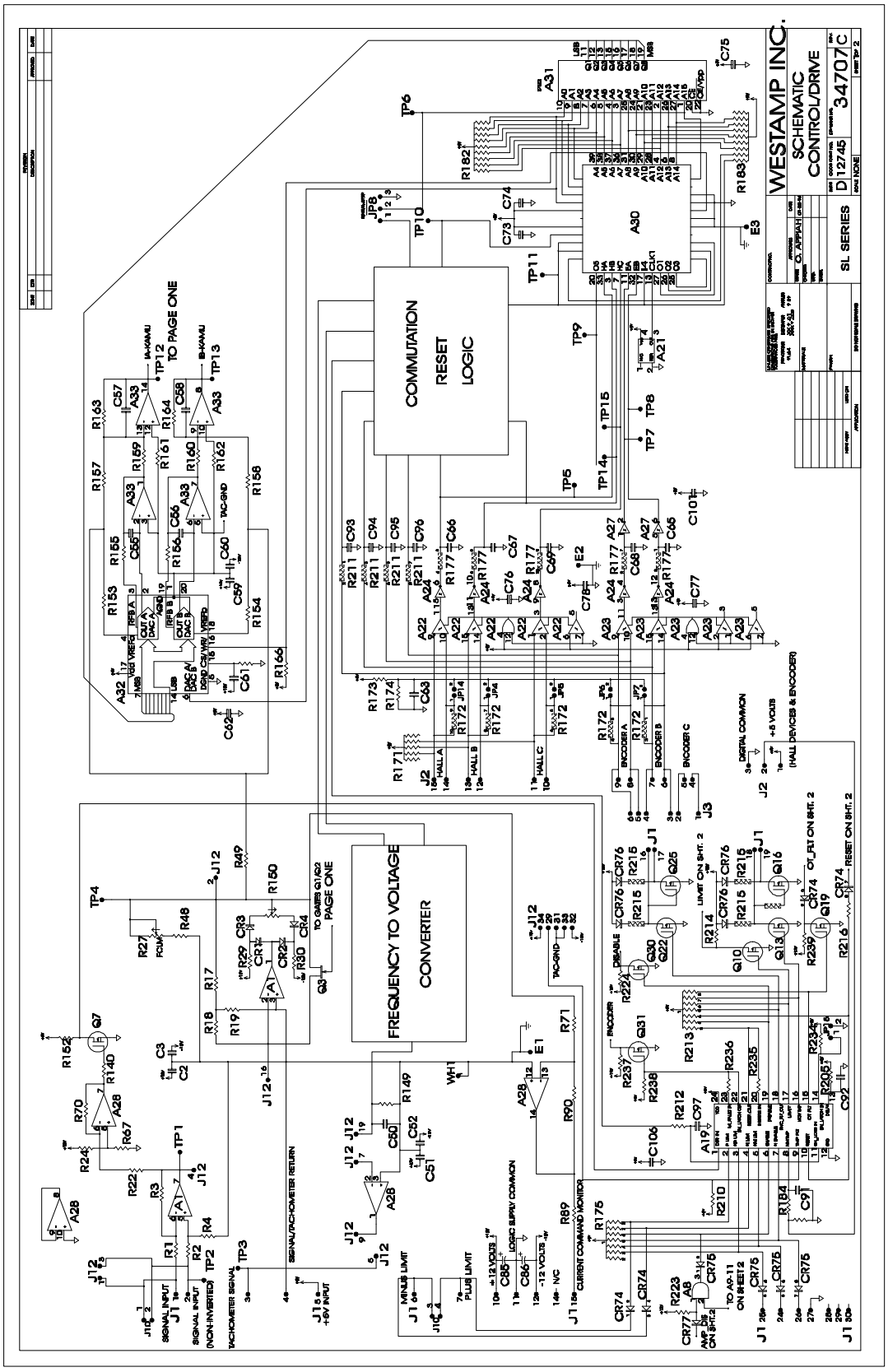
Servo Control Board Schematic 2 of 2



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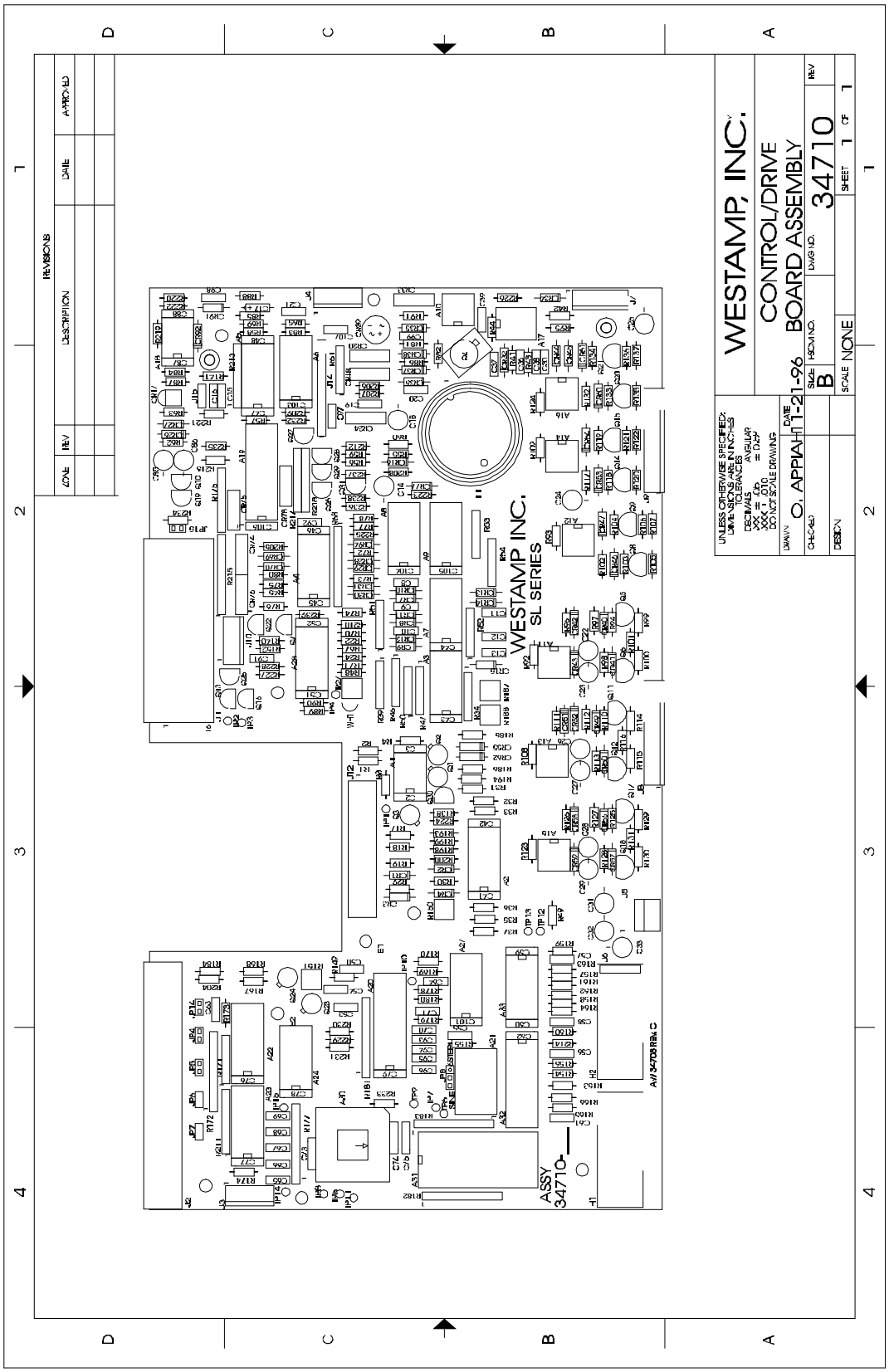
Servo Control Board Assembly



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