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CHAPTER 1

SYSTEM DESCRIPTION

1.1 INTRODUCTION

The information in this chapter will enable you to understand the product's basic functions and features. These concepts will allow you to apply them to your own unique applications.

1.2 PRODUCT DESCRIPTION

Superior Electric' SS2000-S Servo Amplifier products are 3-phase sine wave, brushless motor controllers. They are fully regenerative four-quadrant, bi-directional velocity loop amplifiers designed to be used with Superior Electric' high performance S Series permanent magnet brushless motors.

Although the amplifier is basically an analog servo amplifier, it contains a microprocessor to implement the patented Torque Angle Control function for maximum system performance.

The amplifiers are available in sizes of 6, 12, 20, 40, 60, 80, and 110 amps RMS/phase peak. The modular design provides the flexibility for multiple axes to share a common power supply requiring no input isolation transformer.

The power supplies are available in sizes of 8, 12, 20, 50, and 75 amps RMS/phase continuous (AC input line ratings).

Superior Electric's S-series of brushless servo motors have been designed to meet exacting requirements .

The S-series motors incorporate high energy rare earth Neodymium-Iron-Boron (Ne-Fe-B) magnets and excellent thermal characteristics. This results in the highest torque-to-inertia ratios, with exceptional continuous and peak torque performance, available in a compact package.

Numerous Superior Electric S-series motors with various diameters, stack lengths, and windings are available.

1.3 FEATURES

Highlighted design features are:

- Modular construction maximizing serviceability.
- Two-part plug connectors interfacing between the amplifier, power supply, and other equipment.
- Routine adjustments accessible from the front of the amplifier.
- High frequency (20 kHz) motor current ripple for quality servo performance, higher efficiency, and less audible noise.
- Differential velocity or current command input.
- Voltage programmable current limit input.

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- A removable compensation board containing all the components that make the amplifier compatible with a particular motor.

- Thermal overload protection against overtemperature conditions. The amplifier is protected against peak current overloads by a current foldback circuit. Also, it is protected from logic bus out-of-tolerance conditions and motor stator short circuit conditions, both line-to-line and line-to-ground.

- Drive-Up contact which indicates the amplifier is ready for an input command signal; contact opens on fault conditions.

- Standard Power Supply units contain a Soft Start function and a dynamic bus discharge function.

- The 12 and 20 amp power supplies have , as standard, 40 watts of internal shunt regulation. Optional externally mounted power resistance allowing shunt regulation of up to 700 watts is available. The shunt regulator is protected from excessive peak current by a fuse. It is also protected from excessive duty, if the duty cycle exceeds a preset limit, by a shunt overload shutdown circuit.

- The 50 and 75 amp power supply shunt regulation is accomplished with externally mounted power resistor(s) with ratings from 500 to 2000 watts as standard. Special units may be ordered for even higher power. The shunt regulator is protected from excessive peak current by a thermal overload relay. It is also protected from excessive duty, if the duty cycle exceeds a preset limit, by shunt overload shutdown circuit.

- Diagnostic LED indicators located on the front panel on both the amplifier and the power supply.

- Encoder Equivalent Output Card is standard. A 12-Bit Parallel Position Information card is available as an option.

- Standard on the S-series motors are an integral frameless resolver, IP65 sealing, NEMA metric mounting, and embedded thermostat. Available options include rear shaft extension (except the S070), IP67 sealing, special mountings, fail safe brakes, encoders, second resolvers, tachometers, and other options are readily available.

1.4 THEORY OF OPERATION

The SLO SYN brushless servo system consists of four main components:

1. PS - Power Supply Module
2. SS2000-S - Amplifier Module
3. S - Brushless Motor
4. GCS - General Purpose Cable Set

All of the compensation components necessary to match a amplifier to a particular motor such as, current loop compensation, velocity loop compensation, and torque angle compensation, are located on the removable compensation board located inside the amplifier.

The TL (Test Limits and Modification) Sheet contains the compensation component values and such information as maximum operating speed, peak current limits, etc. that are assigned to each amplifier system.

If a motor having a different base motor model number is to be run on a amplifier, the removable compensation board must be altered or changed accordingly. The amplifier must equal or exceed the motor current rating.

1.4.1 Power Supply Module

Refer to Figure 1.1 for a quick reference of the power supply.

The power supply is divided into four (4) main sections:

1. The Unregulated Logic Bus, supplied by the Control AC line input voltage (normally single-phase 115 VAC), is described in Section 4.2.

2. The 310/140 Main DC Bus is supplied by the main AC line input voltage (normally

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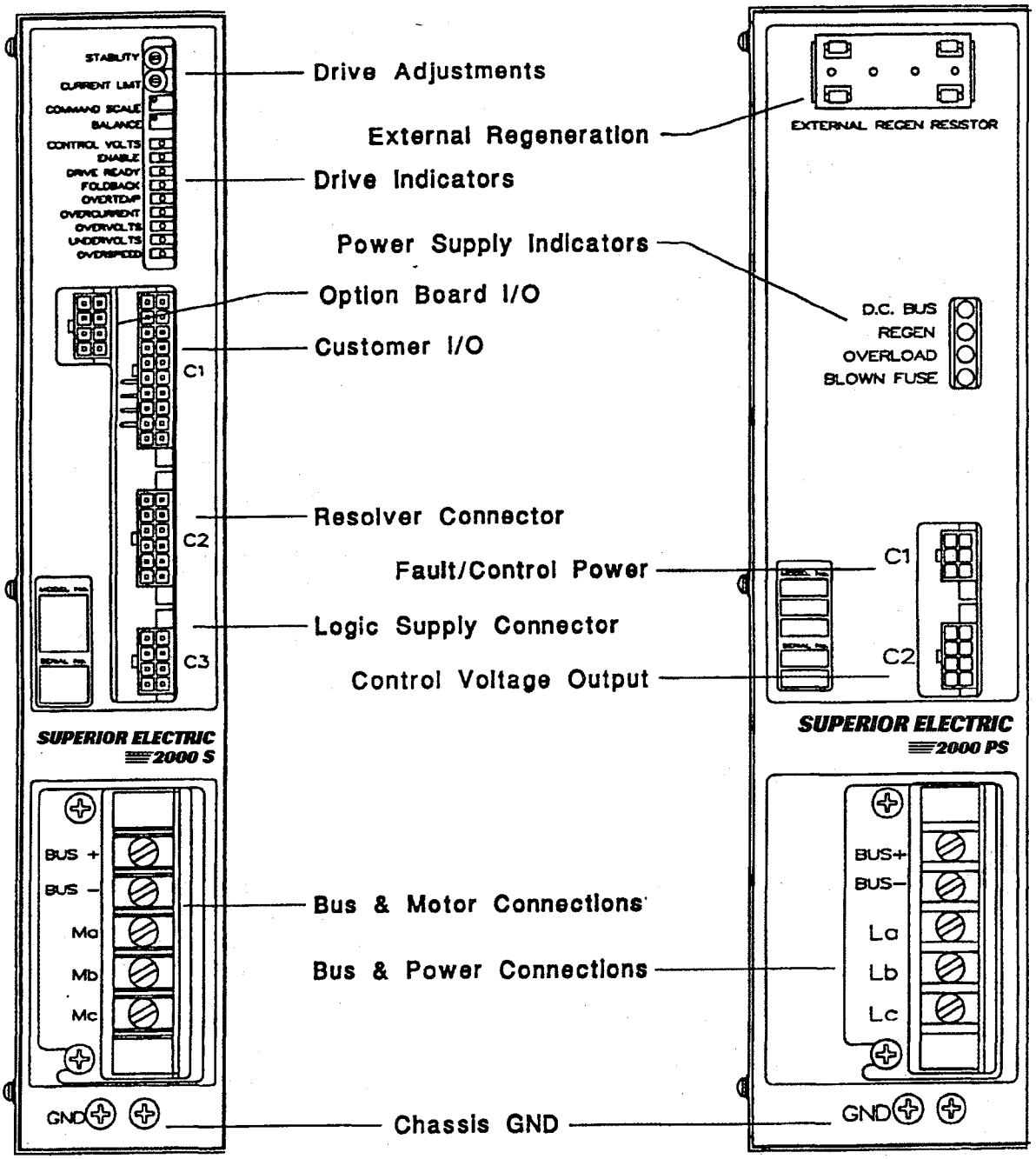


Figure 1.1. Amplifier and Power Supply (Low Current Models shown)

three-phase 230 VAC or single-phase 115 VAC).

3. The Soft-Start Feature (standard) resistor limits the inrush current (to charge-up the Main Bus Capacitors) to a specific amount as listed in Appendix B.

4. The Shunt Regulator (regeneration) section includes circuitry which monitors the main bus. During deceleration profiles, the motor basically operates as a DC generator and

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pumps energy back into the main bus causing the bus to rise. The Shunt Regulator limits the voltage rise during the deceleration periods.

- 12 and 20 AMP Models:

  The shunt regulator (regeneration) resistor load is fuse protected. If the shunt regulator is held on for too long, the shunt regulator power transistor fails, or the shunt regulator load resistor becomes shorted, the fuse will blow and cause the Fault Contact on the Power Supply to open and the BLOWN REGEN FUSE LED to become illuminated.

  The shunt regulator also includes a duty cycle limit circuit to protect against excessive load resistor heating. If the average duty cycle limit is exceeded, the regeneration circuitry will become disabled, the Fault Contact will open, and the OVERLOAD LED will become illuminated. To reset this fault, remove and reapply all input line power; bus capacitors must completely discharge.

- 50 and 75 AMP Models:



The thermal overload output contacts must be connected into a shut down circuit (E Stop string, etc.) to drop the main power or a possible fire hazard will exist. Refer to Drawing A-93231.

The shunt regulator (regeneration) resistor is protected by a thermal overload relay. If the resistor rating is exceeded or if the shunt regulator transistor fails, the thermal overload output contacts will open indicating an IMMEDIATE need to remove the main power.

1.4.2 Servo Amplifier

Refer to Figure 1.1 for a quick reference of the amplifier's features.

The Servo Amplifier is divided into four (4) main sections:

1. Fault Diagnostics monitor various signal leads. When a fault condition occurs the fault circuit will become latched, the amplifier will become internally inhibited, the appropriate red LED will become illuminated, and the Drive-Up contact will open indicating that the amplifier is in its Inhibit mode.

2. The Input/Output interface circuitry is divided into two functions:

   (A) Signals to and from the motor and amplifier.

   These signals are associated with the motor system resolver. A 7.0 kHz excitation signal is generated in the amplifier and sent to the resolver. Two resolver feedback signals (sine and cosine) are received by the amplifier and processed by an R/D (resolver-to-digital) converter. The R/D unit generates a digital position word used in electronically commutating the motor and an analog velocity (internal tach) signal to close the servo loop.

   (B) Signals to and from the signal source (PLC, CNC, etc.) and amplifier.

   There are numerous signals that may interface between the signal source (PLC, CNC, etc.) and the amplifier. These inputs and modes of operation differ with each application.

3. The amplifier consists of a single velocity loop and three inner current loops. To give precise velocity control, the velocity loop is normally configured as a proportional, plus an integral, plus a derivative gain servo loop. The output of the velocity loop is the current command for the three microprocessor-based current loops.

   The heart of the amplifier is its microprocessor which receives and processes the current command (velocity error) signal from the output of the velocity loop circuit, the position information from

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the resolver-to-digital converter, and several other signals. After receiving the velocity error, the microprocessor generates three sinusoidal current commands. These current commands are forwarded to the three proportional plus integral current loops, one for each of the three motor phases.

The microprocessor is the key element in the patented torque angle technique. The microprocessor varies the phase of the currents with respect to motor flux and significantly improves the motor speed-vs-torque profile.[1]

4. The outputs from the three current loop circuits are converted into a 10 kHz pulse width modulation signal. The modulation is such that the 10 kHz PWM results in 20 kHz current ripple in the motor, resulting in very quiet motor operation.

   The PWM switching signals are optically coupled to the power stage gate amplifier hardware for complete electrical isolation. The amplifier uses IGBT's (Isolated Gate Bipolar Transistors) for the output power stage; allowing high frequency operation and minimizes amplifier losses.

1.4.3 Brushless DC Motor

Superior Electric's S Series brushless motors feature the latest in permanent magnet technology, utilizing high energy Neodymium-Iron-Boron alloys. These brushless motors consist of permanent magnet rotors and three-phase Y-stator windings. This places the heat producing member on the outside where it can best dissipate heat. These motors (depending on size) are either four- or six-pole motors. Since they are brushless motors, there are no commutators or associated brushes. The motors run as synchronous motors, meaning the rotor speed is the same as the speed (frequency) of the stator's rotating magnetic field. The feedback device is a brushless resolver, mounted internally as part of the overall motor construction. Another available option is the integral brush tachometer. For more information, refer to Appendix E, Motor Installation.

1.4.4 Power Up/Down Sequencing

First, apply the 115 VAC control voltage. Second, apply the main AC voltage. Third, check for faults and then enable the amplifier. The AC line input voltages may be removed in any sequence.

1.4.5 With Soft-Start Circuit (Standard)

1. Only the Control AC line input voltage is applied.

   a. The logic bus comes up.

   b. A power-up reset pulse is generated in the amplifier.

   c. If no faults (other than main bus undervolts) are present after the power-up reset pulse is generated (a delay of one second) then the amplifier is ready to be enabled. However, there can be no motor movement until the main AC line input voltage is applied.

2. The Main AC line input voltage is applied.

   a. The soft-start circuit charges the Main DC bus capacitors in the power supply through a current limiting resistor.

   b. The shunt regulator regeneration circuitry is switched from dynamic bus discharge to regular mode.

c. The undervoltage fault in the amplifier is now cleared (after approximately 3/4 sec. delay), and if jumper J21 is installed on the Compensation Board, the Amplifier Ready LED will become illuminated and the Drive-Up contact in the amplifier (between Pins 10 and 20 of Connector C1) will close. The amplifier is ready to be enabled and will enable once the enable input is activated.

1 The SS2000-S sine-wave controller allows a wider range speed because it has the ability to electronically change the angle between the rotor flux and the stator flux—commonly referred to as torque angle.

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3. Only the Main AC line input voltage is removed.

   a. Approximately 30 msec. after the Main AC line input voltage is removed, the shunt regulator is switched from regulate to the dynamic bus discharge mode, and the main DC bus power is discharged.

   b. The shunt regulator circuit is deactivated.

   c. The Drive-Up contact within the amplifier will open due to Bus undervolts.

4. Only the Control AC line input voltage is removed.

   a. The Drive-Up contact in the amplifier will open. The amplifier is immediately disabled.

   b. Operation of the soft-start/dynamic bus discharge and other circuits within the power supply will not be affected.

   c. The power supply fault contact will open.

1.4.6 Without Soft-Start Circuit or Dynamic Bus Discharge (Optional)

1. Only the Control AC line input voltage is applied.

   a. The logic bus comes up.

   b. A power-up reset pulse is generated in the amplifier.

   c. If no faults (other than main bus undervolts) are present after the power-up reset pulse is generated (a delay of one second) then the amplifier is ready to be enabled. However, there can be no motor movement until the main AC line input voltage is applied.

2. The Main AC line input voltage is applied.

   a. The soft-start circuit charges the Main DC bus capacitors in the power supply through a current limiting resistor.

   b. The shunt regulator regeneration circuitry is switched from dynamic bus discharge to regular mode.

   c. The undervoltage fault in the amplifier is now cleared (after approximately 3/4 sec. delay), and if jumper J21 is installed on the Compensation Board, the Drive Ready LED will become illuminated and the Drive-Up contact in the amplifier (between Pins 10 and 20 of Connector C1) will close. The amplifier is ready to be enabled and will enable once the enable input is activated.

3. Only the Main AC line input voltage is removed.

   a. The DC bus will bleed down slowly after approximately five minutes.

   b. The shunt regulator is deactivated.

   c. The Drive-Up contact within the amplifier will open.

4. Only the Control AC line input voltage is removed.

   a. The amplifier will be immediately disabled.

   b. The Drive-Up contact will open.

   c. The power supply fault contact will open.

1.5 TYPICAL SYSTEM DIAGRAM

Figure 1.2 illustrates a typical system with all of the major components.

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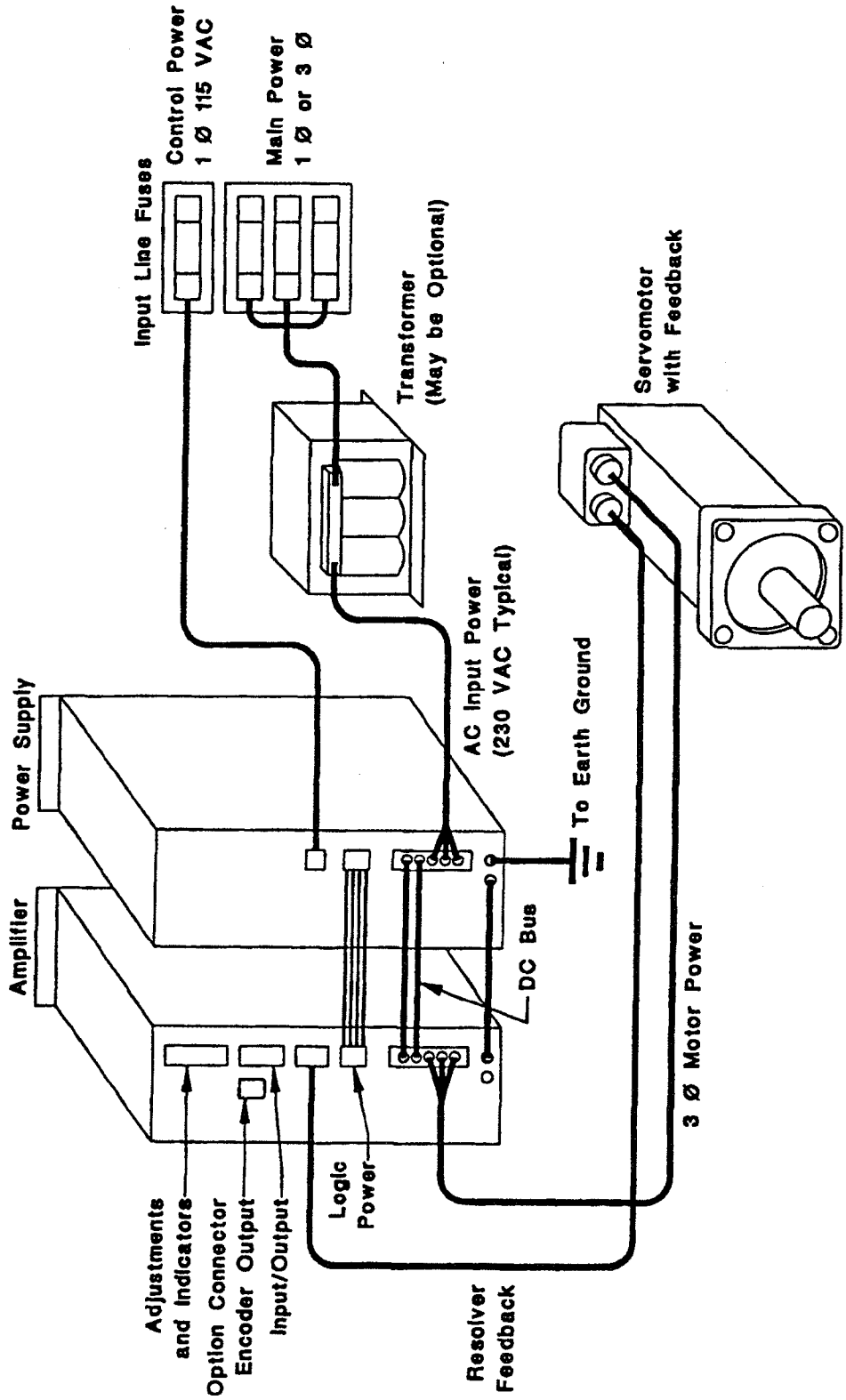


Figure 1.2. Typical System Diagram

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CHAPTER 2

INSTALLATION

2.1 INTRODUCTION

The information in this chapter will familiarize you with the safety information, unpacking and inspection, installation requirements, assembly procedures and electrical connections for installing the amplifier. A checklist is provided at the end of this chapter to insure proper installation.

2.2 SAFETY INFORMATION

The purpose of this section is to alert you to possible safety hazards associated with this equipment and the precautions you can take to reduce the risk of personal injury and damage to the equipment.

Safety notices in this manual provide important information. Read and be familiar with these instructions before attempting installation, operation, or maintenance. Failure to observe these precautions could result in serious bodily injury, damage to the equipment, or operational difficulty.

The safety-alert symbols are illustrated in Figure 2. When you see these symbols in this manual, be alert to the potential for personal injury. Follow the recommended precautions and safe operating practices included with the alert symbols.



Figure 2.1. Safety-Alert Symbols

"Warning" refers to personal safety. They alert you to potential danger or harm. Failure to follow warning notices could result in injury or death.

"Caution" directs attention to general precautions, which if not followed, could result in personal injury and/or equipment damage.

"Note" highlights information critical to your understanding or use of these products.

2.3 CONVENTIONS

To assist you in understanding the material in this manual, conventions have been established to enhance reader comprehension. Explanations of these conventions are as follows:

- Safety warnings, cautions, and notes present material that is important to user safety. Be sure to read any safety notices you see as they could prevent equipment damage, personal injury, or even death to you or a co-worker.
- **Bold** text highlights other important information that is critical to system operations.

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- CAPITALIZED text stresses attention to the details of the procedure.
- Underlined text emphasizes crucial words in sentences that could be misunderstood if the word is not recognized.

2.3.1 Model Numbering Scheme

All Superior Electric SS2000 servo components contain a model and serial number printed on a black and blue tag on the front panel. The model number identifies how the equipment is configured. Refer to Appendix A for the model number scheme tables. These tables explain what the model configurations are. You should verify that the model numbers represent the equipment desired for your application. Also verify the compatibility between components of the servo system.

2.3.2 Abbreviations

C	Cable Set
CCW	Counter Clockwise
CW	Clockwise
DIFF CMD	Differential Command
D/L	Direction Limit
LED	Light Emitting Diode
NEC	National Electrical Code
P/N	Part Number
R/D	Resolver-to-Digital
Regen	Regeneration
TL	Test Limits
UL	Underwriters Laboratories

2.4 UNPACKING AND INSPECTION



Electronic components in this amplifier are static sensitive. Use proper procedures when handling component boards.

Upon receipt of the equipment, closely inspect components to ensure that no damage has occurred in shipment. If damage is detected, notify the carrier immediately.

Carefully remove packing material and remove the equipment from the shipping container. Do not dispose of shipping materials until the packing list has been checked. Parts that are contained within the shipment, but not physically attached to the equipment, should be verified against the packing list. If any parts are missing, notify Superior Electric at once.

2.5 INSTALLATION REQUIREMENTS

Proper installation and field wiring are of prime importance when considering the application of servo amplifiers. Many problems may be avoided if installation of the equipment is done properly. Users should familiarize themselves with and follow installation and wiring instruction in addition to all applicable codes, laws and standards. Pay special attention to the following topics when installing Superior Electric equipment.

2.5.1 Environmental Considerations

The environment that this equipment is placed in can have dramatic effects on its operation. Superior Electric recommends that the amplifier and power supply be operated and stored under the following conditions:

- Operating Temperature:
  32 °F to 113 °F (0 °C to 45 °C)
- Storage Temperature:
  -4 °F to 158 °F (-20 °C to 70 °C)
- Humidity: 10% to 90% (Non Condensing)

2.5.2 Enclosures

It is suggested that the amplifier and power supply be mounted in a cabinet or other suitable enclosure to protect them from physical and environmental damage. Refer to Appendix B for complete system dimensions.

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CAUTION

Allow sufficient clearance for the large "regenerative" heat producing resistor(s) mounted at the upper edge of the Power supply unit and the externally mounted regen (shunt regulator) power resistor(s).

2.6 ASSEMBLY

The amplifier and power supply are both constructed prior to shipping from the factory. The only assembly required is the mounting of the devices.

2.6.1 Mounting

Refer to the drawing of your model system in Appendix D for outline and dimensions. Be sure to look at the proper drawing for mounting measurements.

The power supply and amplifier modules should be mounted in the vertical position. To minimize cross talk and enhance air flow, maintain a minimum of 0.75 inches (20 mm) on either side of each unit and at least 1.5 inches (40 mm) of unobstructed space above and below the units.

Depending on the continuous current ratings of the amplifier and power supply modules, a total of six (6) amplifiers may be mounted with a single power supply. However, the maximum number of amplifiers mounted on either side of the power supply module must not exceed four (4).

Mounting combinations for the power supply and amplifier modules are as follows:

- PS08; a maximum of one (1) amplifier.
- PS12; a maximum of four (4) amplifiers sequentially or "split mounted" (amplifiers are mounted on both sides of the power supply) at either side of the power supply in descending order of continuous current ratings.
- PS20; a maximum of four (4) amplifiers sequentially or "split mounted" at either side of the power supply in descending order of continuous current ratings.
- PS50 & PS75; a maximum of six (6) amplifiers ("split mounted" only) to either side, not to exceed four (4) amplifiers on a side, mounted in descending order of continuous current ratings.


NOTE

Refer to The drawing of your model system in Appendix D for the Mounting Hole Pattern information.


CAUTION

Allow sufficient clearance for the large "regenerative" heat producing resistor(s). The internal resistors are mounted at the upper edge of the power supply unit. The externally mounted regen (shunt regulator) power resistor(s) are mounted above the Power Supply.

2.6.2 Mounting the External Regeneration Resistor(s)


WARNING

External regenerative resistors are a shock hazard!

Mount these resistors properly! Enclose these resistors to protect personnel and equipment!


CAUTION

External regen resistors can become extremely hot!

Allow safe clearance around the resistor(s) enclosures. Proper ventilation must be provided.

Some power supplies use an externally mounted regen (shunt regulator) resistor. The resistor kit includes mounting hardware and, depending on the model, a thermal overload relay to be wired in with the resistors. A suitable enclosed location outside the equipment cabinet needs to be set aside for mounting these components while observing the heat and shock requirements of these resistors.

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Refer to the Amplifier wiring diagram (A-93231) for wiring of the relay output contacts.

2.7 ELECTRICAL CONNECTIONS



Dangerous voltages, currents, temperatures, and energy levels exist in this product and in the associated servo motor(s). Extreme caution should be exercised in the application of this equipment. Only qualified individuals should attempt to install, set-up, and operate this equipment. Ensure that he motor, amplifier, and the end-user assembly are properly grounded per NEC requirements.

To facilitate wiring, the amplifiers must be mounted next to the power supply in descending order according to their continuous current ratings. Refer to Section 2.6.



In order to adhere to suitable engineering practice, the AC control voltage (115 VAC for the logic bus) must be applied first to activate the control and fault logic circuits prior to applying the main AC voltage.

Follow these precautions:

1. Observe all notes on the wiring diagram.
2. All motor stator leads, signal input leads, resolver leads, encoder leads, and tachometer leads must be shielded.
3. Twist all AC leads to minimize electromagnetic emissions (noise).
4. Minimize lead lengths as much as possible.
5. Avoid running signal leads (must be shielded) in close proximity to power leads, motor stator leads, or other sources of electromagnetic noise.
6. Connect the Servo system according to the System Wiring Diagram (A-93231); pay close attention to the grounding scheme.
7. Provide adequate stress relief for cables.



The notes on Amplifier Wiring Diagram (A-93231) give specific wiring details.

Thermal overload protection for the motor is not provided within the power supply or the amplifier and must be provided externally. Refer to the National Electrical Code for proper sizing of overload protection.

With the exception of the hook-up of the motor, the main input voltage, and the main Bus+ and Bus- DC voltage, all interface wiring between the amplifier, power supply, and other equipment is accomplished by using the connectors supplied with the amplifier and power supply units or by using the cable kits available from Superior Electric.

The input/output connections are grouped by connector or terminal block. They are input/output, motor, resolver, AC main power and control voltages, main DC bus, and unregulated DC voltages.

To connect the power bus of the power supply to the amplifiers the following is suggested:

- For the PS08 and PS12-230 module, use 600 VAC insulated 14 AWG or larger wire.
- For the PS20-230 module, use 600 VAC insulated 10 AWG wire.
- For the PS50-230 and PS75-230 module, use 600 VAC insulated 8 AWG or larger wire.

Refer to local electrical codes for proper wire gauge for the applicable current. Captive screws are used in the power terminals of the PS-12, PS-20, and the 6 amp thru the 40 amp amplifiers. Do not attempt to remove these screws to use ring terminals. Use

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Table 2.1. Torque Values

CONNECTING POINTS	SS2000-S 6 to 40 AMP UNITS	SS2000-S 60 to 110 AMP UNITS	PS08, PS12 & PS20	PS50 & PS75
AC Input Screws	12 in. lb.	20 in. lb.	12 in. lb.	20 in. lb.
DC Bus Screws	12 in. lb.	20 in. lb.	12 in. lb.	20 in. lb.
Motor Connecting Screws	12 in. lb.	20 in. lb.		
External Regen Screws			12 in. lb.	20 in. lb.
Ground Screws	12 in. lb.	20 in. lb.	12 in. lb.	20 in. lb.

locking spring terminals similar to Hollingsworth #XSS20945S or #SS20947SF for 16 and 14 AWG wire and #XSS20836 or #SS20832F for 12 and 10 AWG wire. All other signal and control wiring is to be 22-18 AWG. All crimp terminals are provided. If 16 AWG wire is used order Molex #39-00-0078 terminals.

2.7.1 Recommended Torque for Electrical Connections

Table 2.1 displays the recommended torque values for terminal block and grounding connecting points. All torques are measured with the wire or terminal lug underneath the screw head.

2.7.2 Grounding Scheme

To prevent shock hazard to personnel and to ensure proper operation of the servo system, the amplifier, power supply, and the servo motor must be grounded according to National Electric Code (NEC) specifications. Each amplifier and power supply has at least two grounding screws on the front of the chassis.



NOTE

Provisions of the NEC with respect to grounding should be followed. These precautions generally deal with the ground loop currents arising from multiple ground paths. Only <u>one</u> ground path should be used.

One of the screws on the chassis of the power supply should go to earth or machine ground. The other should be connected to the adjacent amplifier ground screw along with the ground wire from the motor. The free ground screw on the amplifier chassis should then be connected to the next amplifier, etc.

For grounding to machine or earth ground, a screw lug should be attached to the ground screw or stud on the power supply or amplifier. A torque of 12 in.lb. for ground screws and 20 in.lb. for ground studs is recommended. Also refer to the National Electrical Code (NEC) or UL standard 486B for recommended torque's.

2.7.3 Connecting the AC Input Voltages

The Main AC Input Voltage, either single- or three-phase, should be connected at L_a, L_b, and L_c (L_1, L_2, and L_3 on PS08) on the power terminal block located on the front of the power supply unit. The power supply <u>is not</u> line-phase sensitive. When using the 8, 12 or 20 amp power supply with single-phase main power, the input lines may be connected to any two (2) terminals L_a, L_b, or L_c (L_1, L_2, or L_3 on PS08).

The Control AC input voltage should be wired to Connector C1 - Pins 2 and 3 on the power supply and from Connector C1 - Pins 5 and 6 of the power supply to Connector C4 - Pins 1 and 2 (fan units only) on the amplifier. Do not wire the power supply control lines (C1) through the main power contactor. This is so the control power won't be removed if the power supply fault contact opens.

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NOTE

Connector C4 is present only on Drive Amplifiers that have continuous ratings of 20 amps and above.

2.7.4 Connecting the power supply Fault Output Contact (Connector C1)

NOTE

The Fault contact is not present on the PS08 power supply. Connector C1 on the PS08 is identical to connector C2 on the PS12 - PS75 units.

Pins 1,4 Fault Contact

The Fault Output Contact closes when power is applied to the power supply. This contact opens on a fault condition within the power supply only.

The pinouts for C1 are listed in Figure 2.2.

CAUTION

The power supply fault contacts (rated 115 VAC 1 Amp) must be wired in series with the overload relay as shown on the System Wiring Diagram (A-92231). The PS12 & PS20 contact is normally open and will close within 250 ms, after application of control and main power. The contact OPENS in fault conditions. The PS50 & PS75 contact closes on application of control power and will OPEN in a fault condition

2.7.5 Connecting the Unregulated DC Voltage to the Amplifier (Connector C3)

The wiring between the amplifier Connector C3 and the power supply Connector C2 (unregulated voltage) is in Table 2.2 and the pinouts are in Figure 2.3.

2.7.6 Connecting the Main DC Bus Voltage

Refer to section 2.7 for details concerning the hook-up of the Bus + and Bus - circuits between the power supply and the amplifiers. Fuses for main power should be a U.L. rated, time delay type, such as the Buss FRN-R Series.

WARNING

Failure to observe correct polarity will result in damage to the power supply and Amplifier.

2.7.7 Connecting the External Regeneration Resistor(s)

If an external regeneration resistor is specified, connecting points are provided on the Power Supply Unit .

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Table 2.2. Amplifier Unregulated DC Voltages (C3)

VOLTAGE	CURRENT	AMPLIFIER CONNECTOR C3 PINS	POWER SUPPLY CONNECTOR C2 (C1 on PS08) PINS
+18 V Nominal (+17 V to +26.5 V)	NO LOAD	1, 5	1, 5
-18 V Nominal (-17 V to -26.5 V)	NO LOAD	2, 6	2, 6
COMMON	---	3, 7	3, 7
10 V Nominal (+9 V to +14 V)	NO LOAD	4, 8	4, 8
+ 14.5 V MIN.	1 AMP ON 8,12, OR 20 AMP POWER SUPPLY UNITS 2 AMP ON 50 OR 75 AMP PS UNITS	1, 5	1, 5
- 14.5 V MIN.	1 AMP ON 8, 12, OR 20 AMP POWER SUPPLY UNITS 2 AMP ON 50 OR 75 AMP PS UNITS	2, 6	2, 6
COMMON	---	3, 7	3, 7
+ 6.5 V MIN.	2 AMP ON 8, 12 OR 20 AMP POWER SUPPLY UNITS 4 AMP ON 50 OR 75 AMP PS UNITS	4, 8	4, 8

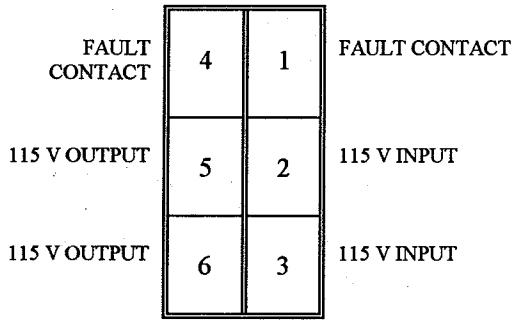


Figure 2.2. Power Supply (C1) Except PS08

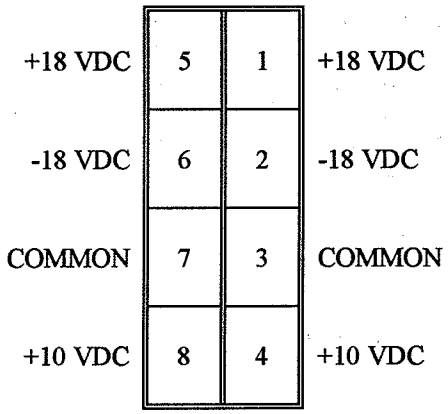


Figure 2.3. Amplifier (C3) , PS12-PS75 Power Supply (C2), & PS08 (C1)

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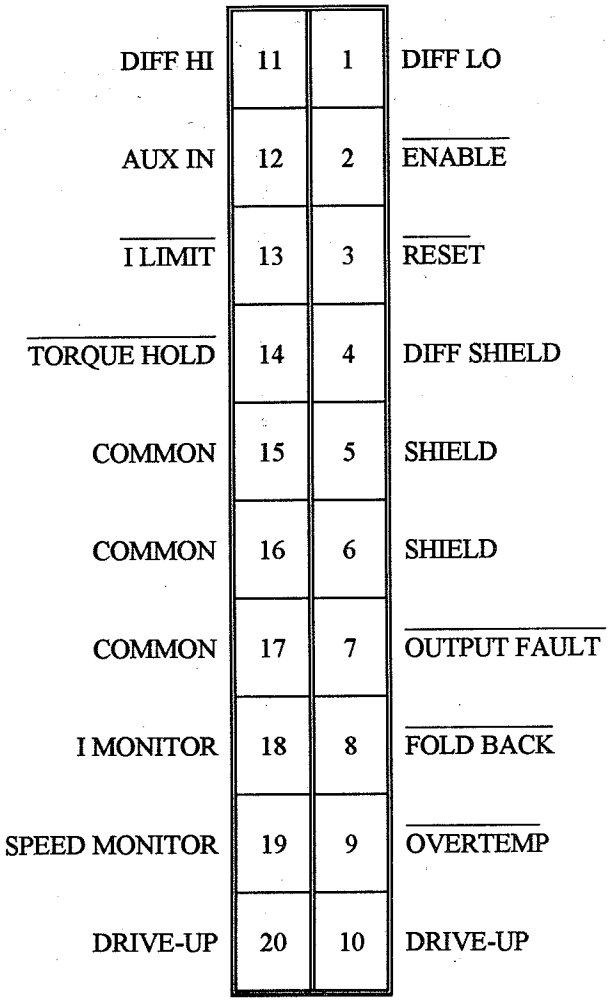


Figure 2.4. Amplifier Connector (C1)

2.7.8 Connecting the Amplifier Input/Output (Connector C1)

The following descriptions tell the user which inputs and modes of operation are available, enable the user to identify the appropriate connecting points on Connector C1, and help the user decide which inputs and modes of operation to use. The pinouts are listed in Figure 2.4.

Pins 15,16,17 Common

These pins provide commons (returns) between external equipment (numerical controls, etc.) and the amplifier.

Pins 4,5,6 Shield

These pins provide termination points for cable shields. To insure there are no ground loops in the shield common, connect only one end, butt and insulate the other end.

Pin 11 DIFF CMD HI

Pin 1 DIFF CMD LO

Differential velocity or current command input ±10 V full scale, 20 K Ohm input impedance. Should be shielded.

Pin 2 $\overline{\text{Enable}}$

Allows the amplifier to be enabled or disabled without removing the main power. When a circuit is closed between Pin 2 and common, the amplifier will be put into the Drive-Up mode. Opening the circuit puts the amplifier into the Inhibit mode [internal 20 K Ohm pull-up resistor to +12 VDC] (Green LED indicated).

Pin 3 $\overline{\text{Reset}}$

Allows any latched fault circuit except OVERVOLTS or OVERCURRENT faults to be reset by toggling Pin 3 to common. It has a 20 K Ohm pull-up resistor to +12 VDC.

Pin 7 $\overline{\text{Output Fault}}$

Open collector signal (logic low) to indicate that either an overcurrent or overvoltage fault has occurred in the Power Stage of the amplifier. 25 ma sink capabilities, 30 VDC Max (red LED indicated).

Pin 8 $\overline{\text{Foldback}}$

Open collector signal (logic low) to indicate that the amplifier has started to reduce peak current due to excessive loading, 25 ma sink capabilities, 30 VDC max (red LED indicated).

Pin 9 $\overline{\text{Overtemp}}$

This output will transition low to indicate the amplifier is being subjected to an excessive temperature condition. Open collector, logic low, 25 ma sink capability, 30 VDC max (red LED indicated).

Pins 10,20 $\overline{\text{Drive-Up}}$

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The Drive-Up contact closure (internally) indicates to the outside world that the amplifier is in the Drive-Up mode; or when the contact is open, it indicates the Inhibit mode. The contact is rated at 115 VAC at 2 amps (green LED indicates amplifier Ready).

The Drive-Up relay acts in conjunction with the Enable circuit in one of two possible modes of operation as determined by optional jumper J21. To determine which mode of operation is being utilized, refer to J21 on the TEST LIMITS SHEET.

1. Drive-Up Mode

J21 is not installed on the Compensation Board.

Apply power.

When the Enable input circuit is activated (pulled low), the internal Drive-Up contact will close and the green Drive Ready LED will become illuminated. However, when the Enable input circuit is not activated, or a fault occurs, the internal Drive-Up contact will be open and the green Drive Ready LED will be off indicating that the amplifier is in the Inhibit Mode.

If a fault occurs within the amplifier, the Drive Ready LED will turn off and the Drive-Up contact will open and remain open regardless of the state of the Enable input circuit.

2. O.K. to Enable/Drive-Up Mode

JR21 is installed on the Compensation Board (Standard).

Apply power.

When there are no faults present, the internal Drive-Up contact will be closed and the green Drive Ready LED will be illuminated indicating that the amplifier is OK-TO-ENABLE. However if there is a fault present, the Drive-Up contact will be open and the Drive Ready LED off indicating that the amplifier is in a fault mode. In this case, activating the Enable input circuit will not enable the amplifier.

Pin 12 Aux IN

This is an additional single ended input to the velocity loop. This input may be used in adaptive mode applications or used as the tach input for integrally motor-mounted tachometer generators.

Pin 13 I Limit

The Current Limit input allows access to the Current Limit circuitry providing a means by which inputs may be applied for adaptive control applications.

This single ended input may also be used to adjust the peak current limit of the amplifier from 7.5% to 100% of its rating. A positive voltage from 0 VDC to 7.5 VDC corresponds to 7.5% to 100% respectively. Also, a resistor to common may be used to program the current limit with 75% of I peak = 8.6 K Ohm, 50% of I peak = 3.3 K Ohm. The Current Limit Adjustment Pot may also be used to adjust the peak torque of the motor to the desired level.

Pin 14 Torque Hold

The amplifier may be converted from a constant velocity amplifier to a constant torque amplifier (at stall only) by closing a circuit between Pin 14 and common (via internal 20 K Ohm pull-up resistor). The velocity loop operational amplifier is maintained at unity gain while in this mode of operation.

Pin 18 I Monitor

There is a direct relationship between the signal appearing at this output and actual motor current. A DC voltmeter placed between Pin 18 and common, calibrated in either current or torque, can be used to estimate the constant load levels placed on the motor. The current scale factor at Pin 18 is 8V = Peak RMS current rating of the amplifier (3 K Ohm output impedance). This output is for reference only. Its accuracy decreases as current decreases: ± 4% at peak current, ± 9% at continuous current, ± 12% at 1/2 continuous current.

Pin 19 Speed Monitor

There is a direct relationship between the signal appearing at this output and actual motor speed. A DC voltmeter (or other instrument) placed between Pin 19 and common, calibrated in RPM, can serve as a means by which speeds may be monitored. Refer to the TL Sheet for the scale factor in volts/RPM (8 volts = maximum speed) as listed on the TL Sheet for the particular motor/amplifier combination (3K Ohm output impedance).

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2.7.9 Connecting the Motor

NOTE

S SERIES MOTORS have a thermostat switch wired to the resolver connector at the motor.

CAUTION

The motor thermostat switch is an automatic resetting device and should be connected directly into a latched (locked out) power down type circuit.

WARNING

Incorrect motor resolver phasing can cause erratic operation, runaway, or damage to the system.

Terminate Pins A, B, C, D, E, and F of the resolver connector at Connector C2 on the amplifier as shown by Figures 2.5, 2.6 and Table 2.3. Also see the Amplifier Wiring Diagram (A-93231) and the appropriate motor HD (hook-up) drawing or Motor Connection Diagram (A-63542). Use cables with three (3) independently shielded pairs for the resolver. All shields must have continuity for the entire length of the cable.

The leads of the three-phase synchronous motor are brought out to Pins A, B, and C of the motor connector. Pin D is ground for the motor. Refer to Figure 2.7 for pin connections.

SIN HI	7	1	SIN LO
SIN SHIELD	8	2	COS SHIELD
COD HI	9	3	COS LO
REF LO	10	4	REF HI
SPARE SHIELD	11	5	REF SHIELD
N/C	12	6	N/C

Figure 2.5. Amplifier (C2)

Terminate Pins A, B, and C of the motor connector to Ma, Mb, and Mc, respectively, on the power terminal block located on the front of the amplifier. Terminate Pin D at the amplifier chassis ground screw. Refer to Wiring Diagram A-93231 and the appropriate motor HD (hook-up) drawing.

The optional integrally-mounted tachometer is brought out to Pins R and S on the resolver connector. Pin R (Tach Hi) should be terminated at Connector C1 - Pin 12 (Aux In) of the amplifier. Pin S (Tach Lo) should be terminated at Connector C1 - Pin 15 (common) of the amplifier. The tachometer is an option and is not installed on most motors.

2.8 INSTALLATION CHECKLIST

Refer to Amplifier Wiring Diagram A-93231.

Before applying power to the power supply and amplifier, check the following items to ensure proper operation:

CAUTION

To prevent damage to the equipment, the motor and resolver, the AC line voltage, and the DC bus voltages must be connected as indicated by Amplifier Wiring Diagram A-93231.

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2.8.1 Checking the Motor and Resolver Wiring

Disconnect both the motor stator and resolver connectors from the motor. Using an ohmmeter, check the continuity of each motor stator lead between the motor stator connector pin and the amplifier. Using an ohmmeter, check the continuity of each motor resolver lead between the motor resolver connector pin and the amplifier. The motor stator and resolver leads should be connected according to Amplifier Wiring Diagram A-93231. There are no other options for connecting the motor stator and resolver leads.

2.8.2 Checking the AC Line Voltages

Open the circuit breaker or remove the fuses in the Main AC lines that are connected to the power supply at L_a, L_b, and L_c. Remove Connector C1 from the power supply, and remove (if present) Connector C4 from the amplifier.

Apply only the AC main power. Use an AC voltmeter to check and record the 1- or 3-phase line-to-line voltage at the circuit breaker or fuse holders. Remove power. Note the model number of the power supply and refer to Appendix A to confirm the correct Main AC voltage level.

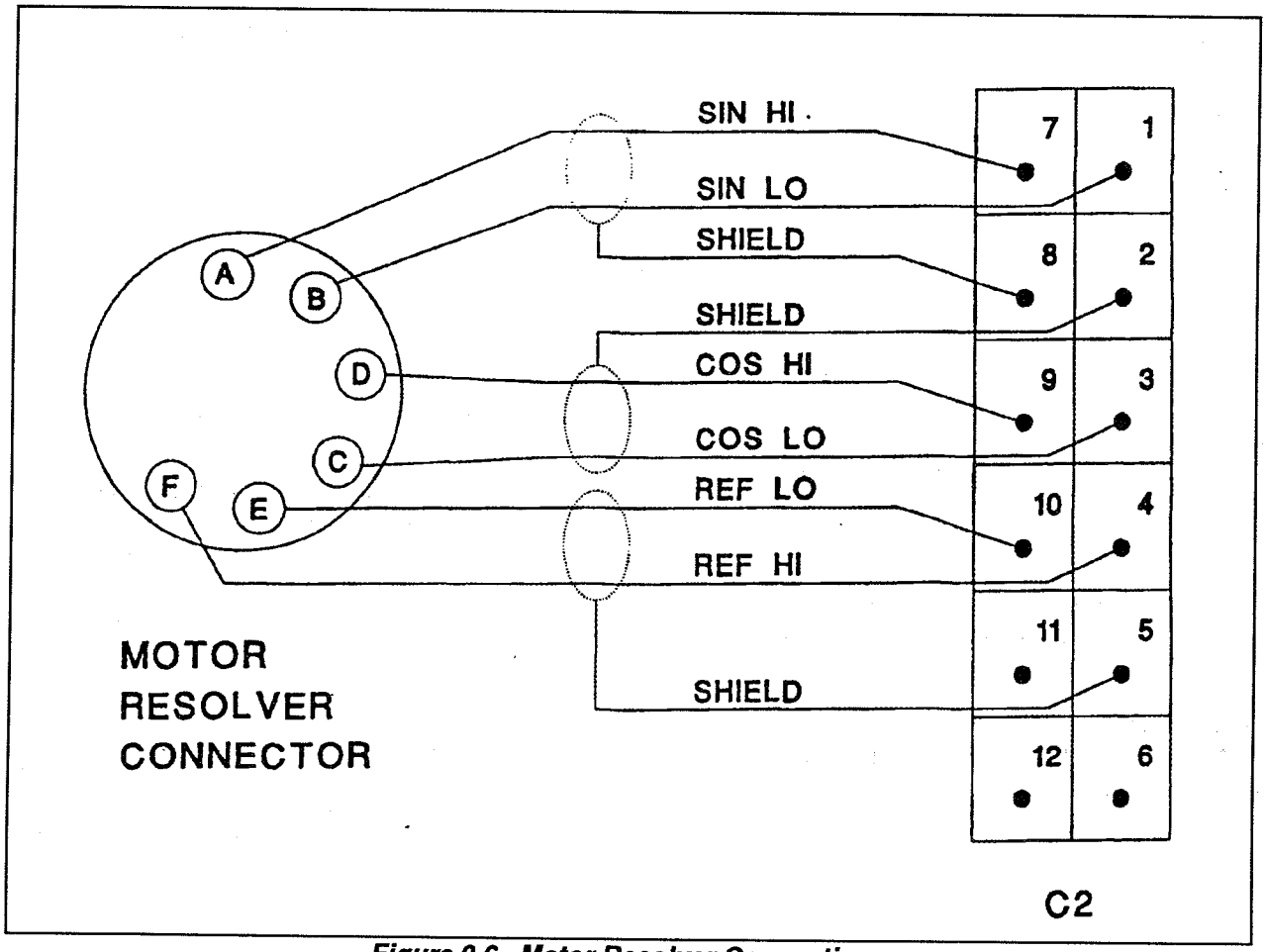


Figure 2.6. Motor Resolver Connections

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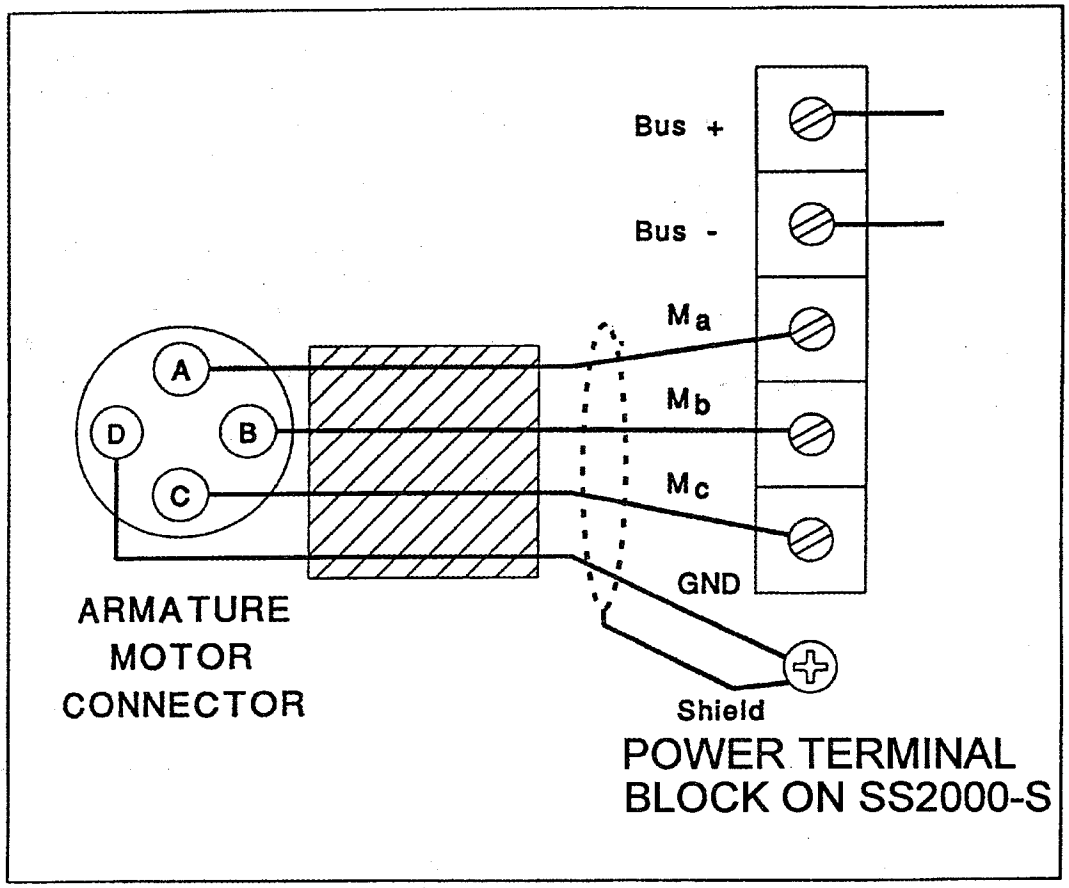


Figure 2.7. Armature Motor Connections

Apply only the AC control power. Use an AC voltmeter to check and record the single-phase voltage at Connector C1 of the power supply. Remove power. Note the model number of the power supply and refer to Appendix A to confirm correct Control AC voltage level.

If the voltage levels are within the specifications listed in Appendix B, proceed with the Check-Out procedure.

Close the circuit breaker or re-install the fuses for the Main AC input power. Re-install Connectors C1 and C4 (if present).

2.8.3 Checking the DC Bus Voltages

WARNING

Allow sufficient time (after removing power from the system) for the voltage to bleed down before connecting or disconnecting wires at the bus.

Remove power.

Remove the Bus+ and Bus- leads from the power supply power terminal block. Remove mating Connector C2 from the power supply.

Apply power.

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Check and record the Main DC Bus Voltage output at (+) with respect to (-) on the power supply terminal block according to Section 2.1. Check and record the unregulated DC voltage levels at Connector C3 of the power supply. They should be ± 17 to 26.5 and + 9 to 14.5 VDC per Section 2.7.5.

Remove power.

Note the model number of the power supply and refer to Section 2.1 to confirm DC voltage levels.

If the voltage levels are within the specifications listed in Appendix B, proceed.

WAIT FOR THE BUS TO BLEED DOWN and reconnect the B(+) and B(-) leads to the power terminal block of the power supply. Be careful to reconnect the leads with the proper polarity. Re-install Connector C2 on the power supply.



Failure to observe correct polarity will result in damage to the Power supply and Amplifier.

Table 2.3 Motor Connections

Motor Connections	Amplifier Connections		Resolver Cable with Thermostat (CA-XX\R-Y-ZZ)	Resolver Cable with Thermostat & Brake (CA-XX\RB-Y-ZZ)	Resolver Cable with Thermostat, Brake & Tach (CA-XX\RBT-Y-ZZ)
	C2	C1	Wire Color	Wire Color	Wire Color
Terminal A	7		RED	RED	RED
Terminal B	1		BLACK	BLACK	BLACK
N/C	8		SHIELD	SHIELD	SHIELD
Terminal C	3		WHT/YEL	GREEN	GREEN
Terminal D	9		WHT/GRN	BLACK	BLACK
N/C	2		SHIELD	SHIELD	SHIELD
Terminal E	10		WHT/RED	WHITE	WHITE
Terminal F	4		WHT/BLK	BLACK	BLACK
N/C	5		SHIELD	SHIELD	SHIELD
Terminal N	Customer			BLUE	BLUE
Terminal P	Brake		N/C	BLACK	BLACK
N/C	Hook-up			SHIELD	SHIELD
Terminal S		Tach. pin 16		NOTE	BLACK
Terminal R	N/C	Tach. pin 12	N/C	SEE	BROWN
N/C		Tach. pin 5		#1	SHIELD
Terminal T	Customer		GREEN	YELLOW	YELLOW
Terminal U	Thermostat		WHITE	BLACK	BLACK
N/C	Hook-up		SHIELD	SHIELD	SHIELD

Note 1: Resolver end; cut-off remaining pair 0.5" (12.7 mm) from cable jacket and fold back over jacket, place under heat shrink. Motor end; cut-off remaining pair flush with cable jacket.

XX = Applicable motor type number (first 5 digits of the motor number, example, 0921M).
Y = Cable termination at amplifier end of the cable, C = connector, N = leads.
ZZ = Cable length in meters, 3 to 75 meters in 3 meter increments.

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CHAPTER 3

OPERATION

3.1 INTRODUCTION

The information in this chapter will enable you to become familiar with system components and their dependence upon one another. Also, it will help you ensure each component is configured and functions properly. At this point, all safety stops and other precautions should be in place and working properly. Be prepared to stop the machine if necessary.

3.2 INITIAL START-UP

You should now be ready to supply power to test the servo systems functions and features. Work with only one axis section at a time. Confirm all other amplifiers are inhibited, meaning the enable circuits are open (high).



Incorrect servo-to-position loop phasing can cause excursion oscillations, or runaways.

Appropriate precautions should be taken to stop the machine if necessary. Limit switches and safety devices should be in place.



Unloaded motors, compensated for a large inertia mismatch, may become unstable when the system is activated. Refer to the test limits (TL) sheet for stable load inertia range. If the system becomes unstable, remove the power immediately.

3.3 SEQUENCE OF OPERATIONS

This section contains a basic start-up sequence that should be followed the first time the servo system is initialized. READ THIS ENTIRE SECTION BEFORE PERFORMING ANY OF THESE PROCEDURES. When you apply power to the system, pay special attention to the LEDs on the amplifier front panel. The CONTROL VOLTS and DRIVE READY (green) LEDs should be illuminated. This indicates that the system is functioning properly. Should a FAULT (red) LED remain on for more than a instant, immediately disconnect power and consult Chapter 5 - Troubleshooting.

1. Apply power. Enable only one amplifier. Observe the action of the machine. If the direction of the motor shaft rotation is reversed

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(motor shaft turns in the wrong direction), remove power.

2. Reverse the input to the amplifier at DIFF CMD HI and DIFF CMD LO at Connector C1, Pins 1 and 11. **DO NOT ATTEMPT TO REVERSE DIRECTION OF ROTATION BY INTERCHANGING MOTOR LEADS AND/OR RESOLVER LEADS.**



If the motor is commanded to move and does not respond, turn the command scale adjustment several turns CW.

If the servo system performed properly, then read Chapter 4 - Maintenance for adjustments and other information that may be helpful in adapting your system to your own applications.

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CHAPTER 4

MAINTENANCE

4.1 INTRODUCTION

The information in this chapter will enable you to maintain the systems components ensuring smooth, efficient operation of the motor. Adjustments to the system are broken in three (3) categories: Set-Up, Response and Application Dependent, and Design Tolerance. These adjustments allow the user to tailor the amplifier to their specific applications.

4.2 PREVENTATIVE MAINTENANCE


CAUTION

Preventative maintenance to this equipment must be performed by qualified personnel familiar with the construction, operation, and hazards involved with the application.


CAUTION

Electronic components in this Amplifier are static sensitive. Use proper procedures when handling component boards.

Preventative maintenance should be performed with the amplifier system out of operation and disconnected from all sources of power.

4.2.1 Transient Voltages


NOTE

All transient-producing devices must be properly suppressed.

Solid state controls of the amplifier may be affected by transient voltages. These voltages are in excess of the specified voltage for any given circuit. When these peak voltages occur, even for less than a second, permanent damage to the amplifier can occur.

In order to help avoid transient voltages that may interfere with electronic circuit functions within the power supply and amplifier, all switched inductive devices or their wiring (solenoids, relay coils, starter coils, etc.) must be suppressed. A 220 ohm, 1/2 watt resistor in series with a 0.5 micro farad, 600 volt capacitor or equivalent is suggested.

4.2.2 Surge Current

Excessive current greater than that of the specified limits of the power supply and amplifier can cause permanent damage to the system. Current limiting means are recommended to protect from these currents.

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If the short circuit inrush current generated by the power source is in excess of 5000 amps RMS symmetrical current, an isolation transformer or line inductor must be utilized in the incoming power circuit. Failure to observe this precaution could result in damage to, or destruction of the Power supply and Amplifier.

Input transformers step up or step down input voltage and can be either auto transformers or isolation transformers. Isolation transformers help eliminate the following:

- Damaging AC line voltage transients reaching the power supply and amplifier.
- Damaging currents which may develop if a point inside the power supply or amplifier becomes grounded.

4.2.3 Electrical Noise

The low levels of energy in the amplifier control circuits may cause them to be vulnerable to electrical noise. Sources of electrical noise are those pieces of equipment that have large, fast changing voltages and currents when they switch on and off. These devices have the capability of inducing critical current and voltage transients on their respective power lines. These transients must be accommodated for with noise immunity provisions.

Electrical noise is prevented with the same methods as Surge Current and Transient Voltages. However, there are other methods of preventing electrical noise. Such as:

- Maintain physical separation between electrical noise sources and the amplifier.
- Maintain physical separation between electrical noise sources and the amplifier control wiring. This can be accomplished by using separate conduits or wiring trays for control wiring and power wiring.
- Use twisted-pair wiring for control circuits of the amplifier.
- Follow good grounding practices when wiring the power supply and amplifier. Be careful not to create a grounding loop with multiple ground paths. Follow the NEC's provisions on grounding.

4.2.4 Radio Frequency Energy



This equipment generates radio frequency energy.

This equipment uses, and can radiate radio frequency energy and must be installed and used in accordance with this installation and service manual in order to prevent possible interference with radio communications or other electronic equipment.

4.3 PERIODIC MAINTENANCE

Periodic maintenance must be performed by qualified personnel familiar with the construction, operation, and hazards involved with the amplifier and its application. Power should be disconnected during all maintenance procedures.

4.3.1 Ventilation

The power supply and amplifier should be mounted vertically to allow maximum ventilation of the components. This configuration allows the heat generated by the components to vent through the top and draft in cooler air through the bottom. The top and bottom of the components are vented to allow this drafting to occur. These ventilation passages should be kept open. If the power supply requires auxiliary cooling with fans, inspect the fans on a regular basis.

4.3.2 Grounding Integrity

The method employed for grounding or insulating the equipment from ground should be checked to assure its integrity on a regular basis. This check

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should be performed with the power off and the testing equipment grounded.

4.4 ADJUSTMENTS



If the amplifier is equipped with a Torque input personality module (standard) no adjustments are required.



Adjust pots with proper adjustment tool.

DO NOT FORCE.

The adjustments are classified into three categories:

1. Set-Up Adjustments - Adjustments that are necessary at installation (accessible at the front of the amplifier).

   Motor System Resolver Phasing and Alignment - Should be checked the first time (if Superior Electric cables are not used).

   Balance Adjustment.

   Command Scale Adjustment.

2. Response and Application Dependent Adjustments - These adjustments add versatility to the amplifier and allow it to be "tailored" to specific applications (accessible at the front of the amplifier).

   Stability Adjustment.

   Current Limit Adjustment.

3. Design Tolerance Adjustments - Factory set and sealed adjustments should never require customer adjustment (internal adjustments).

   Current Sensor Offset Adjustments - Pots AZ and CZ.

   Resolver Excitation Adjustment - Pot OSCG.

   FACTORY ONLY ADJUSTMENTS - Pots R/DTR, R/DG, and R/DZ.

4.4.1 Set-Up Adjustments

At equipment start-up, make these adjustments.

4.4.1.1 Balance Adjustment (Within Position Loop)

If a monitor or readout displays Following Error, adjust Balance Pot for zero Following Error at zero speed.

Optional: Monitor DIFF CMD HI with respect to DIFF CMD LO with a DC voltmeter. Command zero speed from the Numerical Controller. Adjust Balance Pot for zero volts on the meter.

4.4.1.2 Balance Adjustment (Automatic or Manually Operated Machines)

Monitor DIFF CMD HI with respect to DIFF CMD LO with a DC voltmeter. With the input signal at zero volts or with the input shorted to common, adjust Balance Pot for zero speed.

4.4.1.3 Command Scale Adjustment (Within Position Loop)

If the following error is displayed by monitor or readout, command a slow feed rate and adjust Command Scale Pot for the proper amount of Following Error at that speed.

4.4.1.4 Command Scale Adjustment (Automatic or Manually Operated Machines)

Turn the Command Scale Pot fully CCW. Apply an input signal level which equals maximum desired motor speed in RPM. Adjust Command Scale Pot CW for maximum desired motor speed. **DO NOT EXCEED THE MAXIMUM MOTOR SPEED THAT IS LISTED ON THE TL SHEET FOR THE SYSTEM.**

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Refer to the Test Limits Sheet (TL) to identify the maximum scaling of input signal. Maximum ± 10 volts is standard.

4.4.2 Response and Application Dependent Adjustments

These adjustments allow versatility in altering the dynamic response of the amplifier system as needed.

When altering the response of the system, it may be necessary to adjust both the STABILITY and the CURRENT LIMIT adjustments.

4.4.2.1 Stability Adjustment

In many cases, the Stability Pot will not need to be adjusted and may be left in its fully CCW position.

However, this pot can be used to improve the dynamic response of the servo loop, by adjusting the Dynamic (AC) Gain. To adjust the AC Gain to the proper point, use an oscilloscope to monitor the internal tach signal at the SPEED MONITOR test point with respect to A-COM (refer to Figures 1 and 3). Use a second channel of the scope to monitor the current signal at the I MONITOR test point, also with respect to A-COM (refer to Figures 1 and 3). Turn the STABILITY Pot fully CCW. Apply a step input (rapid) command signal. While accelerating and decelerating the motor at approximately 25% of maximum speed, adjust the STABILITY Pot CW and notice the tach and current wave forms at the SPEED MONITOR and I MONITOR test points. Watch for indications of instability (i.e., ringing) in the wave forms while accelerating and decelerating the motor. Turn the STABILITY Pot CCW until the tendency to go unstable disappears.

4.4.2.2 Current Limit Adjustment

The maximum peak current limits are set at the factory and can not be increased above the level listed on the Test Limits sheet (TL). Although the peak current limits cannot be increased above the specified value, they may be decreased.

To reduce the peak current limit level, apply a step input command signal. Use an oscilloscope to monitor the I-MONITOR test point (refer to Figures 1 and 3). Accelerate and decelerate the motor. Adjust the CURRENT LIMIT Pot for desired peak current limit. The current scale factor at the I MONITOR test point is 8V = Peak RMS rating of the amplifier (refer to Section 2.2 for Peak Rating and Section 4.1 for more information on this signal).

4.4.3 Design Tolerance Adjustments

(Factory Set and Sealed)



These adjustments should not be made in the field. They have been factory set and sealed and should never require adjustment.

The following procedures are to be followed only if the seals are broken.

4.4.3.1 Resolver Excitation Adjustment

Inhibit the amplifier by opening the Enable input circuit.

Using an oscilloscope, monitor REFERENCE HIGH at TC2-1 (refer to Figure 1 or 3). Adjust Pot OSCG (inside the amplifier) for 12 volts peak-to-peak. This signal should be 7.0 kHz ±500 HZ.

4.4.3.2 Current Sensor Offset Adjustments

Using a digital DC voltmeter, monitor TC4-1. Adjust Pot AZ (inside the amplifier) for minimum voltage level. Using the digital voltmeter, monitor TC4-3 and adjust Pot CZ (inside the amplifier) for minimum voltage level.

4.4.3.3 Motor System Resolver Alignment



This procedure applies only to the system resolver, not the application (position loop) resolver.

The motor system resolver is properly aligned at the factory and should never require realignment. However, this procedure is included here in the event

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(motor repair, etc.) the resolver should ever need realignment.

In order for the following test to be valid, the motor and resolver phasing must be correct. If there is any doubt as to whether the motor and resolver are wired correctly, refer to Section 4.6 and check the motor and resolver wiring.

The motor system resolver alignment can be confirmed by conducting the following test:

1. Remove power. Disconnect the motor shaft from any mechanical load.

2. Connect a small jumper between TC1-3 and TC1-4 (refer to Figures 1 and 3). While in this mode (resolver zeroing test mode), the FOLDBACK LED will become the resolver alignment indicator.

3. Apply power. DO NOT ENABLE THE amplifier. If necessary have a colleague observe the FOLDBACK LED. The FOLDBACK LED will be either off or slowly blinking. Slowly rotate the motor shaft until the FOLDBACK LED blinks at its fastest rate (rotate slowly then pause, giving the circuitry time to react). The closer the resolver is to being correctly aligned, the faster the LED will blink. The LED should be somewhere between one pulse per second and fully illuminated when it blinks at its fastest rate.



Remove hand from motor shaft before enabling. The shaft will jerk into position with some force.

4. Enable the amplifier by pulling Connector C1-Pin 2 on the amplifier to common. The internal software of the amplifier will cause phase M_a to have zero current. The M_b and M_c phases will have equal, but opposite, currents causing the motor shaft to align itself in a neutral position. The FOLDBACK LED should be fully illuminated indicating correct alignment of the resolver. No further attempt at alignment is necessary. Resolver alignment is correct.

5. If, however, the LED does not become fully illuminated as indicated in Step 4 above, proceed with the alignment procedure.

   Inhibit the amplifier.

   Remove power.

   Remove the end plate (cover) from the rear end of the motor. The shaft-mounted frameless resolver will be in sight.

   The frameless resolver rotor is slid forward onto the motor shaft and secured by a large lock nut. This part of the resolver should not be disturbed.

6. Loosen, but do not remove, the two servo clamp screws holding the resolver stator secure. DO NOT MOVE THE POSITION OF THE MOTOR SHAFT.

7. Apply power. If necessary, repeat Step 3 above. Enable the amplifier. Slowly rotate the resolver stator (outside element) while a colleague watches the FOLDBACK LED on the front of the amplifier.

   If the LED does not become fully illuminated, turn the resolver stator in the opposite direction. Continue to rotate the resolver stator until the LED becomes fully illuminated. If the correct alignment position is passed, the LED will blink more slowly. When the LED becomes fully illuminated, discontinue turning the resolver stator and tighten the two servo clamp screws.

   Inhibit the amplifier.

   Remove power.

8. Repeat Steps 3 and 4 above.

9. Inhibit the amplifier.

   Remove power.

   Remove the jumper from the test points.

   Replace the motor end cover.

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4.4.3.4 Factory Only Adjustments



Do not adjust Pots R/DTR, R/DG, and Pot R/DZ. These pots are set and sealed at the Factory and cannot be adjusted in the field. If these pot seals are ever broken, return the complete Amplifier to the Factory for alignment.

The Factory Only Adjustments are not intended, nor should they be used by personnel not employed by Superior Electric.

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CHAPTER 5

TROUBLESHOOTING

5.1 INTRODUCTION

The information in this chapter will enable you to isolate and resolve common system hardware problems. The troubleshooting methods in this manual isolate each component from the system until the problem is resolved.

5.2 FIELD SERVICEABILITY

CAUTION

Dangerous voltages exist in this equipment. Also, motor temperature may exceed 100°C. Extreme caution should be exercised when troubleshooting this equipment. Only qualified individuals should attempt to install, setup, operate, or troubleshoot this equipment.

The amplifier and power supply are designed to promote minimum down time situations. Due to the compact package size and to the fact that there are few user-serviceable components on the modules, it is recommended that they be replaced if they cease to function properly. Return the modules, in their entirety, to Superior Electric for repair.

The only user-serviceable items on the power supply are the output line fuses in the control DC voltage supply and (in the 12 and 20 amp units) the shunt regulator regeneration load resistor fuse.

CAUTION

To preserve the level of protection for the product as designed, replacement fuses must be the exact same style and ampere rating as those originally installed.

The amplifiers may be interchanged, provided the following guidelines are adhered to:

1. The amplifiers must be the same rating.
2. The motors being controlled must bear the same model number.
3. In the event the motors have different model numbers, the Compensation Board must bear the model number of the motor being controlled or the Compensation Board must be altered, per TL (Test Limits Sheet) to make the amplifier compatible with the motor.

Before beginning the troubleshooting process, consider the following points:

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I. There are four (4) distinct areas within which a fault may occur:

   A. External Interface (Circuitry external to, but connecting to, the amplifier.)

   B. SS2000-S Amplifier Module

   C. Power Supply Module

      1. Main DC bus voltage

      2. Control DC bus voltages

      3. Shunt Regulator Regeneration Circuitry

      4. Soft-Start/Dynamic Bus Discharge Circuitry

   D. Motor

      1. Resolver

      2. Tachometer (Optional)

II. There are only two (2) basic fault characteristics to be considered:

   A. The motor exhibits very low torque or is totally inoperative.

   B. The motor is erratic or exhibits an improper mode of operation.

5.3 SYMPTOMS AND CORRECTIONS

If the motor does not respond or responds in a manner other than with smooth operation, remove power and troubleshoot the system with the following guidelines. Also refer to Table 5.1 for more improper motor operation symptoms.

5.3.1 The Motor Exhibits Very Low Torque or is Totally Inoperative

Prerequisites for motor movement:

1. The amplifier and power supply must be wired correctly, per the Amplifier Wiring Diagram A-93231.

2. All power must be present.

3. The amplifier must be in the Enable mode, as indicated by the green CONTROL VOLTS, ENABLE, and DRIVE READY LED's.

4. A command signal (other than zero volts) must be present at the input of the amplifier.

5. Command Scale Adjustment should not be fully CCW.

6. Fault circuits must not be activated. Fault modes are identified by red LED's located on the front of the amplifier and power supply modules.

5.3.2 The Motor is Erratic or Exhibits an Improper Mode of Operation.

Prerequisites for proper motor operation:

1. Proper grounding scheme must be provided. The motor ground wire should be connected as shown by Amplifier Wiring Diagram A-93231.

2. Motor armature leads must not be run in conduit or wire ducts with any signal carrying conductors.

3. The resolver leads, tach leads (when used), and motor armature leads must be wired according to Amplifier Wiring Diagram A-93231.

4. The motor system resolver must be set at its zero point (refer to Section 4.4.3.3).

5. Stability Adjustment should not be fully CW.

6. The motor should be loaded with its specified load inertia's — see TL sheet for stable load inertia range. Otherwise, the amplifier may become unstable.

5.3.3 SS2000-S6, 12, 20, 40, 60, 80 and 110 AMP STATUS LED'S

The status of the amplifiers is indicated by three (3) Green and six (6) Red LED's. Refer to Figure 5.1 for

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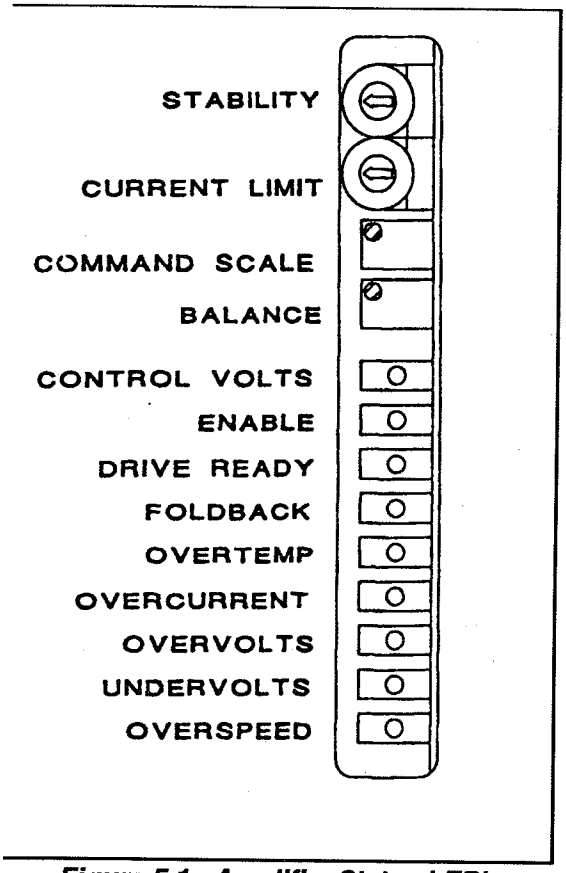


Figure 5.1. Amplifier Status LED's

the LED configuration. The diagnostic information indicated by these LED's is listed as follows:

- Approximately one second after all power is applied, the green CONTROL VOLTS LED on the front of the amplifier module should become illuminated to indicate that the Control AC line input voltage is applied.

- When the Enable input circuit of the amplifier is closed, the green ENABLE LED should become illuminated indicating that the amplifier is now in the enabled mode.

- No fault (red) LED's should be illuminated.

- The green DRIVE READY LED may or may not be illuminated, depending on whether or not jumper J21 is installed on the Compensation Board.

The red FOLDBACK LED will become illuminated during any situation where the RMS current exceeds the continuous rating of the amplifier (peak current is allowed for only 2.0 seconds). The LED indicates that the peak current of the amplifier is automatically being reduced to the RMS continuous rating. Once the current demand is reduced, the FOLDBACK circuit will reset and the LED will turn off. This LED acts only as an indicator.

If the red OVERTEMP LED becomes illuminated, the amplifier will become latched in the Inhibit mode indicating an overheated amplifier heatsink.

When the red OVERCURRENT LED becomes illuminated, it indicates an overcurrent condition usually due to a shorted load (motor), wiring, or amplifier power stage transistor. The amplifier will become latched in the Inhibit mode.

If the red OVERVOLTS LED becomes illuminated, the amplifier will become latched in the Inhibit mode, indicating the presence of excessive main DC bus voltage.

When the red UNDERVOLTS LED becomes illuminated, the amplifier will be put into the Inhibit mode (but not latched) indicating the main DC Bus is insufficient or absent.

If the red OVERSPEED LED becomes illuminated, the amplifier will become latched in the Inhibit mode indicating that the motor has obtained an excessive speed, or the resolver cable is miswired or has an intermittent connection.

The Fault Output contact located within the power supply module will not be affected by any faults occurring within the amplifier.

More diagnostic information about the amplifier is listed in the Table 5.2.

5.3.4 PS08 Status LED

The status of the PS08 module is indicated by one (1) Green LED. The diagnostic information indicated by this LED is as follows:

- Approximately 0.25 seconds after the main power is applied, the green DC BUS LED will become illuminated to indicate the presence of voltage on the main DC bus capacitors. Voltage indication may range in magnitude from over 300 VDC, during normal operation with AC line voltage applied, to below 50 VDC when the

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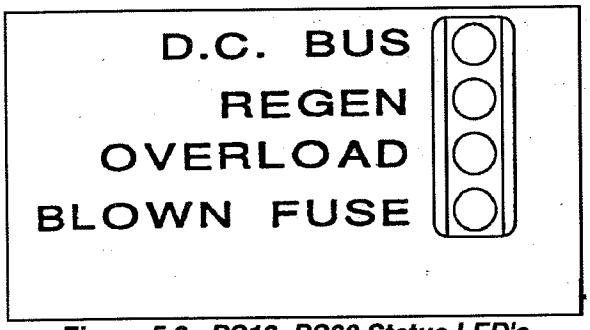


Figure 5.2. PS12, PS20 Status LED's

line voltage is removed but the bus capacitors have not completely discharged.

5.3.5 PS12 and PS20 Status LED's

The status of the PS12 and PS20 modules is indicated by one (1) Green, one (1) Yellow, and two (2) Red LED's. Refer to Figure 5.2 for the LED configuration. The diagnostic information indicated by these LED's is as follows:

- Approximately 0.25 seconds after the main power is applied, the green DC BUS LED will become illuminated to indicate the presence of voltage on the main DC bus capacitors. Voltage indication may range in magnitude from over 300 VDC, during normal operation with AC line voltage applied, to below 50 VDC when the line voltage is removed but the bus capacitors have not completely discharged.
- The yellow REGEN LED is for monitoring purposes only. When this LED becomes illuminated, the shunt regulator regeneration circuit is active. No fault is indicated.
- The red OVERLOAD LED will become illuminated in the event the shunt regulator regeneration circuit experiences an overload condition. The Fault Output contact will also open.
- The red BLOWN REGEN FUSE LED will become illuminated and the Fault Output contact will open in the event the shunt regulator regeneration fuse blows.
- Faults occurring within the power supply will cause its Fault Output contact to open.

More diagnostic information about the PS12 and PS20 LED's is listed in Table 5.3.

5.3.6 PS50 & PS75 Status LED's

The status of the 50 and 75 amp power supplies is indicated by one (1) Green, one (1) Yellow, and one (1) Red LED. Refer to Figure 5.3 for the LED configuration. The diagnostic information indicated by these LED's is as follows:

- Approximately 0.5 seconds after the main power is applied, the green DC BUS LED will become illuminated to indicate the presence of voltage on the main DC bus capacitors. Voltage indication may range in magnitude from over 300 VDC, during normal operation with AC line voltage applied, to below 50 VDC when the line voltage is removed but the bus capacitors have not completely discharged.
- The yellow REGEN LED is for monitoring purposes only. When this LED becomes illuminated, the shunt regulator regeneration circuit is active. No fault is indicated.
- The red FAULT LED, when illuminated, indicates an excessive heatsink temperature within the unit due to an overload condition and may also indicate excessive ambient temperature.
- Faults occurring within the power supply will cause its Fault Output contact to open.

More diagnostic information about the PS50 & PS75 LED's is listed in Table 5..

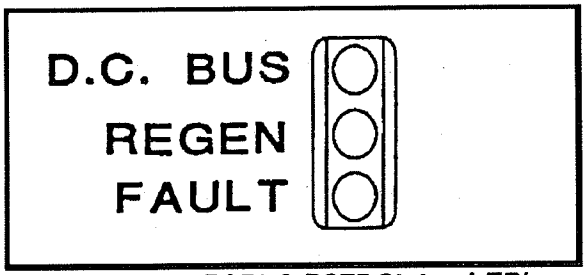


Figure 5.3. PS50 & PS75 Status LED's

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5.3.7 Amplifier or Power supply Reset Procedures

To reset the OVERVOLTS and OVERCURRENT fault latches within the amplifier and all fault latches within the power supply units, remove all AC line input voltage for at least five (5) minutes or until the power stage capacitors are fully discharged. All other fault latches within the amplifiers may be reset by toggling the RESET input circuit to common or as described previously.

The thermal overload relay with the 50 amp power supply External Regen Resistor(s) is normally furnished and set for "HAND" reset operation. In the event of excessive shunt regulator activity, its auxiliary contact will open. (THIS CONTACT MUST BE WIRED INTO THE E-STOP STRING OR AN EQUIVALENT SHUNT DOWN CIRCUIT.) The thermal overload relay may be reset by pushing in the reset rod located in the top of the unit.

Table 5.1. Improper Motor Operation Troubleshooting

SYMPTOM	PROBABLE CAUSE
Incorrect Direction of Motor Shaft Rotation	(a) Invert input command signal at Connector C1-1 and 11.
 CAUTION	**DO NOT ATTEMPT TO REVERSE DIRECTION OF ROTATION BY INTERCHANGING MOTOR LEADS AND/OR RESOLVER LEADS.**
Motor Drifts Slowly with Zero Input	(a) Adjust balance Pot for zero speed (in position loop for zero Following Error or zero input signal).
Uncontrolled Excessive Speed	(a) Motor and/or resolver leads incorrectly connected.
	(b) drive backwards in position loop (motor shaft turns in wrong direction).
	(c) Incorrect alignment of system resolver (refer to Section 4.4.3.3).
	(d) Defective Compensation Board.
Motor Erratic	(a) Motor and/or resolver leads incorrectly connected.
	(b) Incorrect alignment of system resolver (refer to Section 4.4.3.3).
	(c) Improper grounding scheme (noise corrupting the input signal, tach signal when used, and/or resolver signals).
System Unstable	(a) Stability Pot improperly adjusted.
	(b) Unloaded motor (load motor with TL specified load inertia).
	(c) Incorrect compensation. Check Compensation Board against TL Sheet.

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Table 5.2. Amplifier Status LED Indicator Troubleshooting

SYMPTOM	PROBABLE CAUSE
1) Control Volts LED (Green) Not Illuminated	(a) Control AC line input voltage out of spec or had a momentary interruption.
	(b) Unregulated logic bus not applied to the amplifier from the power supply due to defective wiring or being miswired (fuses inside of power supply may be blown).
	(c) Defective logic bus supply in the amplifier or power supply or blown logic bus fuse.
	(d) Defective amplifier.
2) Enable LED (Green) Not Illuminated	(a) Enable input circuit not pulled low.
	(b) Defective amplifier.
3) Drive Ready LED (Green) Not Illuminated	(a) Amplifier faulted (see Red LED's).
	(b) Compensation Board not installed or misinstalled.
	(c) Reset input activated (active low).
	(d) Defective amplifier.
4) Foldback LED (RED) Illuminated	(a) Amplifier in resolver alignment test mode (refer to Section 4.4.3.3).
	(b) Excessive RMS current causing amplifier I^2t protection circuit to activate. Reduce motor duty cycle.
5) Overtemp LED (RED)	(a) Excessive heatsink temperature due to overload or high ambient temperature.
	(b) Defective amplifier.
6) Overcurrent LED (RED) Illuminated	(a) When this LED becomes illuminated, an overcurrent condition [usually due to a shorted load (motor stator winding), shorted stator wiring, or a shorted amplifier power stage component] is indicated. If this LED becomes illuminated, remove the power and disconnect the motor. Reapply power. If the amplifier comes up without this LED becoming illuminated, suspect a faulty motor or motor stator wiring. If the amplifier comes up with the LED illuminated, suspect a faulty amplifier power stage.
7) Overvolts LED (RED)	(a) This LED will become illuminated if the Main DC Bus rises above 230 VDC for 115 VAC system, 430 VDC for the 230 VAC system. This can happen due to power supply fault or inadequately sized shunt regulator regeneration resistor.
8) Undervolts LED (RED)	(a) This LED will become illuminated if the Main DC Bus is insufficient or absent.
9) Overspeed LED (RED)	(a) In the event the motor obtains an excessive speed, the OVERSPEED fault circuit will activate, latch the amplifier in the inhibit mode, and this LED will become illuminated.
	(b) Miswired or intermittent resolver cable.

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Table 5.3. PS08 Status LED Troubleshooting

SYMPTOM	PROBABLE CAUSE
1) DC BUS LED (Green) Not Illuminated	(a) Main DC Bus insufficient or not present. AC input power not applied; check input line fuses.

Table 5.4. PS12, & PS20 Status LED Troubleshooting

SYMPTOM	PROBABLE CAUSE
1) DC BUS LED (Green) Not Illuminated	(a) Main DC Bus insufficient or not present. AC input power not applied; check input line fuses.
2) Regen LED (Yellow) Illuminated or Flashing	(a) Not a fault condition. Indicates regeneration circuit activity.
3) Overload LED (Red) Illuminated	(a) Main DC Bus voltage excessively high due to high Main AC line input voltage.
	(b) Shunt regulator regeneration circuit overload.
	(c) Defective power supply.
4) Blown Regen Fuse LED (Red) Illuminated	(a) Shunt regulator regeneration resistor sized too small.
	(b) Defective power supply.

Table 5.5. PS50 & PS75 Status LED Troubleshooting

SYMPTOM	PROBABLE CAUSE
1) DC Bus LED (Green) Not Illuminated	(a) Main DC Bus insufficient or not present. AC input power not applied; check input line fuses.
2) Regen LED (Yellow) Illuminated or Flashing	(a) Not a fault condition. Indicates regeneration circuit activity.
3) Fault LED (Red) Illuminated	(a) Excessive heatsink temperature due to overload or high ambient temperature.
	(b) Defective power supply.



NOTE

Consult Factory if fault occurs during hard deceleration.

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APPENDIX A

MODEL NUMBERS

Table A.1. Power Supply Model Number Scheme

EXAMPLE:	PS	20 -	230	\XXXX*
LEGEND:	A	B	C	D

LEGEND		DEFINITION
A		Power Supply with Regeneration (shunt regulation) and soft-start. (PS08 contains no regeneration)
B		AC Line Current, RMS. 08,12, 20, 50, & 75 Amps
C		
	230	220 VAC, Single-Phase or 230 VAC, Three-Phase.
	115	115 VAC, Single-Phase input, Special order for PS12 and PS20 power supplies (Leave blank for PS08 which contains selection switch for either 90-130 or 190-260 VAC operation)
D		Electrical Options.
	blank	Standard. No Options. 12 and 20 Amp models contain 40 Watt Internal Regeneration Resistor. 50 and 75 Amp Models require Regeneration Resistor Kit ER-XX (must be ordered separately).
	E400	8.8 Ohms, 400 Watt External Regen, 230 Volt, 12 and 20 Amp Models Only. Requires ER-01 External Resistor Kit.
		5.5 Ohms, 200 Watt, 115 Volt External Regen, 12 and 20 Amp Models Only. . Requires ER-02 Resistor Kit. SPECIAL ORDER, consult Application Engineering at 1-800-SUP-ELEC for information.
	E700	5.8 Ohms, 700 Watt, 230 Volt External Regen, 12 and 20 Amp Models Only. Requires ER-03 External Resistor Kit.

* Omit when there are no options.

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Table A.2. External Resistor Kit Model Number Scheme

EXAMPLE:	ER-	01	XX
LEGEND:	A	B	C

LEGEND	DEFINITION
A	External Resistor Kit for Power Supplies.
B	Resistor Rating.
01	8.8 ohms, 400W, (12 or 20 amp, 230V models only).
02	5.5 ohms, 200W, (12 or 20 amp, 115V models only). SPECIAL ORDER, consult with Applications engineering at 1-800-SUP-ELEC.
03	5.8 ohms, 700W, (12 or 20 amp, 230V models only).
20	4.5 ohms, 500W, (50 or 75 amp, 230V models only).
21	4.4 ohms, 1000W, (50 or 75 amp, 230V models only).
22	2.2 ohms, 1000W, (75 amp, 230V models only).
23	2.2 ohms, 2000W, (75 amp, 230V models only).
C	Options (None Available at this Printing).

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Table A.3. Amplifier Model Number Scheme

EXAMPLE:	SS2000-S	12	R	E	\	0921M	A
LEGEND:	A	B	C	D		E	F

LEGEND	DEFINITION
A	Brushless Servo Amplifier.
B	06, 12, 20, 40, 60, 80, 110 Output RMS Current Per Phase, Peak.
C R K Z	R/D Converter. Standard, High resolution 12 bit R-D converter. Accuracy 22 Arc Min. Maximum. High resolution 14 bit R-D converter. Special..
D E X Z	Electrical Options. Standard Unit. Encoder emulation. No options.. Special. For 115 VAC input units only add (-LV) after electrical option.
E	Motor and Winding Designator. First five digits of the motor part number excluding the initial character, "S".
F A B T	Torque or Velocity Compensation Designator. 1 - 5 X. 6 - 20 X. Torque mode. (standard, required for the MX2000 and all other Superior controls)

Table A.4. Compensation Card Model Designator

EXAMPLE:	CMP-	S12-	0921M	T
LEGEND:	A	B	C	D

LEGEND	DEFINITION
A	Compensation Card.
B	Amplifier Base Model Number excluding the initial, "SS2000-".
C	Motor, Winding, and Compensation Designator. First five digits of the motor part number excluding the initial character, "S".
D A B T	Torque or Velocity Compensation Designator. 1 - 5 X. 6 - 20 X. Torque mode. (standard, required for the MX2000 and all other Superior controls)

A.1 CABLE, BUS WIRE, AND MATING CONNECTOR KIT INFORMATION

Extra or spare bus wire and complete cable assemblies are available from Superior Electric.

Mating connector kits are available from Superior Electric or may be purchased directly from the connector vendor.

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A.2 CABLE MODEL NUMBER SCHEME FOR INDIVIDUAL CABLE SET

Motor cable sets are designed to provide reliable and cost-effective interconnection between Superior Electric's S-series Motors and any SS2000-S amplifier. Each Cable Set provides both a motor (stator) and a resolver (feedback) cable of equal length. Cables include motor mating plugs with various termination options at the amplifier end. To assist in ordering, the model number scheme for a cable set is as follows:

Table A.5. Cable Model Number Scheme for Individual Cable Set

EXAMPLE:	GCS	A-	M2 /	R -	4/5 -	03
LEGEND:	A	B	C	D	E	F

LEGEND		DEFINITION
A		Cable Set. Consists of one motor (stator) and one resolver (feedback) cable.
B		Cable connector (Motor End).
	A	MS type connector with screw threads (not available for S070 size motors).
	R	Right Angle MS type connector with screw threads.
	1	Unterminated (with 18 inch flying leads).
	2	Bayonet style MS connector (available for S070 only).
C		Motor specification number.
	M1	S070-xx
	M2	S092-xx
	M4	S115-xx
	M6A	S142-1x, S142-2L, S142-3L
	M6B	S142-2M, S142-2H, S142-3M, S142-3H
	M8A	S190-1x, S190-2L, S190-2M, S190-3L, S190-3M
	M8B	S190-2H, S190-3H
D		Motor Feedback/Option Cable with Mating Plug (In addition to motor power).
	R	System Resolver Only (standard).
	RB	System Resolver and Brake.
	RT	System Resolver and Tachometer.
	RBT	System Resolver, Brake, and Tachometer.
E		Amplifier Termination.
	4/5	Connector on amplifier end.
	N	Leads on end opposite motor.
		(Note: If N is ordered it is recommended that flying lead resolver cable set be ordered P/N RCK-01).
F		Cable Length to Motor. 3 to 75 Meters (10 to 250 feet) maximum in 3-Meter (10 foot) Increments. (Cable lengths are always defined in meters)

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A.3 SPECIAL CABLE SETS FOR RESOLVER FEEDBACK AND INTERFACE

The special cables are designed to eliminate the need for the customer to make crimp connections for SS2000-S I/O connector (C1) and resolver connector (C2). These cables are terminated at C1 and C2 on the amplifier end and are unterminated at the opposite end. The unterminated end is intended to be connected into a customer-supplied terminal block. To assist in ordering, the model number schemes for these special cables are as follows:

Table A.6. Resolver Feedback and Interface Cable Sets

RCK-1	Resolver feedback cable set. One 10 ft (3m) shielded cable with an amplifier resolver connector at one end and flying leads at the other end.
ACK-10	I/O Cable set. Each set consists of one 10 ft (3m) cable terminated with a molex connector on one end and flying leads on the other (for connector C1 on the amplifier and encoder emulation terminals on the motor), three various sized logic power supply to signal power ribbon cables with molex terminals on each end (connector C3 on the amplifier to C2 on the power supply), and a 10 ft (3m) cable terminated on one end with a molex connector on one end and flying leads on the other end (for fan supply connector C4 ON 40 AMP and larger amplifiers).
AXCK-10	I/O Cable set for use with Control Amplifier (DCS) versions of the Servo amplifier.

A.4 SPECIAL CABLE SETS FOR POWER SUPPLY

Special power supply cable sets are available. The Power supply cable kit includes qty 2 ten foot leads terminated with molex connectors on one end and flying leads on other (connector C1 on power supply). To assist in ordering, the model number scheme for this cable set is:

PSK-1

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A.5 MOTOR MODEL NUMBER SCHEME

Brushless servo motors are available in numerous frame sizes, stack lengths, and winding speed combinations. To assist in ordering, the model number schemes for the S-series servo motors are as follows:

Table A.7. Motor Model Number Scheme

EXAMPLE:	S	092-	1	M -	A	4	B2 *-	XXX*
LEGEND:	A	B	C	D	E	F	G	H

LEGEND	DEFINITION
A	SLO-SYN Brushless servo motor
B	Motor Frame Size (Diameter) in mm.
	070, 092, 115, 142, 190
C	Stack Length.
1	Short.
2	Medium.
3	Long.
D	Winding Speed..
L	Low.
M	Medium.
H	High.
E	Connector Options.
1	Unterminated with 18 inch leads.
A	Screw thread, MS connector less mating plugs (Standard on all motors except S070, S092).
B	Screw thread, MS connector with mating plugs (Available on all motors except S070, S092).
2	Bayonet, MS connector less mating plugs (Standard on S070 & S092 motors).
3	Bayonet, MS connector with mating plugs (Available for S070 & S092 only).
X	Special.
F	Mounting, Shaft extension, and Shaft seal options. All motors are supplied with metric mount and IP65 sealing. Options include:
1	Rear shaft extension, front shaft seal.
2	Front shaft seal, no rear shaft extension (shaft extension required for all tachs, encoders, and resolvers)..
3	Rear shaft extension, no front shaft seal.
4	No rear shaft extension, no front shaft seal (Standard).
9	Special.

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Table A.7. Motor Model Number Scheme (cont.)

G	Standard Option Adders; Brakes, 2nd Resolvers, Encoders, and Tachometers
B2	90 Vdc Brake.
B3	24 Vdc Brake.
B9	Special Brake.
E1	Encoder adapter.
R1	Resolver adapter.
T	Tachometer (Not available on the S070), specify voltage.
H	Three digit special identifier.
XXX	

* Omit when there are no options and/or the motor is not a special.

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APPENDIX B

SPECIFICATIONS

B.1 INTRODUCTION

The Specifications for the power supply and amplifier are provided in this appendix. Derating information is also included for environments with high ambient temperatures. As a general rule, the failure rate of solid state components doubles for every eighteen degrees Fahrenheit (ten degrees Celsius) rise in temperature. This exponential failure rate is strong incentive for lower ambient temperatures.

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Table B.1. Power Supply Specifications

DESCRIPTION	PS08	PS12-230
Main AC Line Input Voltage	95-130 VAC or 190-260 VAC (Switch selectable)	207 - 253 VAC
Phase	1 Phase or 3 Phase	3 Phase
Frequency	47 - 63 HZ	47 - 63 HZ
Current RMS/Phase, Continuous	8 AMPS	12 AMPS
Current RMS/Phase, Peak (2 Sec.)	16 AMPS	24 AMPS
Current RMS/Phase, Peak (50 msec.)	40 AMPS	48 AMPS
Control AC Line Input Voltage	None*	95 - 132 VAC
Phase	None*	1 Phase
Frequency	None*	47 - 63 HZ
Current RMS	0.75 AMPS	1.5 AMPS
Output Power	0.54 K WATTS @ 115 VAC 1 PHASE 2.4 K WATTS @ 230 VAC 3 PHASE	3.6 K WATTS
Volts	140 VDC/310 VDC	310 VDC
Unregulated Logic Bus Output No Load	± 26 VDC MAX + 14 VDC MAX	
Full Load	± 14.5 VDC MIN. @ 0.5 AMPS + 6.5 VDC MIN. @ 0.25 AMP	± 14.5 VDC MIN. @ 1 AMPS + 6.5 VDC MIN. @ 2 AMP
Internal Shunt Regulator, Peak Current	None	32 A
Internal Shunt Regulator, Resistance	None	12.5 OHM
Internal Shunt Regulator, Resistor Power	None	40 WATTS
External Shunt Regulator, Peak Current	None	50 A
External Shunt Regulator, Min. Resistance	None	8.8 OHMS
External Shunt Regulator, Resistor Power	None	Model Dependent
Internal Power Dissipation, Continuous (Less Shunt Regulator)	40 W	60 W
Soft-Start Surge Current (MAX)	20 AMPS	80 AMPS
Soft-Start Charge Time (MAX)	0.75 SEC.	0.25 SEC.

* **Derived from the A and B phase inputs.**

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Table B.1. Power Supply Specifications (Con't)

DESCRIPTION	PS20-230	PS50-230	PS75-230
Main AC Line Input Voltage	207 - 253 VAC	207 - 253 VAC	207 - 253 VAC
Phase	3 Phase	3 Phase	3 Phase
Frequency	47 - 63 HZ	47 - 63 HZ	47 - 63 HZ
Current RMS/Phase, Continuous	20 AMPS	50 AMPS	75 AMPS
Current RMS/Phase, Peak (2 Sec.)	40 AMPS	75 AMPS	112 AMPS
Current RMS/Phase, Peak (50 msec.)	80 AMPS	100 AMPS	150 AMPS
Control AC Line Input Voltage	95 - 132 VAC	95 - 132 VAC	95 - 132 VAC
Phase	1 Phase	1 Phase	1 Phase
Frequency	47 - 63 HZ	47 - 63 HZ	47 - 63 HZ
Current RMS	1.5 AMPS	3.0 AMPS	3.0 AMPS
Output Power	6.0 K WATTS	15 K WATTS	22.5 K WATTS
Volts	310 VDC	310 VDC	310 VDC
Unregulated Logic Bus Output No Load	± 26 VDC MAX + 14 VDC MAX		
Full Load	± 14.5 VDC MIN. @ 1 AMPS + 6.5 VDC MIN. @ 2 AMP	± 14.5 VDC MIN. @ 2 AMPS + 6.5 VDC MIN. @ 4 AMPS	± 14.5 VDC MIN. @ 2 AMPS + 6.5 VDC MIN. @ 4 AMPS
Internal Shunt Regulator, Peak Current	32 A	N/A	N/A
Internal Shunt Regulator, Resistance	12.5 OHM	N/A	N/A
Internal Shunt Regulator, Resistor Power	40 WATTS	N/A	N/A
External Shunt Regulator, Peak Current	50 A	N/A	N/A
External Shunt Regulator, Min. Resistance	8.8 OHMS	N/A	N/A
External Shunt Regulator, Resistor Power	Model Dependent	N/A	N/A
Shunt Regulator, Peak Current	N/A	100 A	200 A
Shunt Regulator, Min. Resistance	N/A	4.3 OHM	2.15 OHM
Internal Power Dissipation, Continuous (Less Shunt Regulator)	90 W	175 W	250 W
Internal Power Dissipation, Peak (2 SEC.)	N/A	325 W	475 W
Soft-Start Surge Current (MAX)	80 AMPS	40 AMPS	40 AMPS
Soft-Start Charge Time (MAX)	0.25 SEC.	0.5 SEC.	0.5 SEC.

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Table B.2. Amplifier Specifications

DESCRIPTION	SS2000-S6R	SS2000-S12R	SS2000-S20R	SS2000-S40R
MAIN DC BUS Minimum Maximum	 250 VDC 360 VDC	 250 VDC 360 VDC	 250 VDC 360 VDC	 250 VDC 360 VDC
Unregulated Logic Bus Input	± 14.5-26 VDC @ 0.25 AMPS	± 14.5-26 VDC @ 0.25 AMPS	± 14.5-26 VDC @ 0.25 AMPS	± 14.5-26 VDC @ 0.25 AMPS
	+ 6.5-14 VDC @ 0.50 AMPS	+ 6.5-14 VDC @ 0.50 AMPS	+ 6.5-14 VDC @ 0.50 AMPS	+ 6.5-14 VDC @ 0.50 AMPS
Fan AC Line Input	---	---	---	95-132 VAC 50/60 HZ @ 0.5 AMPS
Output Current (RMS/PHASE) Convection Cooled (45° C AMB) Continuous (RMS) Peak (2.0 SEC.) (RMS)	 3.0 AMPS 6.0 AMPS	 6.0 AMPS 12.0 AMPS	 10.0 AMPS 20.0 AMPS	(Fan Cooled) 20.0 AMPS 40.0 AMPS
Output KVA (@330 VDC BUS) Continuous (45°C AMB) Peak (2.0 SEC.)	 1.1 KVA 2.2 KVA	 2.2 KVA 4.4 KVA	 3.6 KVA 7.3 KVA	 7.3 KVA 14.5 KVA
Internal Heat Dissipation	40 WATTS	65 WATTS	95 WATTS	175 WATTS
PWM Switching Frequency	10.0 KHZ	10.0 KHZ	10.0 KHZ	10.0 KHZ
Motor Current Ripple Frequency ± 10%	20.0 KHZ	20.0 KHZ	20.0 KHZ	20.0 KHZ
Resolver Excitation Frequency	7.0 KHZ	7.0 KHZ	7.0 KHZ	7.0 KHZ
Form Factor RMS/AVG	≤ 1.01	≤ 1.01	≤ 1.01	≤ 1.01
Speed Regulation (Long Term)	0.075%/°C	0.075%/°C	0.075%/°C	0.075%/°C
†Minimum Controllable Speed: Option Standard 12-Bit R/D With 8000 RPM Max. Tracking Rate	 2.0 RPM	 2.0 RPM	 2.0 RPM	 2.0 RPM
12-Bit R/D With 14000 RPM Max. Tracking Rate (standard) R	3.5 RPM	3.5 RPM	3.5 RPM	3.5 RPM
14-Bit R/D With 2000 RPM Max. Tracking Rate	1/8 RPM	1/8 RPM	1/8 RPM	1/8 RPM
14-Bit R/D With 3500 RPM Max. Tracking Rate K	¼ RPM	¼ RPM	¼ RPM	¼ RPM
16-Bit R/D With 500 RPM Max. Tracking Rate	1/64 RPM	1/64 RPM	1/64 RPM	1/64 RPM

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Table B.2. Amplifier Specifications (Con't)

DESCRIPTION		SS2000-S60R	SS2000-S80R	SS2000-S110R
MAIN DC BUS Minimum Maximum		 250 VDC 360 VDC	 250 VDC 360 VDC	 250 VDC 360 VDC
Unregulated Logic Bus Input		± 14.5-26 VDC @ 0.25 AMPS	± 14.5-26 VDC @ 0.25 AMPS	± 14.5-26 VDC @ 0.25 AMPS
		+ 6.5-14 VDC @ 0.50 AMPS	+ 6.5-14 VDC @ 0.50 AMPS	+ 6.5-14 VDC @ 0.50 AMPS
Fan AC Line Input		95 - 132 VAC @ 0.5 AMPS	95 - 132 VAC @ 0.5 AMPS	95 - 132 VAC @ 0.75 AMPS
Output Current (RMS/PHASE) (45° C AMB) Continuous (RMS) Peak (2.0 SEC.)		 (FAN COOLED) 30 AMPS 60 AMPS	 (FAN COOLED) 40 AMPS 80 AMPS	 (FAN COOLED) 55.0 AMPS 110 AMPS
Output KVA (@ 330 VDC BUS) Continuous (45°C AMB) Peak (2.0 SEC.)		 11.0 KVA 22.0 KVA	 14.5 KVA 29 KVA	 20 KVA 40 KVA
Internal Heat Dissipation		255 WATTS	335 WATTS	445 WATTS
PWM Switching Frequency		10.0 KHZ	10.0 KHZ	10.0 KHZ
Motor Current Ripple Frequency ± 10%		20.0 KHZ	20.0 KHZ	20.0 KHZ
Resolver Excitation Frequency		7.0 KHZ	7.0 KHZ	7.0 KHZ
Form Factor RMS/AVG		≤ 1.01	≤ 1.01	≤ 1.01
Speed Regulation (Long Term)		0.075%/°C	0.075%/°C	0.075%/°C
†Minimum Controllable Speed:	Option			
Standard 12-Bit R/D With 8000 RPM Max. Tracking Rate		2.0 RPM	2.0 RPM	2.0 RPM
12-Bit R/D With 14000 RPM Max. Tracking Rate	R	3.5 RPM	3.5 RPM	3.5 RPM
14-Bit R/D With 2000 RPM Max. Tracking Rate		1/8 RPM	1/8 RPM	1/8 RPM
14-Bit R/D With 3500 RPM Max. Tracking Rate	K	¼ RPM	¼ RPM	¼ RPM
16-Bit R/D With 500 RPM Max. Tracking Rate		1/64 RPM	1/64 RPM	1/64 RPM

† Minimum controlled speed is defined as the minimum speed that can readily be run. The standard amplifier is configured with a 12-bit R/D converter for a maximum motor speed of 8,000 RPM. Other resolutions and maximum motor speeds (tracking rates) must be ordered as specials.

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Table B.3. Derating Data

Derating Information (Continuous Duty)			
SS2000-S	60HZ Derating @131 °F (55 °C)*	50HZ Operation In 113 °F (45 °C) Max. Ambient	50HZ % Total Derating @ 131 °F (55 °C)
06R	20%	No Derating	20%
12R	20%	No Derating	20%
20R	20%	No Derating	20%
40R	20%	No Derating	20%
60R	20%	20%	36%
80R	20%	20%	36%
110R	20%	20%	36%

Power Supply Logic Bus Supply	60HZ Derating @131 °F (55 °C)*	50HZ Operation In 113 °F (45 °C) Max. Ambient	50HZ % Total Derating @ 131 °F (55 °C)
08A	No Derating	No Derating	No Derating
12A	10%	No Derating	10%
20A	10%	No Derating	10%
50A	10%	No Derating	10%
75A	10%	No Derating	10%

Power Supply Main Bus Supply	60HZ Derating @131 °F (55 °C)*	50HZ Operation In 113° F (45 °C) Max. Ambient	50HZ % Total Derating @ 131 °F (55 °C)
08A	No Derating	No Derating	No Derating
12A	No Derating	20%	20%
20A	No Derating	20%	20%
50A	10%	10%	20%
75A	10%	10%	20%

- Based on Derating of 1.1% / °F (2% / °C) from 113 °F to 131 °F (45 °C to 55 °C).

  Consult Factory for Derating Above 131 °F (55 °C).

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Table B.4. Environmental Specifications

Operating Temperature	32 °F to 113 °F (0 °C to 45 °C)
Storage Temperature	-4 °F to 158 °F (-20 °C to 70 °C)
Humidity (Non-Condensing)	10% to 90%

Table B.5. Mechanical Specifications

MODEL NUMBER	WIDTH		HEIGHT		DEPTH		WEIGHT	
	IN.	MM	IN.	MM	IN.	MM	LB.	Kg(f)
SS2000-S06R	2.3	60	13.5	340	11	280	6.49	2.95
SS2000-S12R	2.3	60	13.5	340	11	280	7.50	3.41
SS2000-S20R	3.5	88	13.5	340	11	280	10.49	4.77
SS2000-S40R	4.2	106	13.5	340	11	280	14.50	6.59
SS2000-S60R	5.5	140	13.5	340	11.2	284	21.50	9.77
SS2000-S80R	5.5	140	13.5	340	11.2	284	21.96	9.98
SS2000-S110R	6.3	160	13.5	340	11.2	284	22.96	10.43
PS08	2.7	68.2	10.1	257	7.24	184	4.14	1.87
PS12-230	3.1	80	13.5	340	11	280	10.49	4.77
PS20-230	3.1	80	13.5	340	11	280	11.99	5.45
PS50-230	5.5	140	13.5	340	11.2	284	26.49	12.02
PS75-230	5.5	140	13.5	340	11.2	284	27.0	12.25

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APPENDIX C

OPTIONS

Options are brought into existence from time to time to satisfy specific needs and to add versatility to the product. (Refer to the Model Number Schemes in Appendix A.)

The amplifier and power supply may be ordered with various mechanical and electrical options, standard or custom designed for particular applications. If a feature is desired which is not covered here, consult the Superior Electric Sales Staff for information on custom designed options.

C.1 POWER SUPPLY ELECTRICAL OPTIONS

12 and 20 AMP Models:

OPTION:

\E400 400 watts external regeneration resistor kit for 230V systems, or 200 watts external regeneration resistor kit for 115V systems (refer to Section 2.6 and 2.7). Resistor kits are ordered separate from the power supply.

\E700 700 watts external regeneration resistor kit for 230V systems (refer to Section 2.6 and 2.7). Resistor kits are ordered separate from the power supply.

Consult factory at 1-800-SUP-ELEC for information on other options available.

50 and 75 AMP Models:

OPTION:

Consult factory at 1-800-SUP-ELEC for information on options available.

C.2 AMPLIFIER ELECTRICAL OPTIONS

The standard amplifier is fitted with a 12-bit R/D converter which allows a maximum tracking rate of 8000 RPM and a maximum operating speed of 7500 RPM.

The amplifiers are available with standard options which are discussed in the following sections. These options are either integrated into the main circuit board of the amplifier or appear as Option Boards that are mounted inside of the amplifier chassis.

C.2.1 Integrated Options

R/D Converter Resolution and Tracking Rate Options:

Optional R/D resolutions and tracking rates are available and produce higher resolution position information and/or better low-speed performance. These options are integrated into the main circuit board (motor control board) within the amplifier and are as follows:

Option - K contains a 14-bit R/D, produces a maximum tracking rate of 3500 RPM, and a maximum operating speed of 3200 RPM.

Electronic Encoder Output, E option (Standard)

When configured as an E option board, only the encoder outputs are offered. The converts the binary (motor shaft) position information from the R/D (Resolver-to-Digital) converter, located within the amplifier, to differential quadrature encoder signals with marker pulse.

The output interface connections are made via Connector 32, mounted on the Encoder Option Board. This connector is an 8-Pin Molex MINI-FIT

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JR connector and is located just to the left of Connector C1 mounted in the top front of the amplifier .

The pin outs are as follows:

OUT A	5	1	$\overline{\text{OUT A}}$
OUT B	6	2	$\overline{\text{OUT B}}$
OUT Z	7	3	$\overline{\text{OUT Z}}$
COM	8	4	COM

Figure C.1. Connector 32

The encoder interface option provides a differential quadrature synthesized encoder output and a differential marker pulse output for customer use. Each output pair (OUT A or A phase, OUT B or B phase, and OUT Z or Z phase) is driven by a DS8830/SN75183 differential line driver integrated circuit. The voltage levels transition between + 5 volts and common. This interface is capable of sinking and sourcing 40 milliamps of current. The differential outputs are designed to drive long lengths of coaxial cable, strip line, or twisted pair transmission lines with characteristic impedances of 50 to 500 ohms.

The quadrature signal is generated by the following sequence:

Up to sixteen parallel resolver data bits are brought to the board via connectors 7 and 33. These bits first pass through LS244 data buffers. Next the data bits are routed to a double row jumper/header (component 35). At this header the quadrature resolution is selected by manipulating two jumpers. The resolution can be from 16 to 16384 encoder lines in increments of power of two (2^X) (i.e., 16, 32, 64, 128, 256, 512, 1024, 2048, 4096, 8192, 16384). The following jumper table shows the jumper combinations for the resolutions available. After two of the twelve data bits have been selected at the jumper/header block (Component 35) by the two jumper selections, these two signals are routed to a pair of Exclusive-Or gates. This is where the quadrature (A Phase offset from B Phase by 90 degrees) signal pair are generated.

After this the two quadrature signals are latched by a pair of LS175 flip-flops. The non-inverting output from each flip-flop drives an LED. The inverting output from each flip-flop drives a pair of DS8830 or 75183 line drivers. The line driver outputs route straight across a jumper/header strip (this is used with other options) and terminate at customer Connector 32.

The marker pulse signal is generated by the following sequence:

All sixteen parallel resolver data bits are brought to the Option Board. These bits first pass through LS244 data buffers. Next the data bits are routed to a bank of DIP switches consisting of Components 23 and 26. At these switches the marker pulse width is selected. For a minimum pulse width all switches should be closed. As more switches are opened from the LSB to the MSB, the pulse width will become wider. The marker pulse width selected has no effect on the quadrature resolution selected although these two types of signals are normally related on a standard encoder. The jumper/switch table that follows shows the wide and narrow marker pulse selection with each of the eleven encoder equivalent resolutions available. After the dip switch, the selected signals are **Anded** together then **Anded** with all of the MSB data lines that were not switch-selectable. Note that the combination of the two Nand gates feeding into an Or gate results in the equivalent of a large Nand gate. The output of the Or gate feeds into a LS175 flip-flop. The non-inverting output of the flip-flop drives an LED. The inverting output of the flip-flop drives a DS8830 or 75183 line driver. The line driver outputs route straight across a jumper/header strip (this is used with other options) and terminate at customer Connector 32.

The encoder resolution (OUT A and OUT B) can be jumpered for resolutions between 16 to 16384 lines in binary (2^X) increments. The OUT Z (Marker Pulse) can be switch-selected for either a narrow pulse width or a wide pulse width in relation to the particular resolution selected. Note that any other marker pulse width can be selected as it has no direct effect on the selected resolution of the encoder equivalent signal.

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STANDARD 12-BIT CONFIGURATION

Place two jumpers on header #35:

JUMPER PINS I-J
JUMPER PINS K-L

Adjust the Dip Switch #23 & #36 to:

SWITCH A - OFF
SWITCH B - OFF
SWITCH C - OFF
SWITCH D - OFF
SWITCH E - OFF
SWITCH F - ON
SWITCH G - ON
SWITCH H - ON
SWITCH I - ON
SWITCH J - ON
SWITCH K - ON
SWITCH L - ON

Double Row Header #28:

JUMPER 1-2
JUMPER 3-4
JUMPER 5-6
JUMPER 7-8
JUMPER 9-10
JUMPER 11-12

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Table C.1. Encoder Board Specifications

ENCODER RESOLUTION SELECTION				MARKER PULSE WIDTH																			
ENCODER RESOLUTION		OUT A & OUT B JUMPER/HEADER #35		DIP SWITCH #23 & #36 (0 = OFF 1 = ON)																			
Encoder Quad Counts	Encoder Lines (/rev)	JUMPER #1	JUMPER #2	WIDE MARKER*												NARROW MARKER											
				1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
65536**	16384	A - B	C - D	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
32768**	8192	C - E	D - F	0	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
16384**	4096	E - F	G - H	0	0	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1
8192**	2048	G - I	H - J	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1	1	1
4096*	1024*	I - J*	K - L*	0	0	0	0	0	1	1	1	1	1	1	1*	0	0	0	0	1	1	1	1	1	1	1	1
2048	512	K - M	L - N	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1	1
1024	256	M - N	O - P	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
512	128	O - Q	P - R	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	1	1	1	1	1
256	64	Q - R	S - T	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1
128	32	S - U	T - V	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	1
64	16	U - V	W - X	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	1

* This is the standard setting (12-bit).

** These resolutions are not available on all amplifier models. A high resolution R/D is also required with these resolutions.

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Table C.2. System Specifications

ACCURACY'S	R/D
R/D CONVERTER ACCY	± 4.0 ARC MIN
RESOLVER ACCURACY	± 7.0 ARC MIN
RESOLVER MOUNTING	± 3.0 ARC MIN
UNCERTAINTY** (± 1 Count)	± 5.27 ARC MIN
WORST CASE ACCY*	19.27 ARC MIN
	0.32 DEGREES
	± 1.8 BITS
TYPICAL ACCURACY	13.87 ARC MIN
	0.22 DEGREES
	± 1.3 BITS
REPEATABILITY	5.27 ARC MIN
	0.088 DEGREES
	1.0 BIT
RESOLUTION	2^{12} BITS (4096)

* Worst Case Analysis assumes all errors add together.

** For 12-bit systems only. For 14-bit systems, the uncertainty drops to ± 1.32 arc min and for 16-bit systems, the uncertainty drops to ± 0.33 arc min. Therefore, the worst case and typical accuracy's will be reduced slightly for 14- and 16-bit systems.

Table C.3. R/D Converter Speeds

R/D CONVERTER MAXIMUM SPEED			MAXIMUM OPERATING SPEED
R/D RESOLUTION	TRACKING RATE		
12-Bit	233.33 RPS	8000 RPM	7500
12-Bit	133.33 RPS	8000 RPM	7500
14-Bit	58.33 RPS	3500 RPM	3150
14-Bit	33.33 RPS	2000 RPM	1800
16-Bit	15.0 RPS	900 RPM	800
16-Bit	13.33 RPS	500 RPM	450

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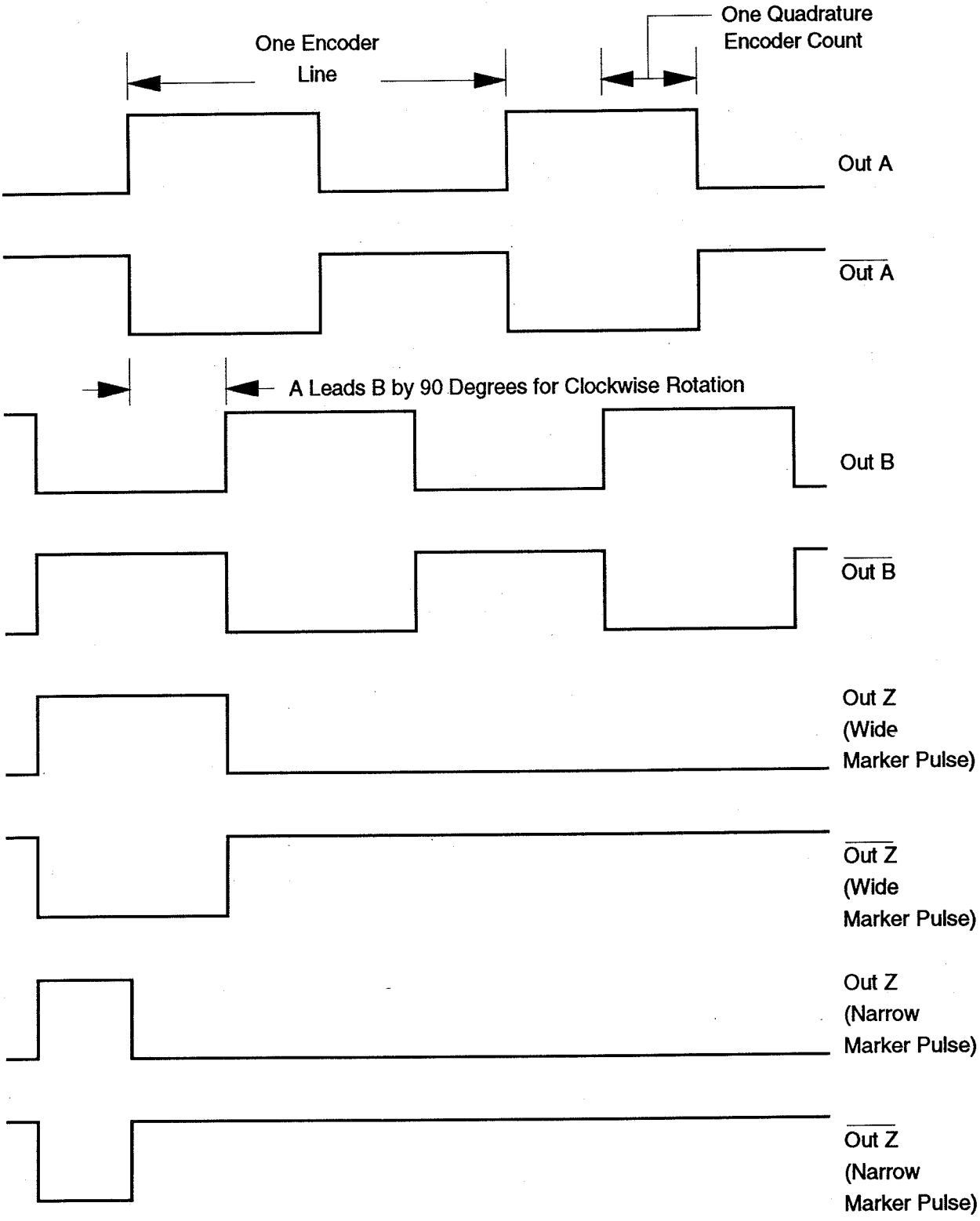


Figure C.2. Encoder Output Timing

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APPENDIX D

DRAWINGS

DRAWING		PAGE
A-63542	Motor Connection	D-2
A-83908	Purchase Spec. for Mini-Fit, Jr. Series Connector	D-3
A-83909	Purchase Spec. for Mini-Fit, Jr. Series Terminals	D-4
A-93369	Amplifier Assembly Guide for Resolver Cables	D-5
A-93581	Outline & Dimension PS12 & PS20	D-6
A-93031	Outline & Dimension PS50 & PS75	D-7
A-93865	Outline & Dimension SS2000-S110R	D-8
A-93141	Wiring & Mounting Diagram RH-500	D-9
A-93878	Outline & Dimension SS2000-S60R & -S80R	D-10
A-93231	Amplifier Wiring Diagram	D-11
A-93314	Wiring & Mounting Diagram RH-1000	D-13
A-93656	Mounting Hole Pattern Amplifiers and Power Supplies	D-14
A-93316	Wiring & Mounting Diagram RH-2000	D-16
A-93567	Outline & Dimension SS2000-S6R & -S12R	D-17
A-93568	Outline & Dimension SS2000-S40R	D-18
A-93572	Outline & Dimension SS2000-S20R	D-19
	Outline & Dimension PS08	D-20
A-63129	Motor Outline Drawing, S070-1	E-3
A-63402	Motor Outline Drawing, S070-2, S070-3	E-4
A-43628	Motor Outline Drawing, S092-1, S092-2, S092-3	E-5
A-43170	Motor Outline Drawing, S115-1, S115-2, S115-3	E-6
A-43603	Motor Outline Drawing, S142-1, S142-2	E-7
A-43991	Motor Outline Drawing, S S142-3	E-8
A-43729	Motor Outline Drawing, S190-1, S190-2, S190-3	E-9

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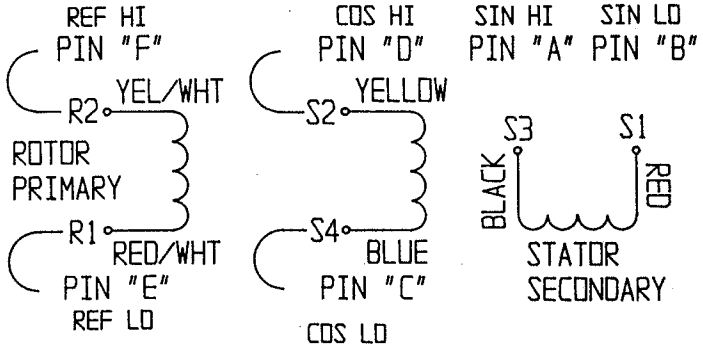
UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.

THIRD ANGLE PROJECTION

METRIC

PHASE A (BROWN LEAD) - PIN "A"
PHASE B (RED LEAD) - PIN "B"
PHASE C (WHITE LEAD) - PIN "C"
CASE GROUND (GREEN w/ YELLOW STRIPE LEAD) - PIN "D"

MOTOR LEAD CONNECTIONS



RESOLVER CONNECTION DIAGRAM

THERMOSTAT (BLACK LEADS) - PINS "T" & "U"
TACH (BLACK LEAD) - PIN "R"
(WHITE LEAD) - PIN "S"
BRAKE (BLUE LEADS) - PINS "N" & "P"

THERMOSTAT, TACH & BRAKE CONNECTIONS (LOCATED IN RESOLVER CABLE ASSEMBLY)

NOTES:
1 - WITH A PHASE SEQUENCE A, C, B MOTOR ROTATION SHALL BE C.W. FACING MOUNTING END.
2 - THERMOSTAT PRESET TO OPEN AT 170°C ±5°C AND CLOSE AT 132°C ±5°C, NORMALLY CLOSED, CONTACTS RATED TO 4 AMPS, 120 V.A.C.
3 - OPTIONAL TACH - WITH ROTATION PER NOTE #1, A POSITIVE VOLTAGE IS GENERATED ON PIN "R" WITH RESPECT TO PIN "S".

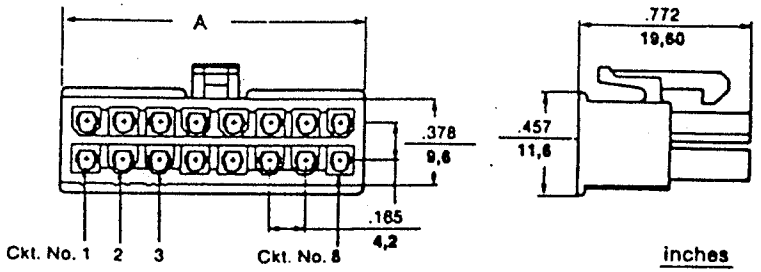
SUPERIOR ELECTRIC

MOTOR CONNECTION

SCALE FULL | DWG. NO. REFERENCE: A-63542

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THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.
METRIC				



inches
mm

DASH NO.	Circuits	Dim. A	Dim. B	Dim. C
002	2	.213 5,4	—	.606 15,4
004	4	.378 9,6	.165 4,2	.772 19,6
006	6	.543 13,8	.331 8,4	.937 23,8
008	8	.709 18,0	.496 12,6	1.102 28,0
010	10	.874 22,2	.661 16,8	1.268 32,2
012	12	1.039 26,4	.827 21,0	1.433 36,4
014	14	1.205 30,6	.992 25,2	1.598 40,6
016	16	1.370 34,8	1.157 29,4	1.764 44,8
018	18	1.535 39,0	1.323 33,6	1.928 49,0
020	20	1.701 43,2	1.488 37,8	2.094 53,2
022	22	1.866 47,4	1.654 42,0	2.60 57,4
024	24	2.031 51,6	1.819 46,2	2.425 61,6

NOTES

1.) USE PIN # A-83909-___ WITH THIS CONNECTOR.

2.) MATERIAL: UL 94V-0 NYLON

NUMBER OF CIRCUITS

APPROVED VENDOR: MOLEX #(39-01-2___5)

SUPERIOR ELECTRIC

PURCHASE SPEC: MINI-FIT JR SERIES CONNECTOR

SCALE | DWG. NO. REFERENCE: A-83908

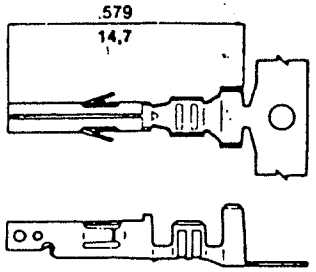
A-83908 Sheet 1 of 1 D-3

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THIRD ANGLE PROJECTION

METRIC

UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	INCHES XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS GIVEN. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.



inches
mm

DASH NO.	PART NO. 5556 Female	Wire Size	Insulation Diameter	Plating	FORM
-001	39-00-0078	AWG #16	.071" - .122" (1,8mm-3,1mm)	Tin Plated Brass	LOOSE
-002	• 39-00-0039	AWG #18-24	.051"-.118" (1,3mm-3mm)		
-003	• 39-00-0047	AWG #22-28	.035"- .071" (0,9-1,8mm)		
-004	39-00-0080	AWG #16	.071" - .122" (1,8mm-3,1mm)	Tin Plated Phosphor Bronze	
-005	• 39-00-0060	AWG #18-24	.051"-.118" (1,3mm-3mm)		
-006	39-00-0090	AWG #16	.071" - .122" (1,8mm-3,1mm)	30 microinches Gold Plated Brass	
-007	39-00-0056	AWG #18-24	.051"-.118" (1,3mm-3mm)		
-008	39-00-0085	AWG #22-28	.035"-.071" (0,9-1,8mm)		
-009	39-00-0038	AWG #18-24	.051"-.118" (1,3mm-3mm)	TIN PLATED BRASS	CHAIN

APPROVED VENDOR: MOLEX

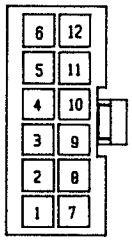
SUPERIOR ELECTRIC

PURCHASE SPEC: MINI-FIT, JR SERIES TERMINALS

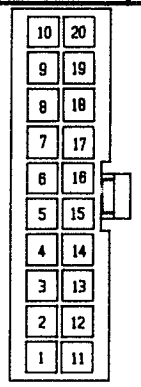
SCALE \ DWG. NO. REFERENCE: A-83909

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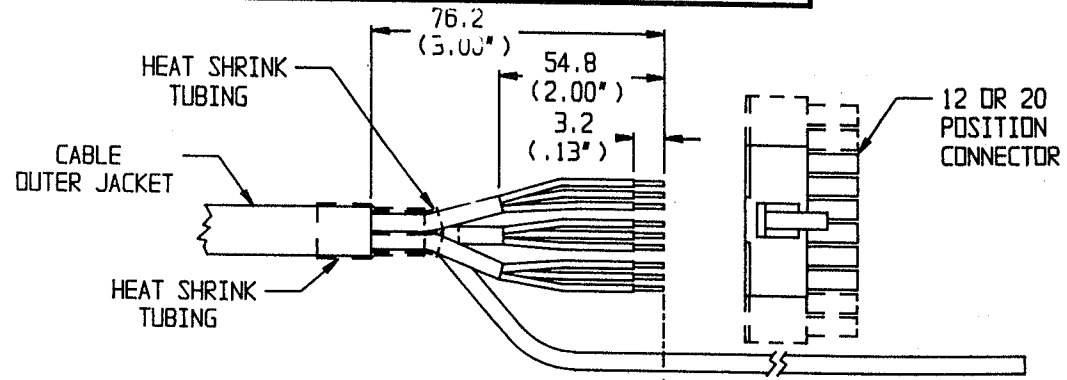
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DETAIL B - B



DETAIL C - C



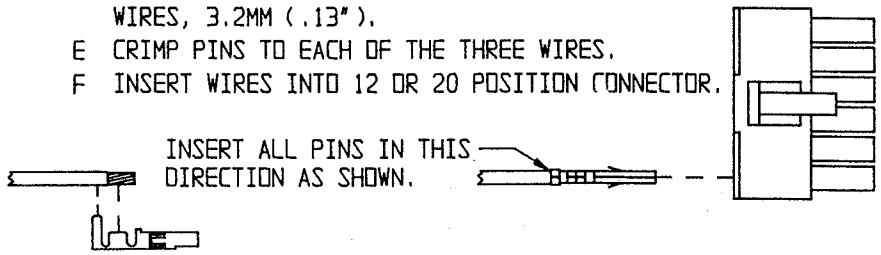
CONNECTOR ASSEMBLY PROCEDURE

STEP 1 BEFORE ANY OUTER JACKET HAS BEEN REMOVED FROM THE CABLE, SLIDE A SECTION OF HEAT SHRINK TUBING ONTO THE CABLE.

STEP 2 STRIP THE CABLE OUTER JACKET BACK, 381MM (15.00"). THIS WILL EXPOSE THE INDIVIDUAL FOIL SHIELDS.

STEP 3 ACCORDING TO THE CONNECTION CHART, SELECT ONE OF THE WIRE PAIRS AND COMPLETE THE FOLLOWING OPERATIONS. SEE NOTE #1.

- A REMOVE THE FOIL SHIELD FROM THE WIRE.
- B COVER SHIELD WIRE WITH TUBING.
- C COVER THE THREE LEADS WITH HEAT SHRINK.
- D USE STRIPPING PLIERS TO STRIP INSULATION FROM INDIVIDUAL WIRES, 3.2MM (.13").
- E CRIMP PINS TO EACH OF THE THREE WIRES.
- F INSERT WIRES INTO 12 OR 20 POSITION CONNECTOR.



STEP 4 PERFORM STEP 3 FOR EACH REMAINING PAIRS.

STEP 5 SLIDE THE HEATSHRINK TUBING, FROM STEP #1, ONTO THE END OF THE CABLE AND SHRINK, AS SHOWN ABOVE.

SUPERIOR ELECTRIC

AMPLIFIER ASSEMBLY FOR RESOLVER CABLES

SCALE FULL | DWG. NO. REFERENCE: A-93369S5

A-93369 Sheet 1 of 1 D-5

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THIRD ANGLE PROJECTION

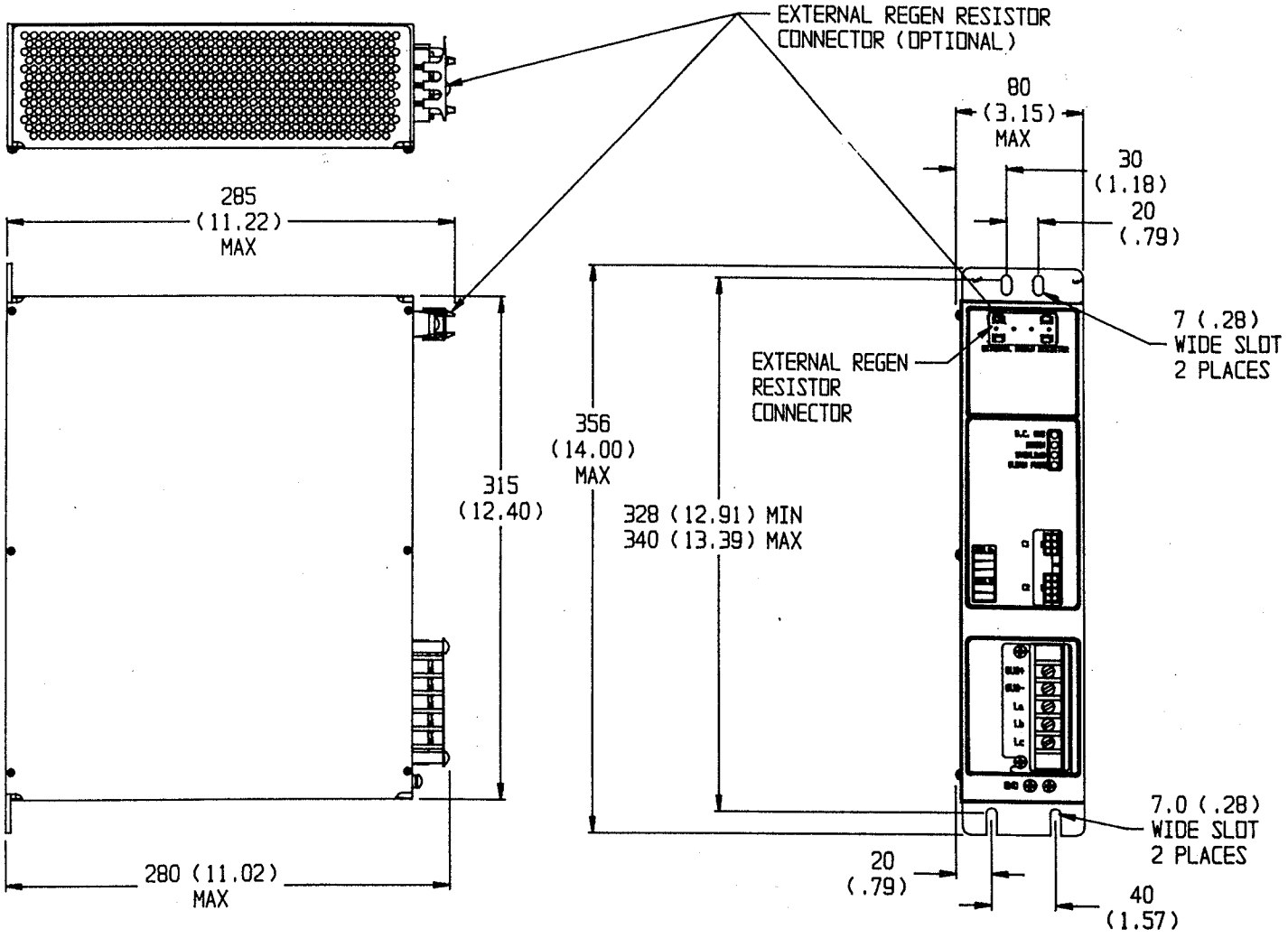
METRIC

UNLESS OTHERWISE SPECIFIED
ANG. DIM. ±1 DEGREE

METRIC
X DEC. PLACES ±.4
XX DEC. PLACES ±.13

[INCHES]
XX DEC. PLACES ±.015 IN.
XXX DEC. PLACES ±.005 IN.

DO NOT SCALE DWG. USE DIMENSIONS ONLY.
ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.



THIS UNIT CONTAINS STATIC SENSITIVE MATERIAL, HANDLE ACCORDINGLY.

SUPERIOR ELECTRIC

OUTLINE
PS12, PS20-230

SCALE 1:4

DWG. NO. REFERENCE: A-93581

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THIRD ANGLE PROJECTION

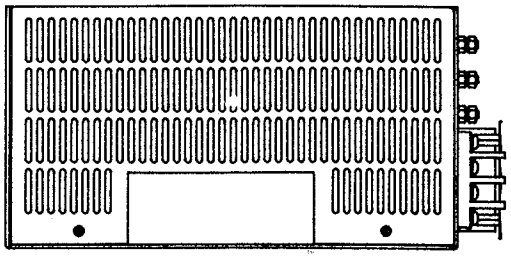
METRIC

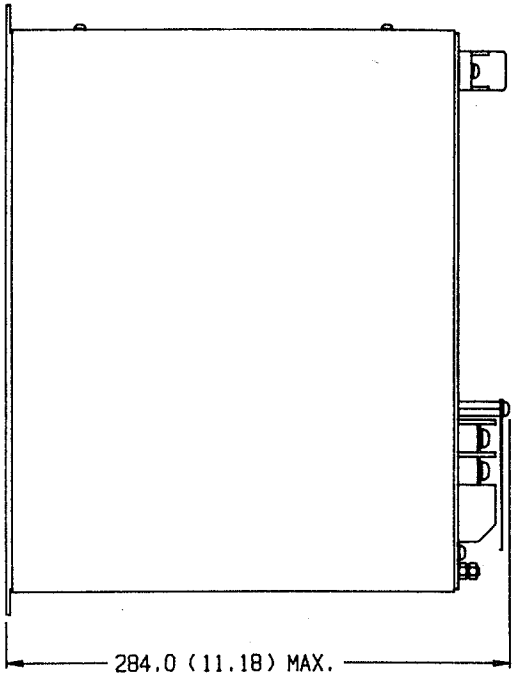
UNLESS OTHERWISE SPECIFIED
ANG. DIM. ±1 DEGREE

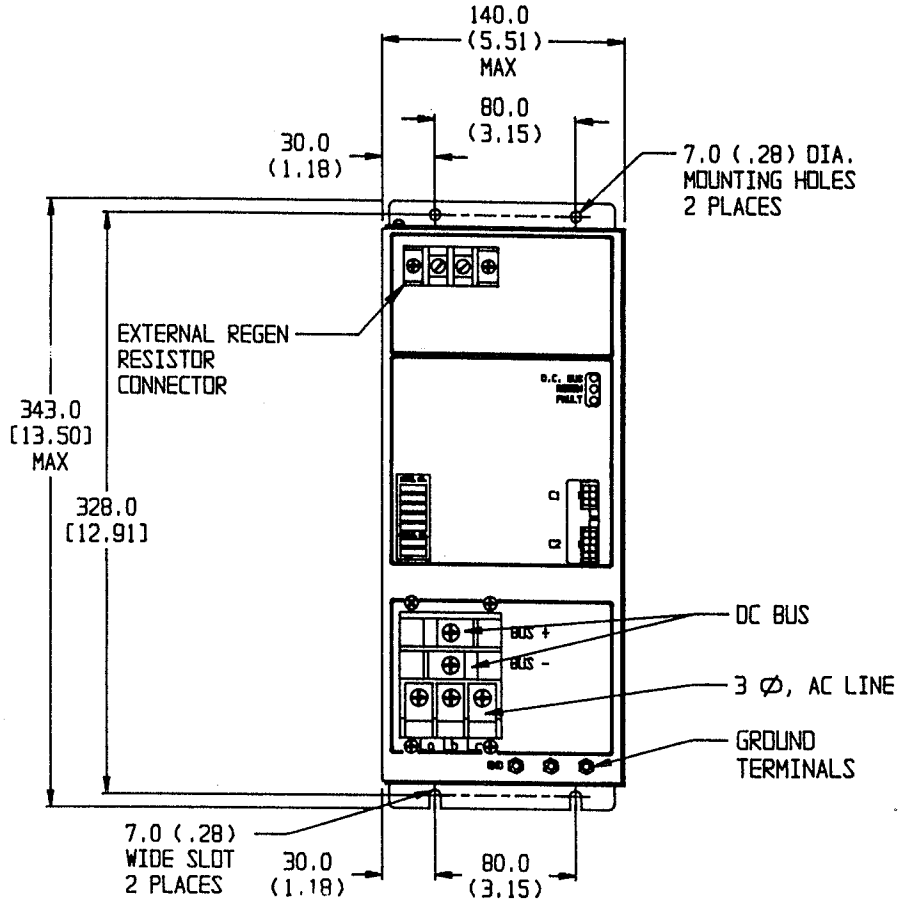
METRIC
X DEC. PLACES ±.4
XX DEC. PLACES ±.13

[INCHES]
XX DEC. PLACES ±.015 IN.
XXX DEC. PLACES ±.005 IN.

DO NOT SCALE DWG. USE DIMENSIONS ONLY.
ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.







SUPERIOR ELECTRIC

OUTLINE
PS50-230

SCALE 1:4

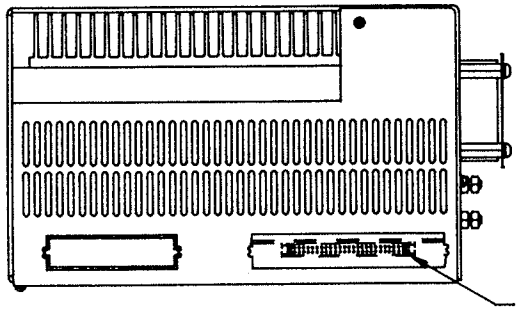
DWG. NO. REFERENCE: A-93031

A-93031 Sheet 1 of 1 D-7

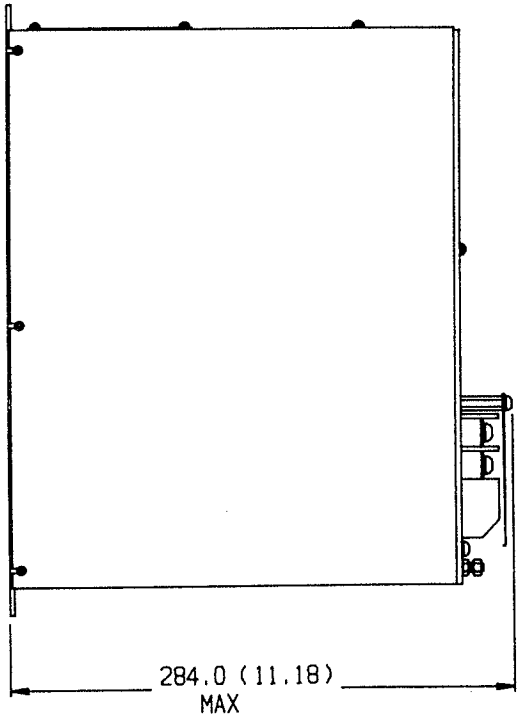
THIRD ANGLE PROJECTION

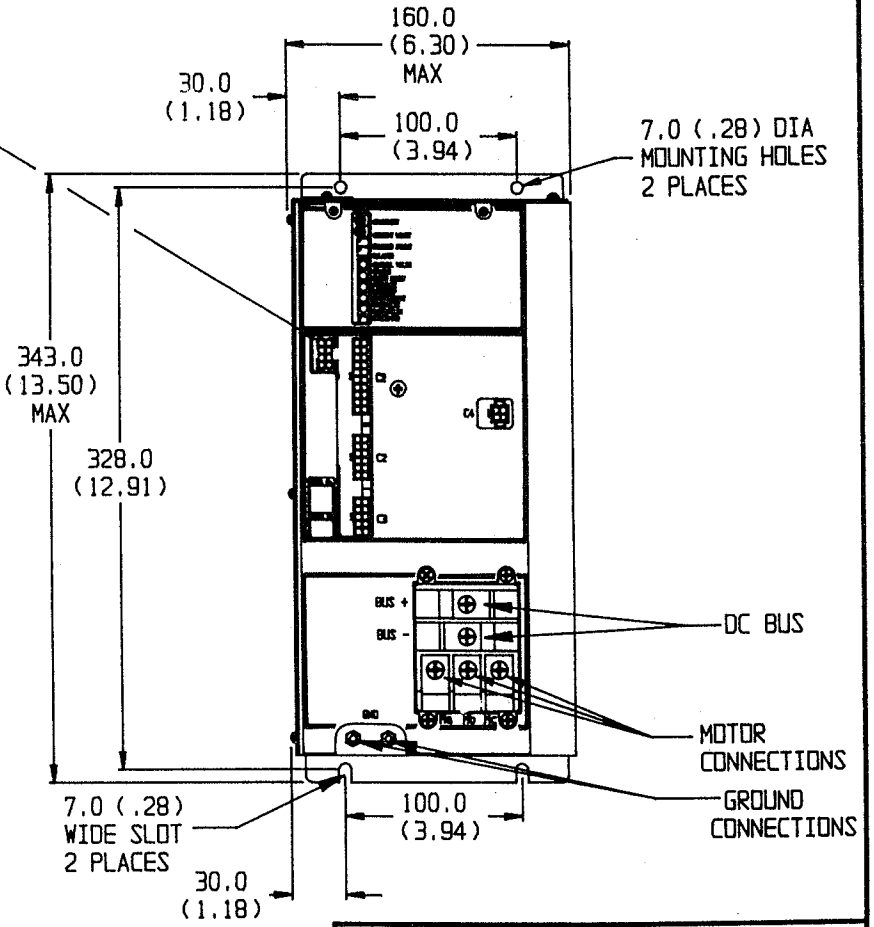
METRIC

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POSSIBLE OPTION BOARD CONNECTORS





THIS UNIT CONTAINS STATIC SENSITIVE MATERIAL, HANDLE ACCORDINGLY.

SUPERIOR ELECTRIC

OUTLINE
SS2000-S110R

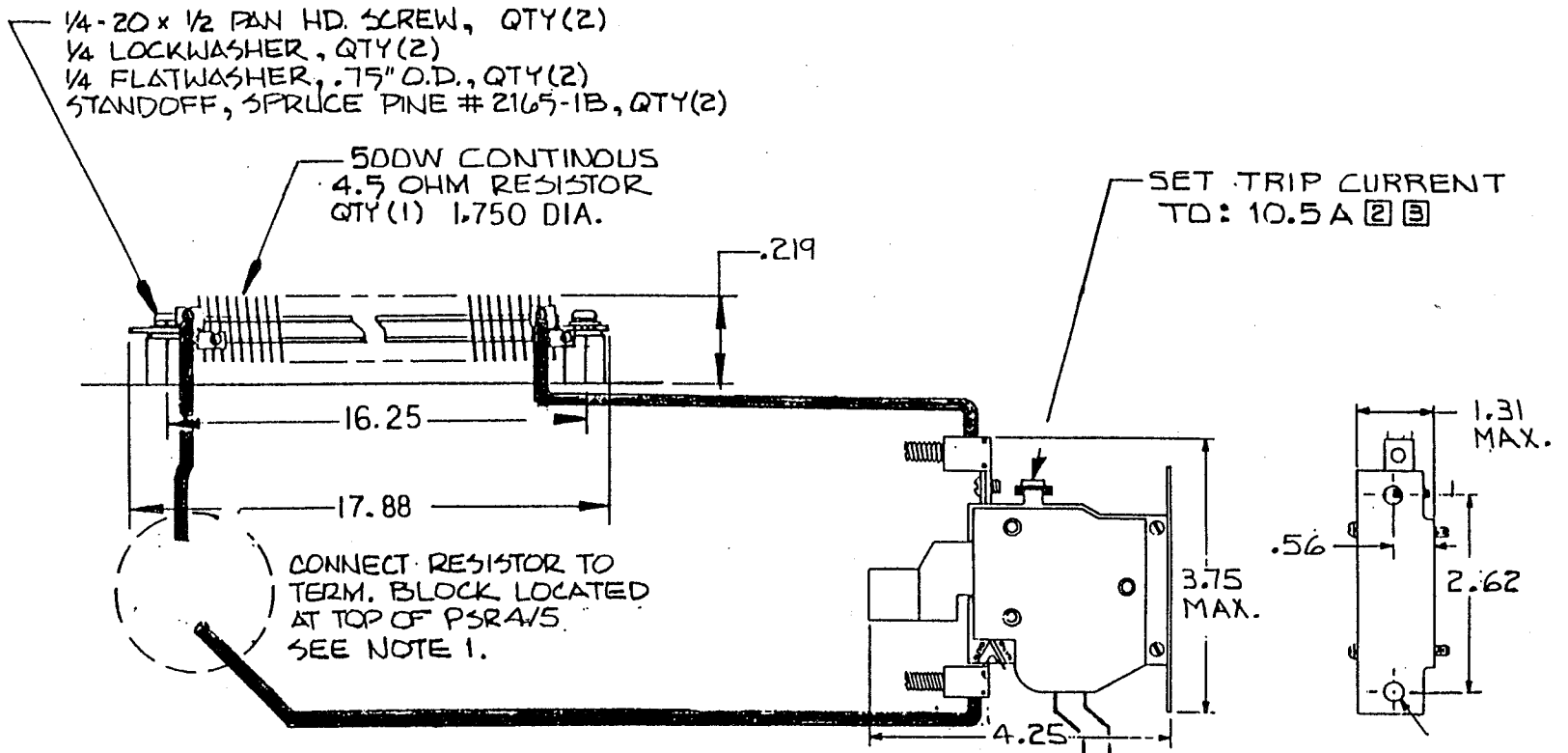
SCALE 1:4 | DWG. NO. REFERENCE: A-93865

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UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.

THIRD ANGLE PROJECTION

METRIC



CAUTION-1) DO NOT INSTALL RESISTOR NEAR FLAMMABLE MATERIAL.

NOTES: 2) SHOCK HAZARD & RESISTOR CONNECTED TO HIGH VOLTAGE.

1. RECOMMENDED WIRE: # 8AWG, 125°C
2. BOTTOM STANDOFFS ARE THREADED 1/4-20 x 3/8" DP FOR MOUNTING RESISTORS TO PANELS, ETC.
3. OUTPUT CONTACTS: WIRED TO DROP MAIN LINES WHEN CONTACTS OPEN ON OVERLOAD.

SUPERIOR ELECTRIC

WIRING & MOUNTING DIAG.

RH500

SCALE \ | DWG. NO. REFERENCE: A-93141

A-93141 Sheet 1 of 1

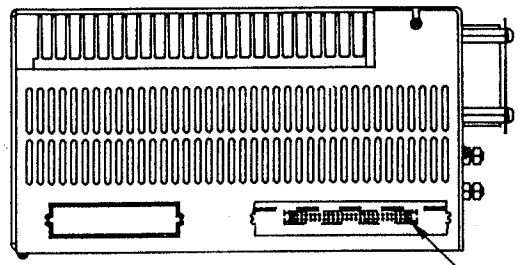
D-9

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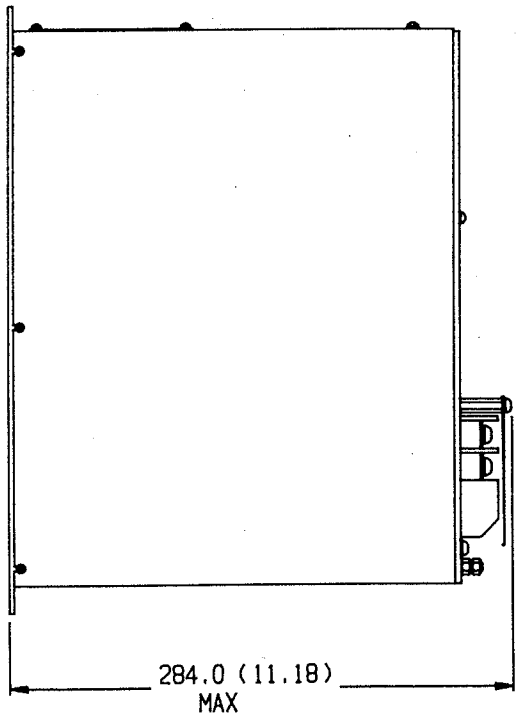
THIRD ANGLE PROJECTION

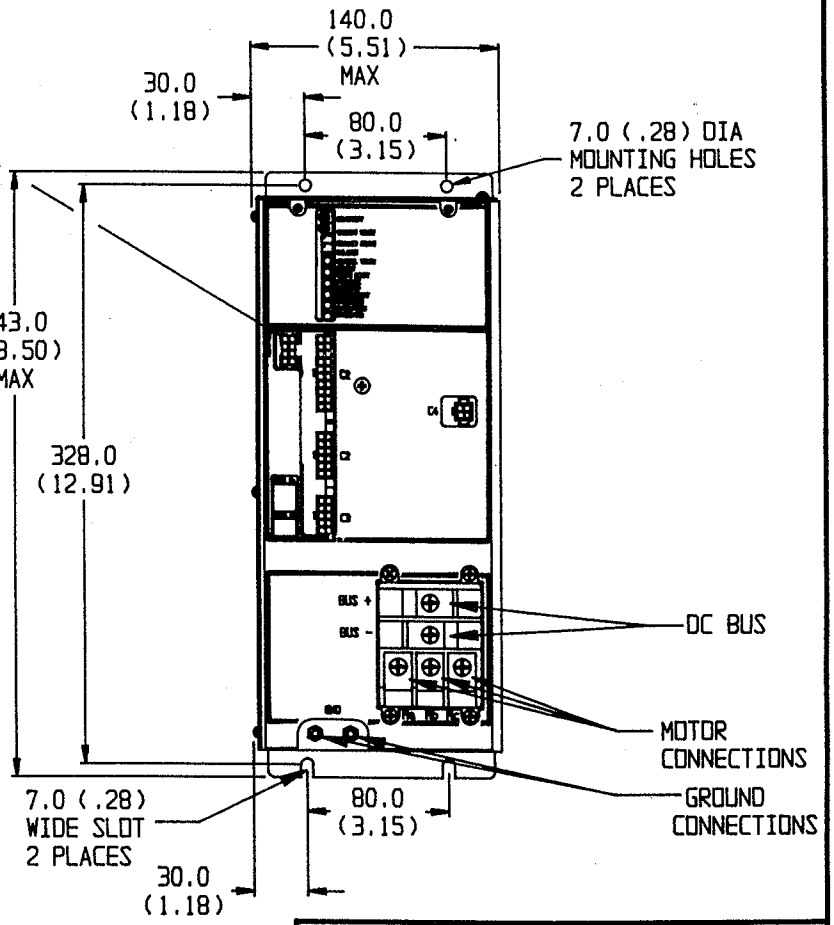
METRIC

UNLESS OTHERWISE SPECIFIED	METRIC	[INCHES]	DO NOT SCALE DWG. USE DIMENSIONS ONLY.
ANG. DIM. ±1 DEGREE	X DEC. PLACES ±.4 XX DEC. PLACES ±.13	XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.



POSSIBLE OPTION BOARD CONNECTORS





THIS UNIT CONTAINS STATIC SENSITIVE MATERIAL, HANDLE ACCORDINGLY.

SUPERIOR ELECTRIC

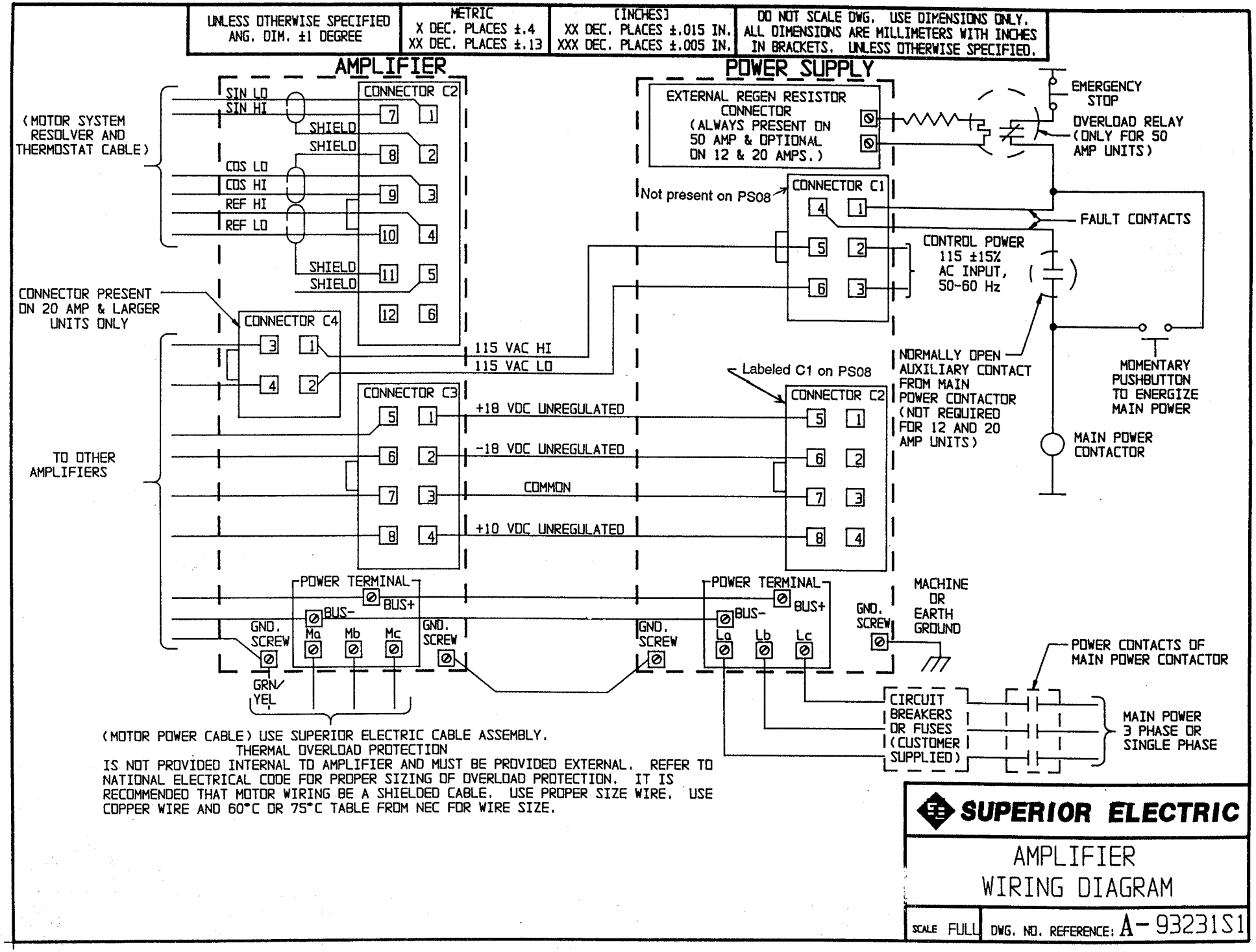
OUTLINE
SS2000S60R, S50R

SCALE 1:4

DWG. NO. REFERENCE: A-93878

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UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.

THIRD ANGLE PROJECTION

METRIC

DIFFERENTIAL VELOCITY OR CURRENT COMMAND INPUT SCALED FOR ±10 VOLTS = FULL SCALE. SEE CIRCUIT TO THE RIGHT (ANALOG INPUT)

DIFF LO

DIFF HI

ADDITIONAL SINGLE ENDED INPUT TO THE VELOCITY LOOP.

AUX. IN

* AN EXTERNAL RESISTOR TO COMMON MAY BE USED TO PROGRAM THE PEAK CURRENT LIMIT OF THE AMPLIFIER AS FOLLOWS:
75% OF I PEAK WITH 8.6K ohm
50% OF I PEAK WITH 3.5K ohm
OR A POSITIVE VOLTAGE FROM 0 VDC TO 7.5 VDC MAY BE USED TO ADJUST THE PEAK CURRENT FROM 7.5% TO 100% OF ITS RATING.

ENABLE

I LIMIT

RESET

TORQUE HOLD

COMMON

SHIELD

COMMON

SHIELD

COMMON

I MONITOR IS A COMMON-REFERENCED SIGNAL SCALED FOR FULL CURRENT = 8 VOLTS. THIS SIGNAL HAS A 3K ohm RESISTOR IN LINE.

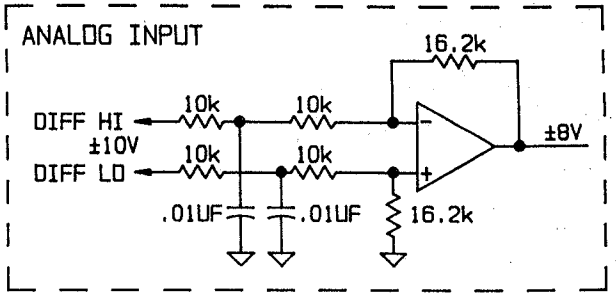
I MONITOR

TACH MONITOR IS A COMMON-REFERENCED SIGNAL SCALED FOR 8 VOLTS AT MAXIMUM SYSTEM SPEED AS STATED ON THE TL SHEET. THIS SIGNAL HAS A 3K ohm RESISTOR IN LINE

TACH MONITOR

CONNECTOR C1

11	1		
12	2		
13	3		
14	4	SHIELD	
15	5		
16	6	SHIELD	
17	7		
18	8		
19	9		
20	10		



OUTPUT FAULT

OUTPUT FAULT IS A COMMON-REFERENCED, OPEN COLLECTOR SIGNAL. THE OUTPUT MAXIMUM RATING IS 30 VDC AND 25 MA.

FOLDBACK

FOLDBACK IS A COMMON-REFERENCED, OPEN COLLECTOR SIGNAL. THE OUTPUT MAXIMUM RATING IS 30 VDC AND 25 MA.

OVERTEMP

OVERTEMP IS A COMMON-REFERENCED, OPEN COLLECTOR SIGNAL. THE OUTPUT MAXIMUM RATING IS 30 VDC AND 25 MA.

DRIVE-UP RELAY

DRIVE-UP RELAY

THE DRIVE-UP RELAY ACTS IN CONJUNCTION WITH THE ENABLE CIRCUIT IN ONE OF TWO POSSIBLE MODES: DRIVE-UP MODE OR O.K. TO ENABLE. THE RELAY CAN DRIVE UP TO 1 AMP RESISTIVE, AND THE CONTACTS ARE RATED FOR 115 VAC. THE RELAY MUST BE DERATED FOR INDUCTIVE LOADS.

SUPERIOR ELECTRIC

AMPLIFIER WIRING DIAGRAM

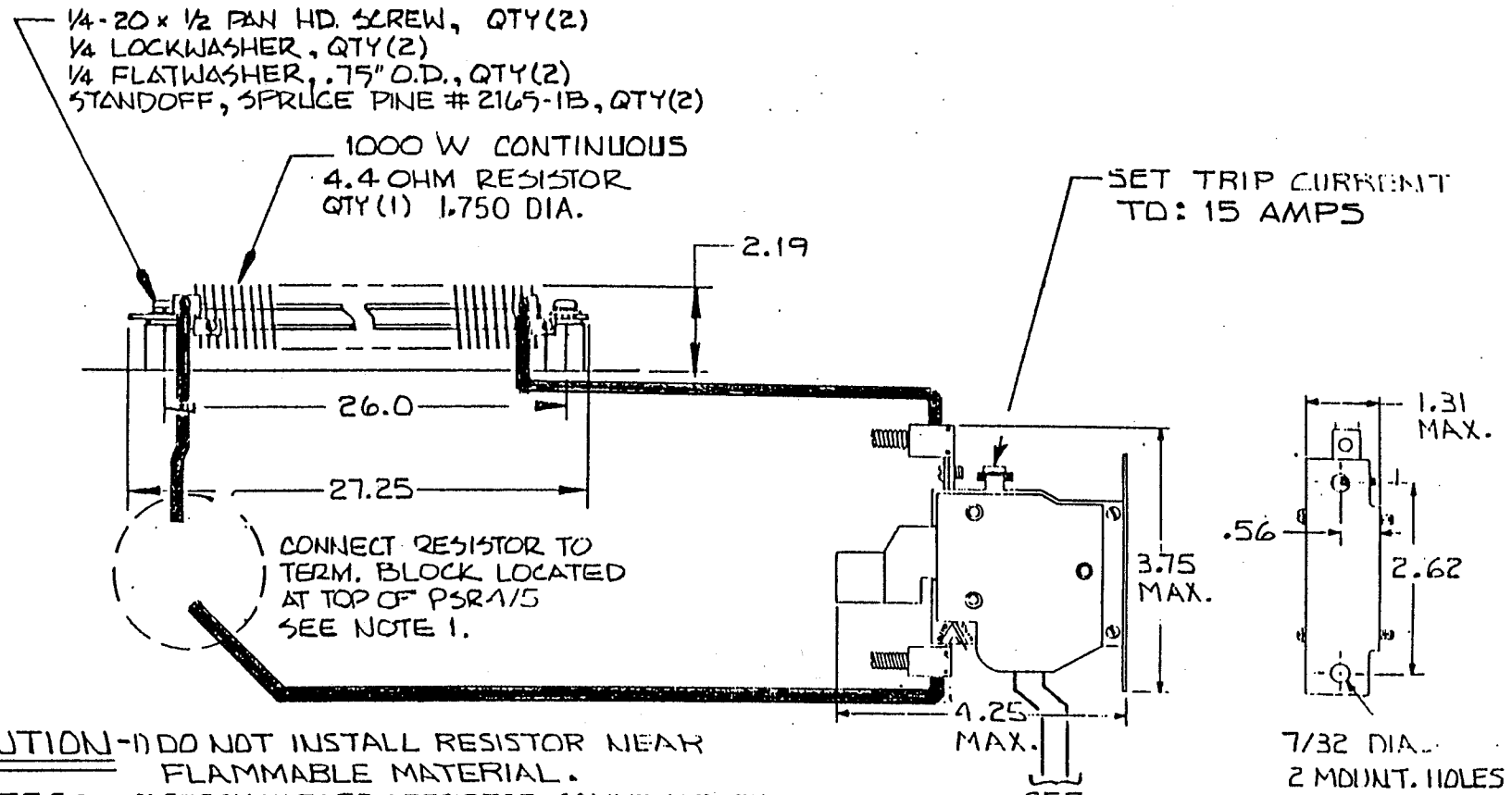
SCALE FULL

DWG. NO. REFERENCE: A-93231S2

UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	INCHES XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.

THIRD ANGLE PROJECTION

METRIC



CAUTION- 1) DO NOT INSTALL RESISTOR NEAR FLAMMABLE MATERIAL.

NOTES: 2) SHOCK HAZARD & RESISTOR CONNECTED TO HIGH VOLTAGE.

1. RECOMMENDED WIRE: # 8AWG, 125°C
2. BOTTOM STANDOFFS ARE THREADED 1/4-20 x 3/8" DP FOR MOUNTING RESISTORS TO PANELS, ETC.
3. OUTPUT CONTACTS: WIRED TO DROP MAIN LINES WHEN CONTACTS OPEN ON OVERLOAD.

SUPERIOR ELECTRIC

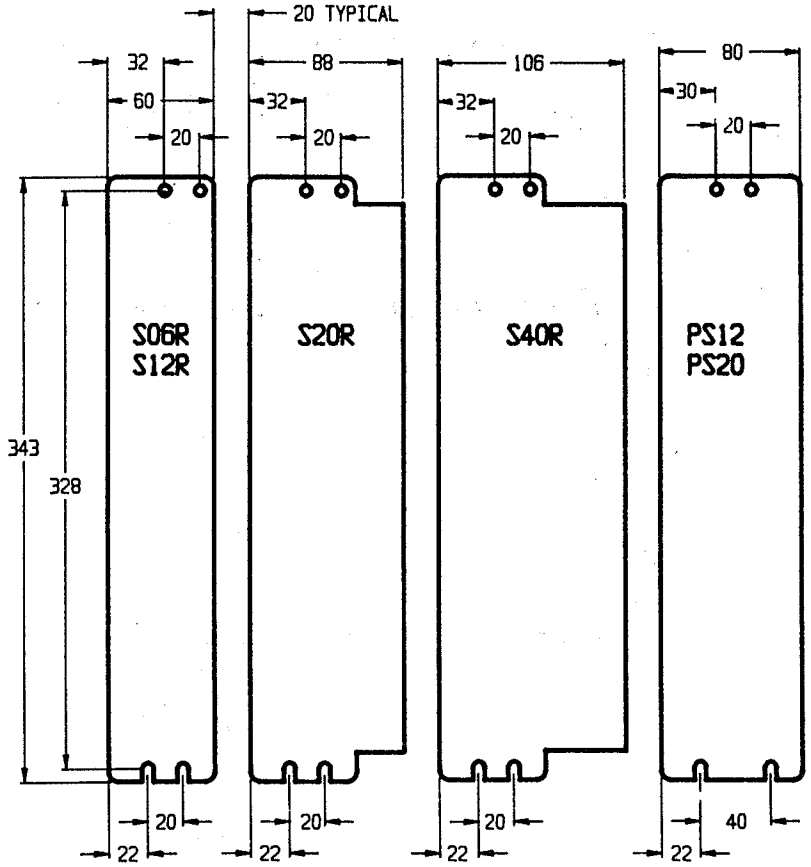
WIRING & MOUNTING DIAG
RH1000

SCALE \ | DWG. NO. REFERENCE: A-93314

A-93314 Sheet 1 of 1 D-13

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THIRD ANGLE PROJECTION METRIC	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.



1-A 25mm MINIMUM FREE SPACE SHOULD BE MAINTAINED AROUND THE SYSTEM.
2-LOCATE THE HIGHEST CURRENT AMPLIFIER NEXT TO THE POWER SUPPLY AND REMAINING AMPLIFIERS IN DESCENDING ORDER.

SUPERIOR ELECTRIC

MOUNTING HOLE PATTERN
SS2000-S06,S40 AMP, PS12,20 POWER SUP

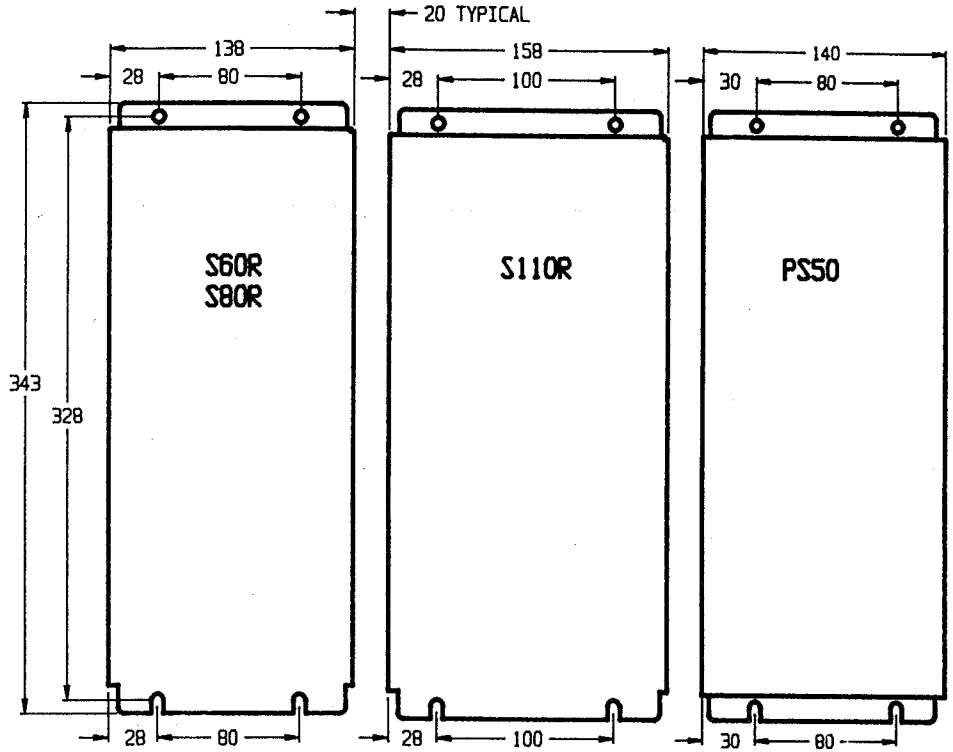
SCALE 1:4 | DWG. NO. REFERENCE: A-93656S1

D-14 A-93656 Sheet 1

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THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.

METRIC



SEE NOTES ON SHEET 1.

SUPERIOR ELECTRIC

MOUNTING HOLE PATTERN

SS2000-S60,S110 AMP, PS50 PWR SUPPLY

SCALE 1:4 | DWG. NO. REFERENCE: A-93656S2

A-93656 Sheet 2

D-15

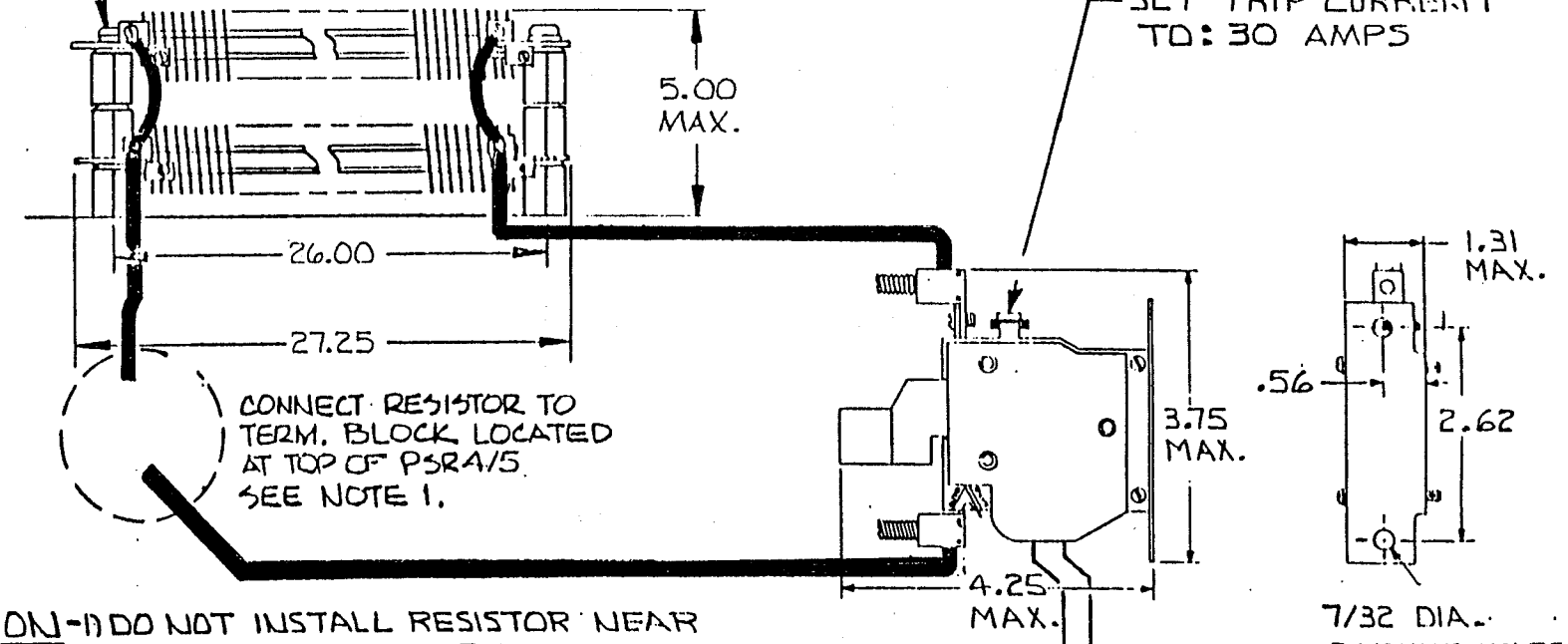
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THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.
METRIC				

1/4-20 x 1/2 PAN HD. SCREW QTY (2)
1/4 LOCKWASHER QTY (2)
1/4 FLATWASHER QTY (2)
1/4-20 x 1/2 THREADED STUD QTY (4)
STAND-OFF, SPRUCE PINE #2165-1B QTY (6)
4.4 OHM RESISTOR, 1000 W QTY (2)

RATED POWER: 2000 W
TOTAL RESISTANCE: 2.2 Ω

SET TRIP CURRENT TO: 30 AMPS



CAUTION-1) DO NOT INSTALL RESISTOR NEAR FLAMMABLE MATERIAL.

NOTES: 2) SHOCK HAZARD & RESISTOR CONNECTED TO HIGH VOLTAGE.

1. RECOMMENDED WIRE: # 8AWG, 125°C
2. BOTTOM STANDOFFS ARE THREADED 1/4-20 x 3/8" DP FOR MOUNTING RESISTORS TO PANELS, ETC.
3. OUTPUT CONTACTS: WIRED TO DROP MAIN LINES WHEN CONTACTS OPEN ON OVERLOAD.

SUPERIOR ELECTRIC

WIRING & MOUNTING DIAG
RH2000

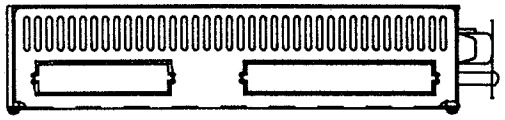
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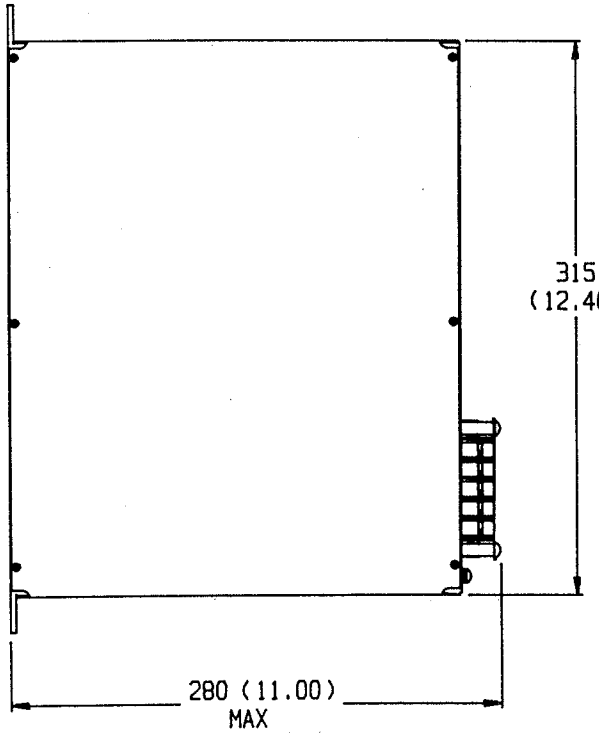
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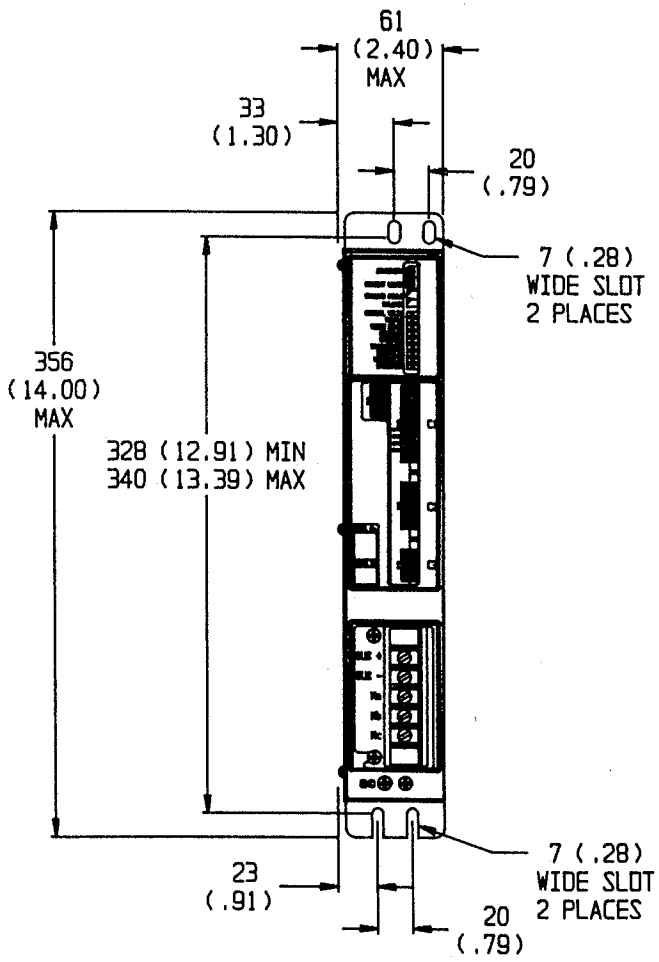
UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.

THIRD ANGLE PROJECTION

METRIC







THIS UNIT CONTAINS STATIC SENSITIVE MATERIAL, HANDLE ACCORDINGLY.

SUPERIOR ELECTRIC

OUTLINE
SS2000-S06R, S12R

SCALE 1:4 | DWG. NO. REFERENCE: A-93567

A-93567 Sheet 1 of 1

D-17

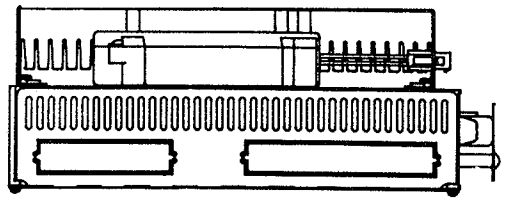
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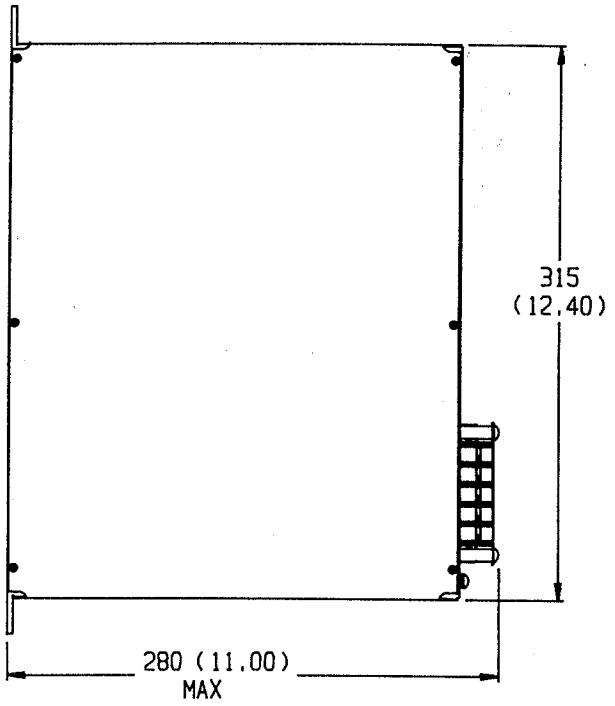
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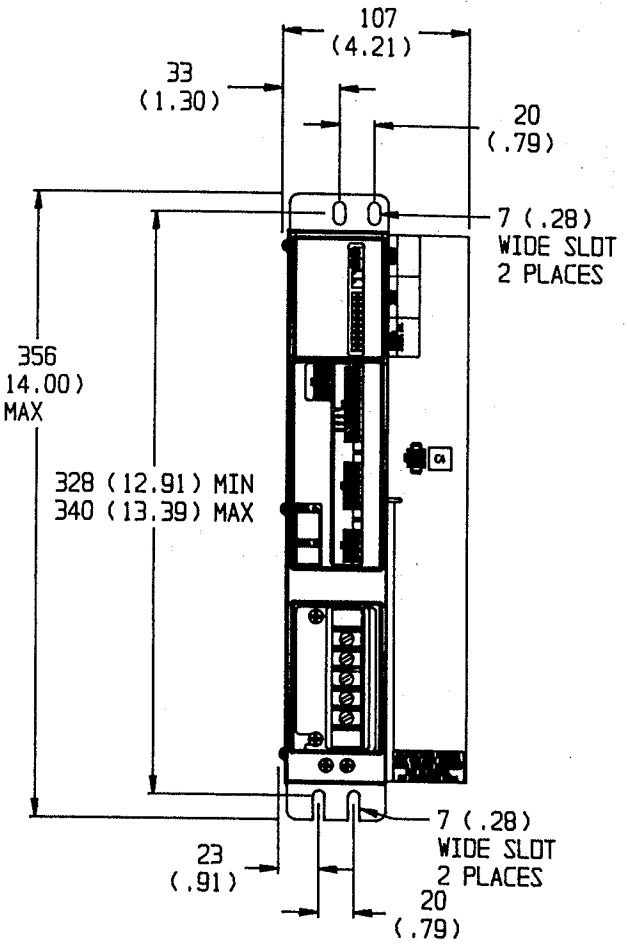
THIRD ANGLE PROJECTION

METRIC

UNLESS OTHERWISE SPECIFIED	METRIC	[INCHES]	DO NOT SCALE DWG. USE DIMENSIONS ONLY.
ANG. DIM. ±1 DEGREE	X DEC. PLACES ±.4 XX DEC. PLACES ±.13	XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.







THIS UNIT CONTAINS STATIC SENSITIVE MATERIAL, HANDLE ACCORDINGLY.

SUPERIOR ELECTRIC

OUTLINE
SS2000-S40R

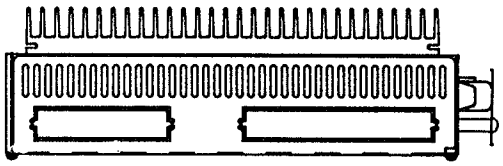
SCALE 1:4

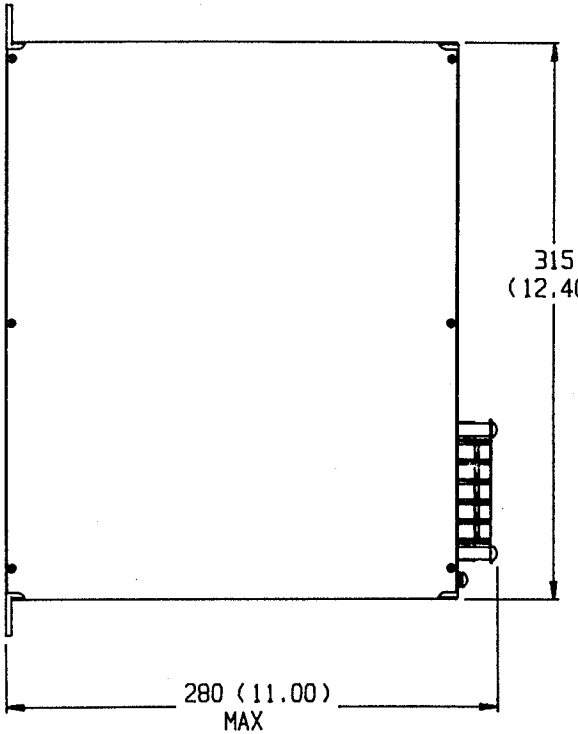
DWG. NO. REFERENCE: A-93568

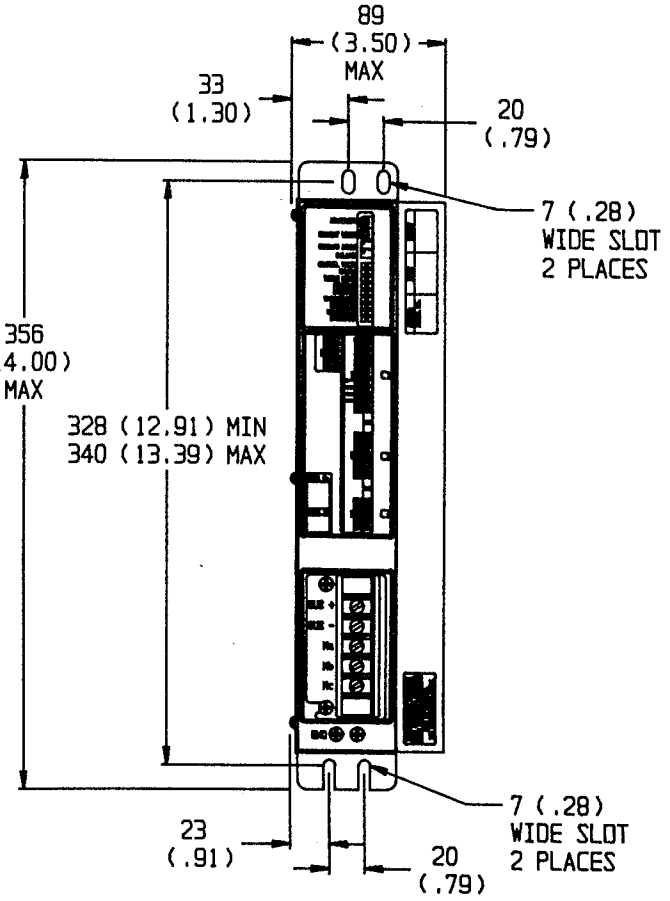
UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.

THIRD ANGLE PROJECTION

METRIC







THIS UNIT CONTAINS STATIC SENSITIVE MATERIAL, HANDLE ACCORDINGLY.

SUPERIOR ELECTRIC

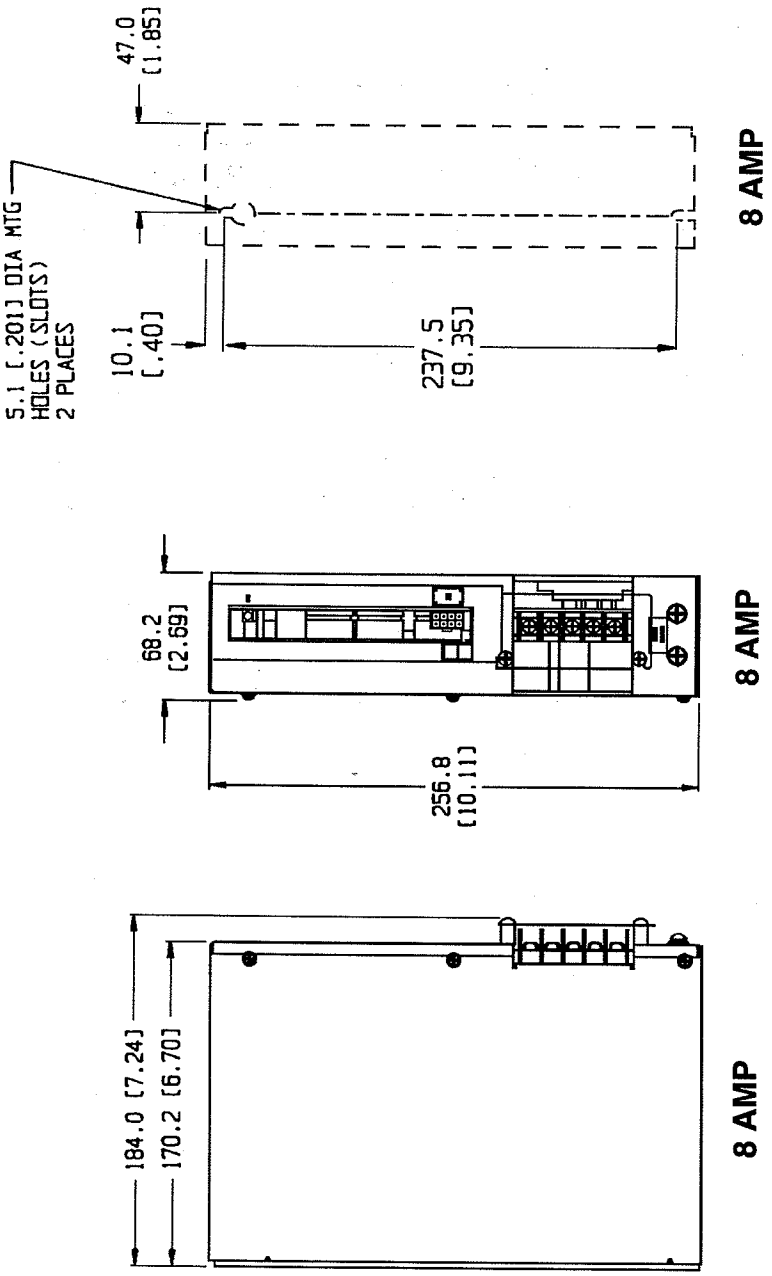
OUTLINE
SS2000-S20R

SCALE 1:4 | DWG. NO. REFERENCE: A-93572

A-93572 Sheet 1 of 1

D-19

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APPENDIX E

MOTOR INSTALLATION

SLO-SYN servo motors are rated for a 207°F (115°C) temperature rise in a 104 °F (40°C) ambient. If these motors are installed in an ambient above 104°F (40°C), they must be derated so that the internal temperature does not exceed 311°F (155°C).



CAUTION

Superior Electric servo motors may attain case temperatures approaching or exceeding 212 F (100 C), the boiling point of water. Use caution when handling the motors.

The motors can be mounted in any orientation. Refer to the appropriate outline, assembly, and hook-up drawings for the necessary mounting dimensions and wiring details.

MS, screw thread, connectors are standard on all motors except the S070 size. One is for the three phase motor stator and case ground wire. A second connector is for the resolver, thermostat, and options such as brake and brush tachometer. These two connectors are furnished with crimp type contacts. Mating plugs for these two connectors are available with solder type contacts to facilitate the wiring of the mating plugs in the field. These motors are also available with flying leads or terminal blocks. Refer to the appropriate hook-up drawing for details.

E.1 RECOMMENDED BEARING LOADS

The bearing loads may be radial or axial such that the sum of the radial and two (2) times the axial does not exceed the specifications given in the following charts:

CHART 1

MOTOR MODEL NUMBER	Load Centered at 1.00 in. (25.4mm) From Mounting Face									
	1000 RPM		2000 RPM		3000 RPM		4000 RPM		5000 RPM	
	LBS	KG	LBS	KG	LBS	KG	LBS	KG	LBS	KG
S092-1	85.4	38.74	67.8	30.75	59.1	26.81	53.8	24.4	50.0	22.68
S092-2	90.1	40.87	71.6	32.48	62.4	28.3	56.8	25.76	52.8	23.95
S092-3	93.5	42.41	74.2	33.66	64.8	29.39	59.0	26.76	54.7	24.81
S115-1	146.5	66.45	116.3	52.75	101.5	46.04	92.3	41.87	85.7	38.87
S115-2	154.7	70.17	122.8	55.7	107.2	48.63	97.4	44.18	90.5	41.05
S115-3	160.0	72.58	127.1	57.65	110.9	50.3	100.8	45.72	93.6	42.46
S142-1	243.5	110.5	193.3	87.68	168.8	76.57	153.4	69.58	142.5	64.64
S142-2	255.6	115.9	202.9	92.03	177.2	80.38	161.0	73.03	149.6	67.86
S142-3	263.0	119.3	208.8	94.71	182.3	82.69	165.7	75.16	153.9	69.81
S190-1	341.4	154.9	271.1	123	236.6	107.3	215.1	97.57	199.7	90.58
S190-2	356.7	161.8	283.2	128.5	247.2	112.1	224.7	101.9	208.7	94.67
S190-3	365.9	166	290.5	131.8	253.6	115	230.5	104.6	214.1	97.12

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CHART 2

MOTOR MODEL NUMBER	Load Centered at 1.75 in. (44.45mm) From Mounting Face									
	1000 RPM		2000 RPM		3000 RPM		4000 RPM		5000 RPM	
	LBS	KG	LBS	KG	LBS	KG	LBS	KG	LBS	KG
S115-1	133.8	60.69	106.2	48.17	92.7	42.05	84.3	38.24	78.3	35.52
S115-2	143.8	65.23	114.1	51.75	99.6	45.18	90.6	41.10	84.1	38.15
S115-3	150.6	68.31	119.6	54.25	104.4	47.36	94.9	43.05	88.1	39.96
S142-1	224.9	102.0	178.6	81.01	155.9	70.72	141.7	64.27	131.6	59.69
S142-2	240.3	109.0	190.8	86.55	166.5	75.52	151.4	68.67	140.6	63.78
S142-3	250.0	113.4	198.5	90.04	173.3	78.61	157.5	71.44	146.3	66.36

CHART 3

MOTOR MODEL NUMBER	Load Centered at 2.00 in. (50.8mm) From Mounting Face									
	1000 RPM		2000 RPM		3000 RPM		4000 RPM		5000 RPM	
	LBS	KG	LBS	KG	LBS	KG	LBS	KG	LBS	KG
S190-1	312.0	141.5	247.8	112.4	216.2	98.07	196.6	89.18	182.5	82.78
S190-2	332.9	151	264.4	119.9	230.7	104.6	209.8	95.16	194.8	88.36
S190-3	346.2	157	274.9	124.7	239.9	108.8	218.1	98.93	202.5	91.85

E.2 MAINTENANCE

Under normal circumstances, the SS2000 family of servo motors require little maintenance. The bearings are permanently lubricated, sealed, and shielded to prevent electrical charges from deteriorating bearing components. However bearings may have to be replaced after approximately 10,000 hours of operation at rated load. Refer to Charts 1, 2, and 3 for bearing load specifications.

The permanent magnet rotor assemblies do not require maintenance. However, in the event of bearing replacement, the rotor assembly can be removed from the wound stator assembly without the use of a magnetic keeper with no loss of field sensitivity.

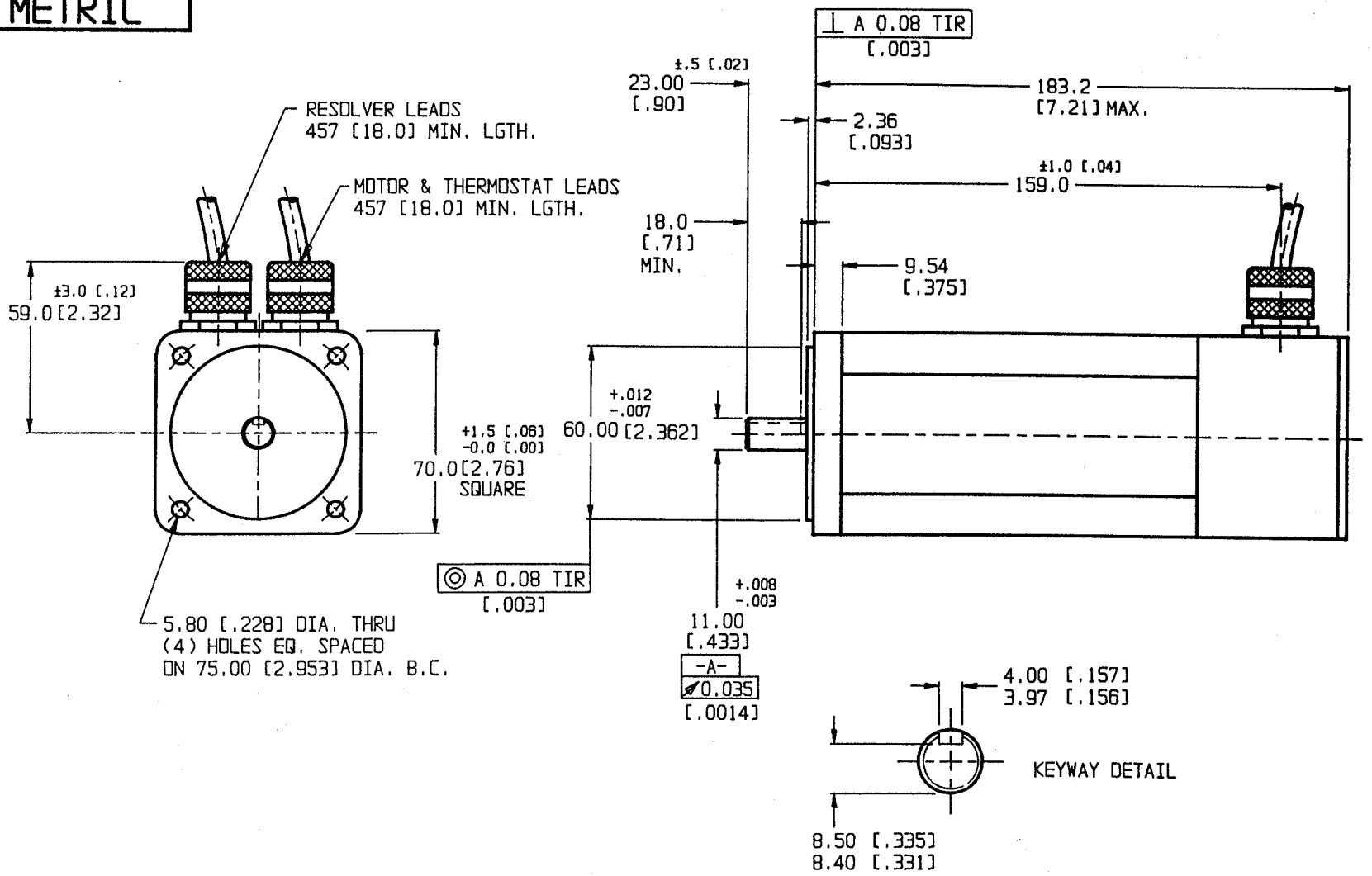
E.2.1 Routine Inspection

Bearing condition should be investigated as a matter of routine maintenance. Excessive or uncommon noise being emitted from the bearing areas is cause for immediate investigation. In such a case the bearings must be inspected. Any bearing which does not operate smoothly, shows evidence of loss of lubrication, or appears to have been overheated should be replaced.

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THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.

METRIC



SUPERIOR ELECTRIC

OUTLINE
S070-1X-14

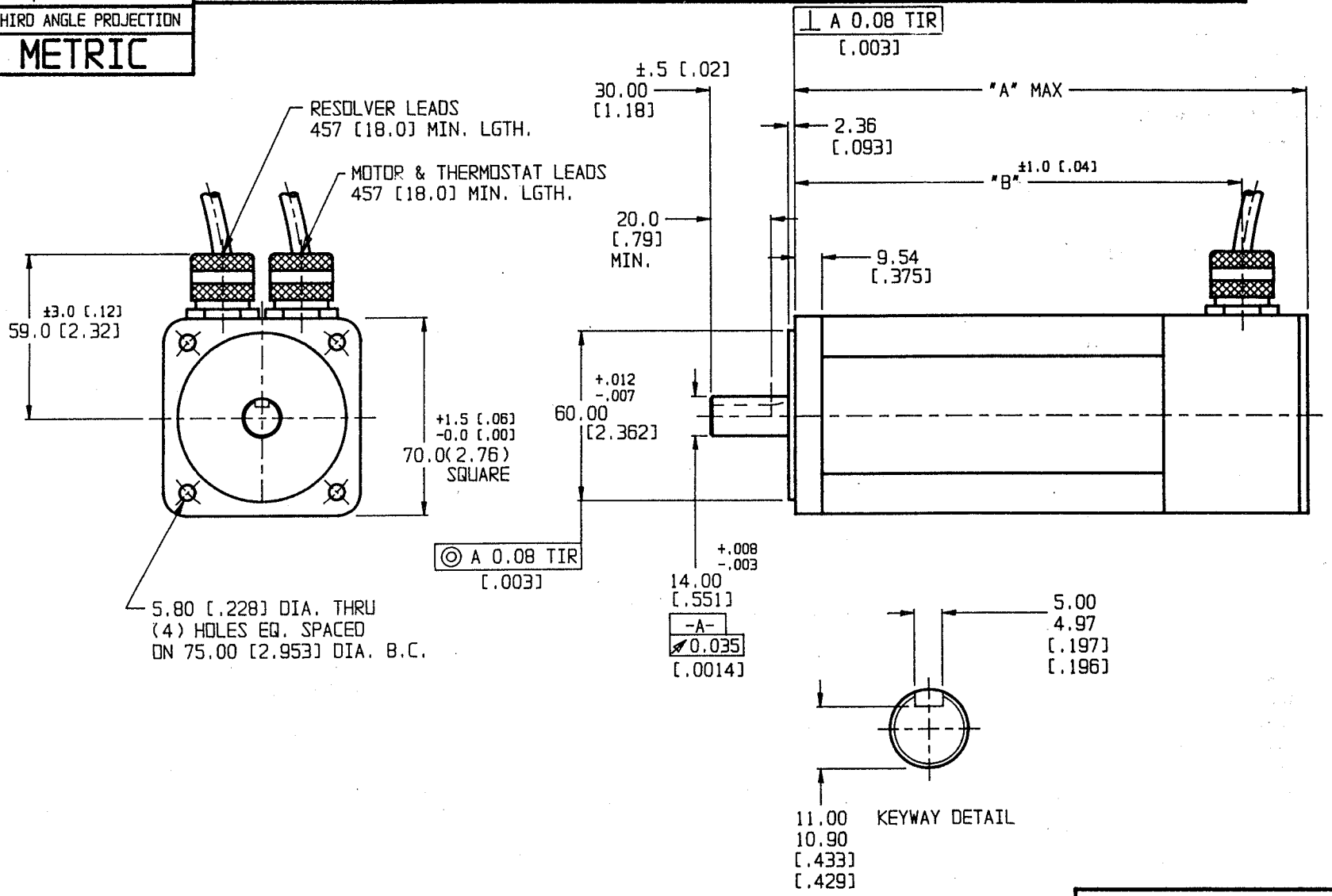
SCALE 1:2 | DWG. NO. REFERENCE: A-65427

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UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.

THIRD ANGLE PROJECTION

METRIC



MODEL	"A" MAX	"B"
S070-3	244.2 (9.61)	220.0 (8.66)
S070-2	213.7 (8.41)	189.5 (7.46)

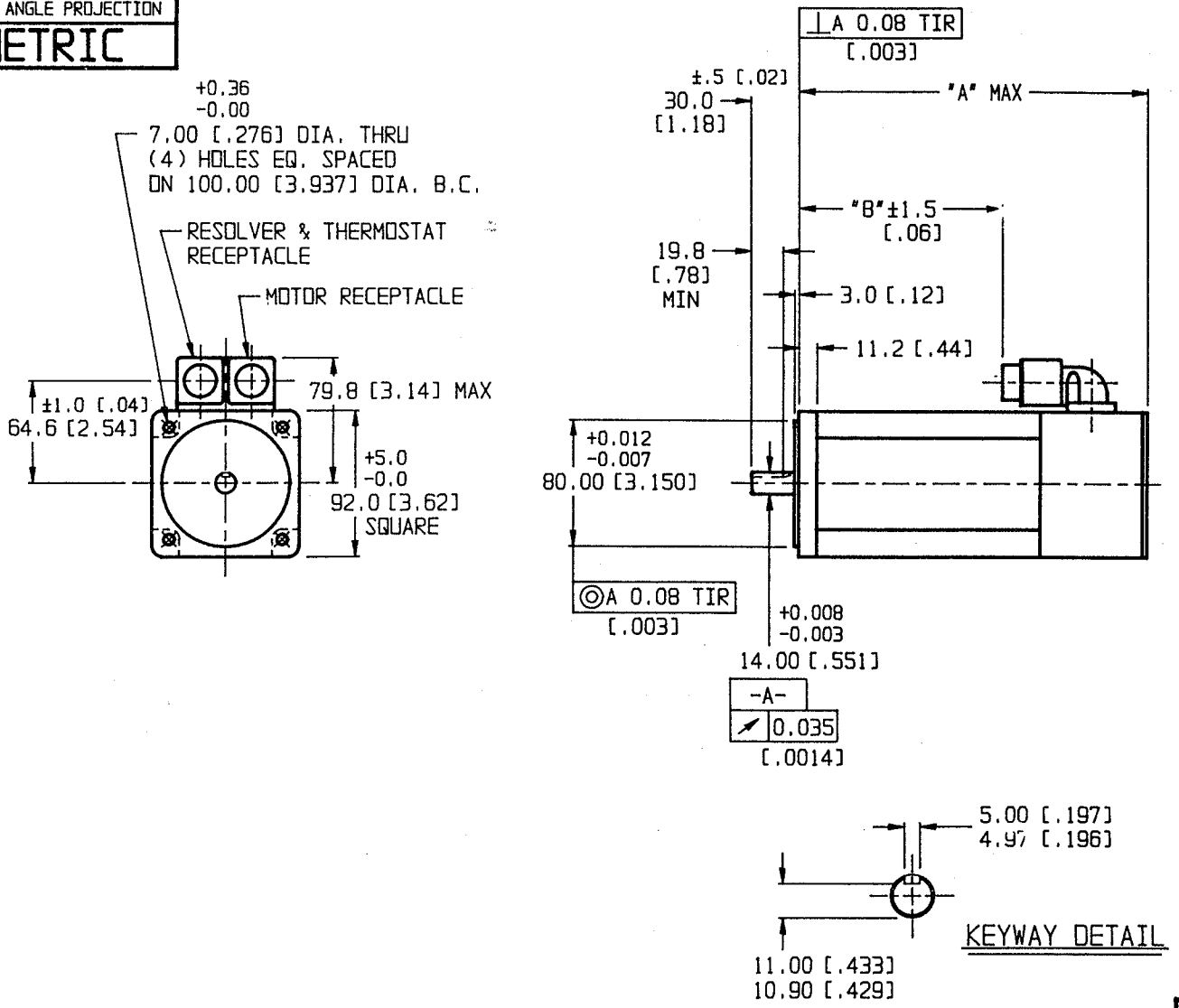
SUPERIOR ELECTRIC

OUTLINE
S070-2X, 3X-14

SCALE 1:2 | DWG. NO. REFERENCE: A-65428

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THIRD ANGLE PROJECTION METRIC	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.



MODEL	"A" MAX	"B"
S092-3	294.0 [11.57]	203.1 [8.00]
S092-2	254.4 [10.02]	163.5 [6.44]
S092-1	214.8 [8.46]	123.9 [4.88]

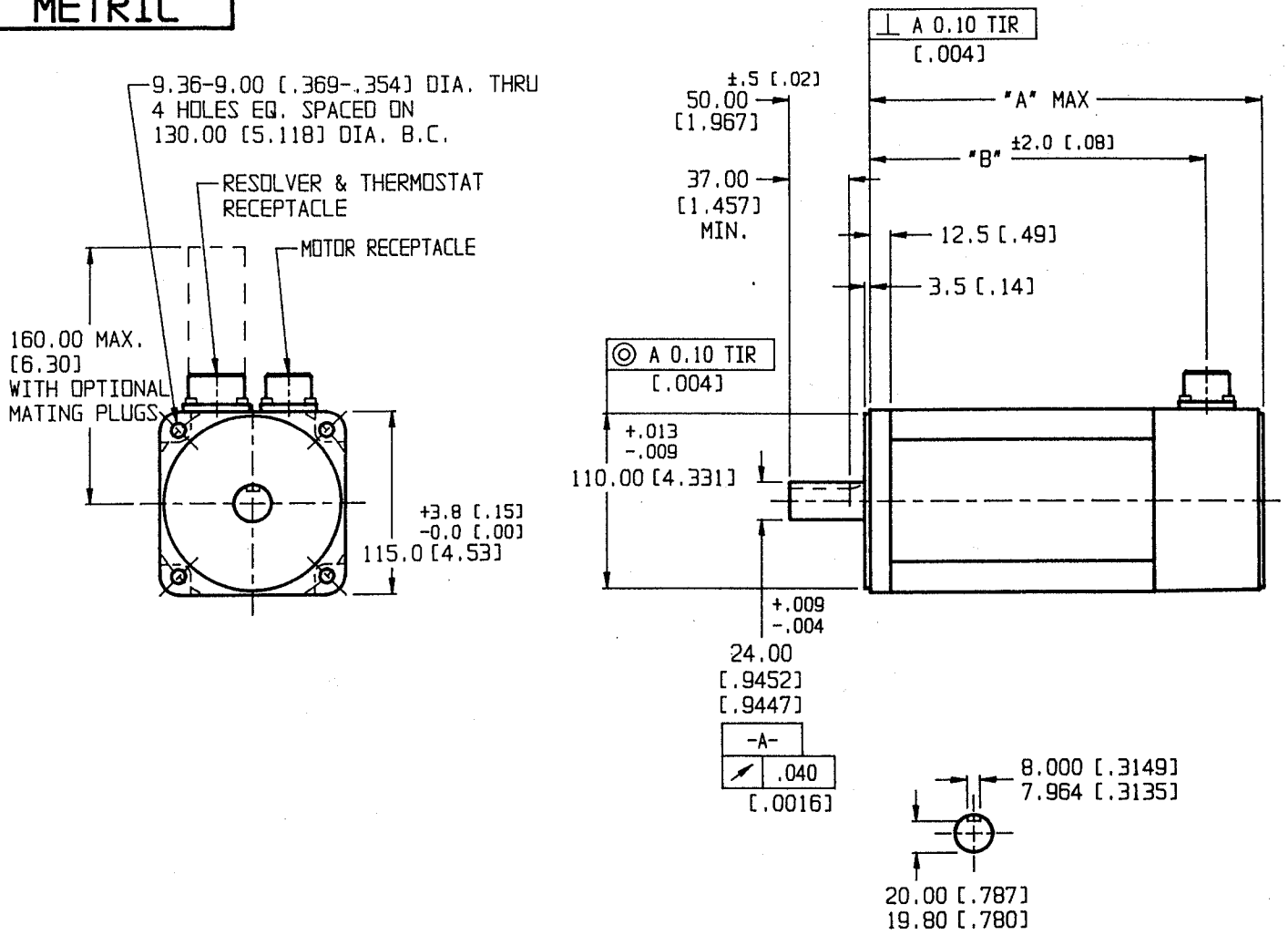
SUPERIOR ELECTRIC

OUTLINE
S092-1X, 2X, 3X-A4

SCALE 1:4 | DWG. NO. REFERENCE: A-65425

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THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.
METRIC				



KEYWAY DETAIL

MODEL	"A" MAX	"B"
S115-3	351.1 [13.82]	320.2 [12.61]
S115-2	297.8 [11.72]	266.9 [10.51]
S115-1	244.5 [9.63]	213.6 [8.41]

SUPERIOR ELECTRIC

OUTLINE
S115-1X, 2X, 3X-A4

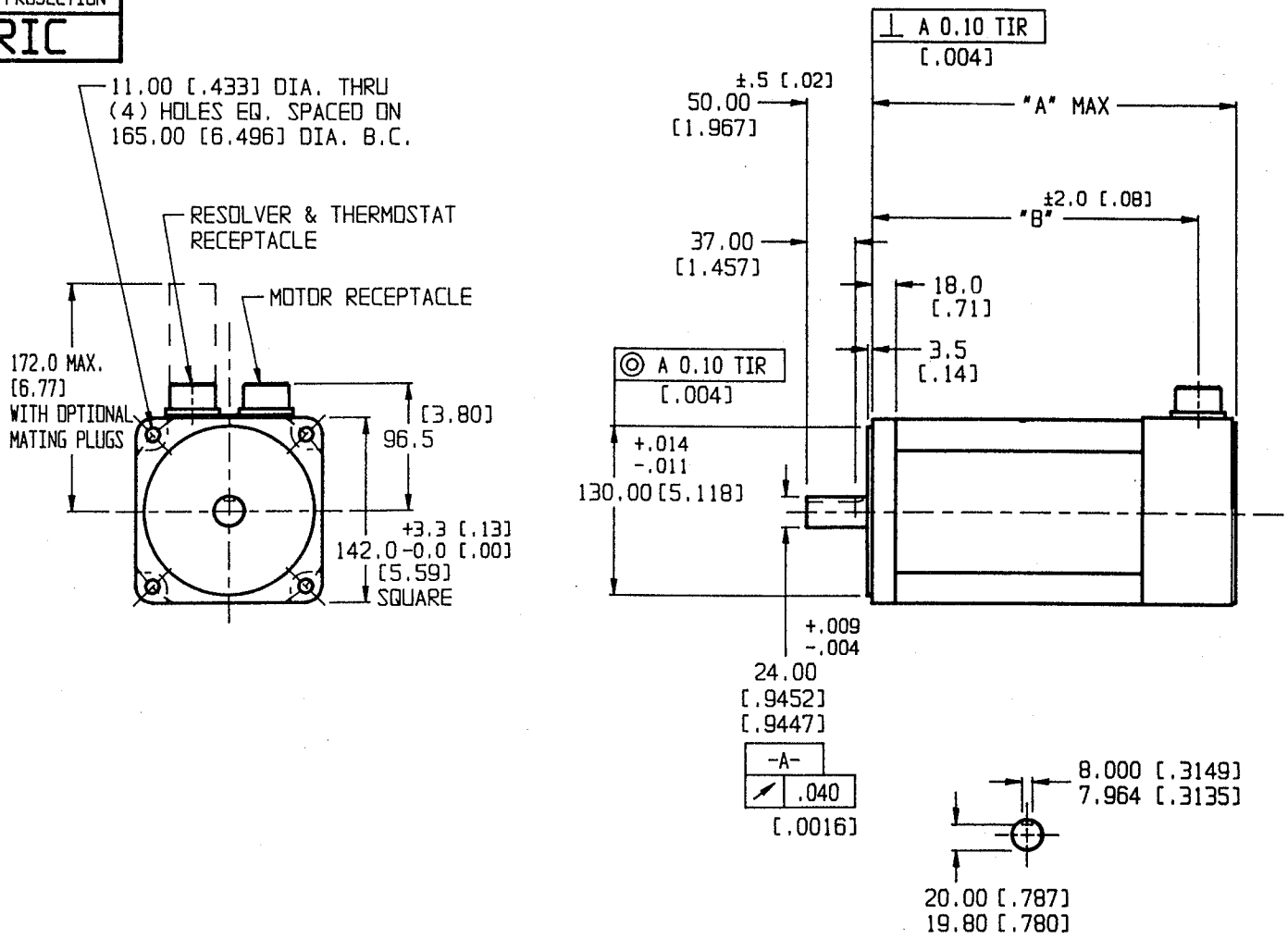
SCALE 1:4 | DWG. NO. REFERENCE: A-65423

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THIRD ANGLE PROJECTION

METRIC



KEYWAY DETAIL

MODEL	"A" MAX	"B"
S142-2	346.8 [13.65]	316.6 [12.46]
S142-1	278.2 [10.95]	248.0 [9.76]

SUPERIOR ELECTRIC

OUTLINE
S142-1X, 2X-A4

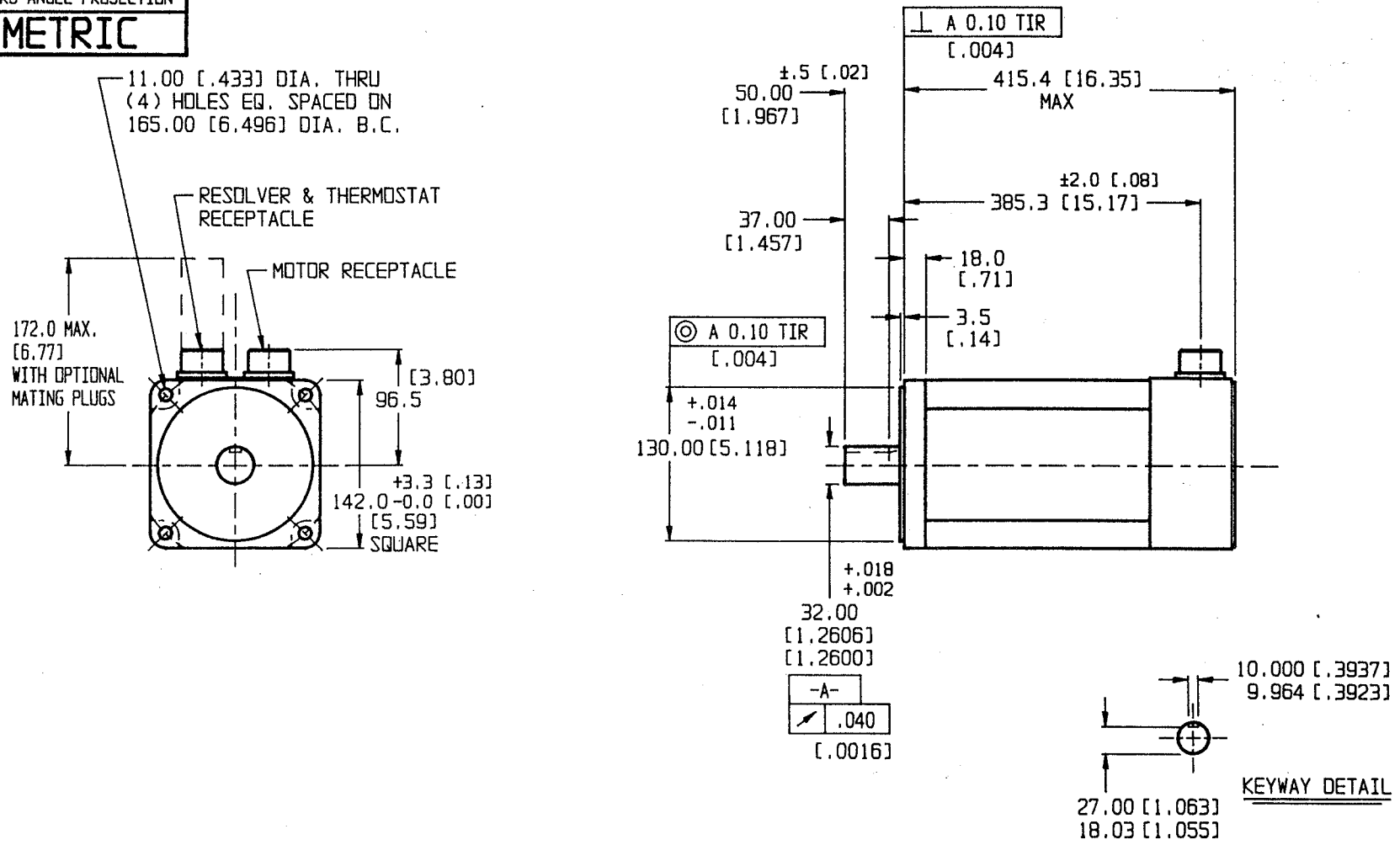
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THIRD ANGLE PROJECTION

METRIC



SUPERIOR ELECTRIC

OUTLINE

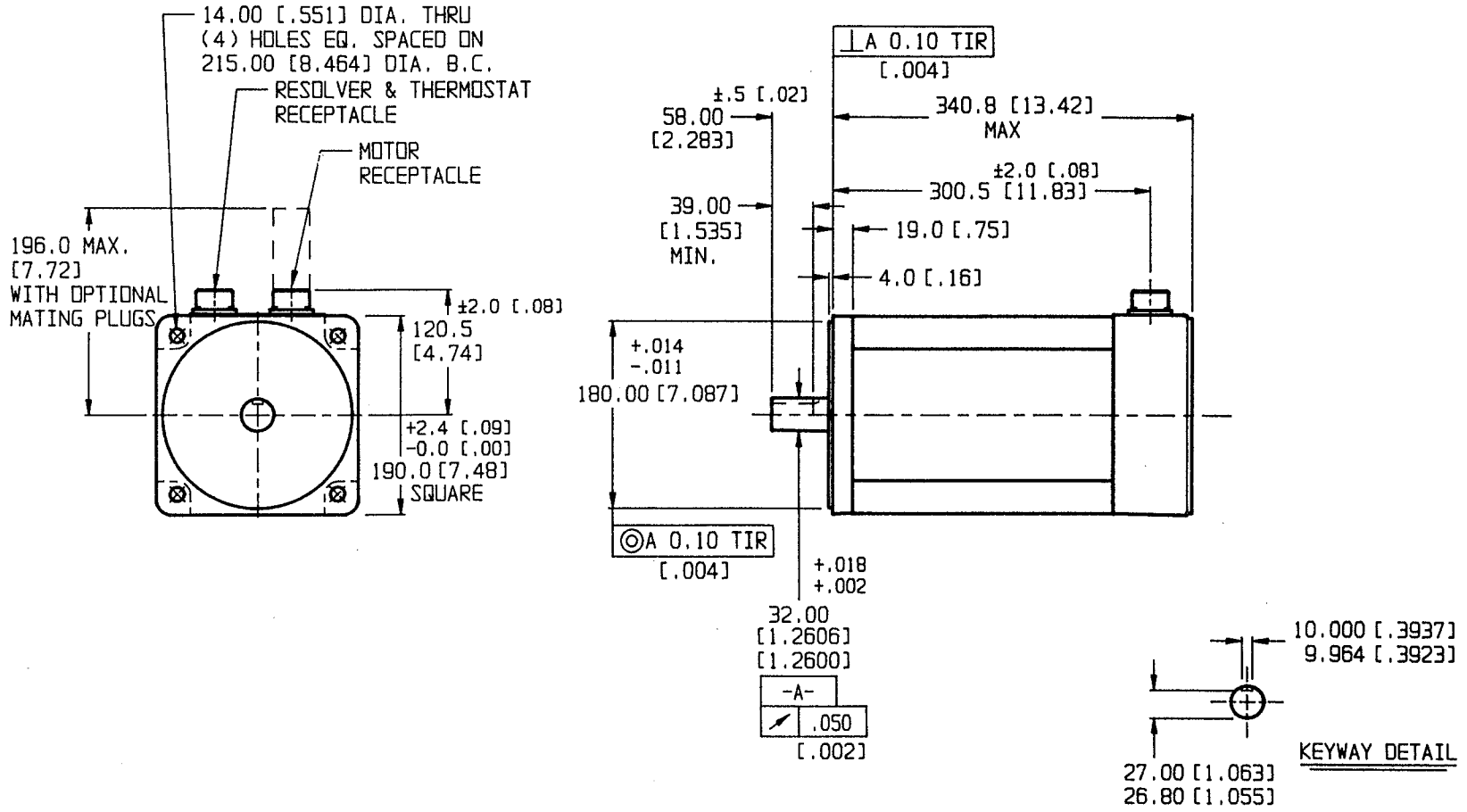
S142-3X-A4

SCALE 1:5 | DWG. NO. REFERENCE: A-65418

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THIRD ANGLE PROJECTION	UNLESS OTHERWISE SPECIFIED ANG. DIM. ±1 DEGREE	METRIC X DEC. PLACES ±.4 XX DEC. PLACES ±.13	[INCHES] XX DEC. PLACES ±.015 IN. XXX DEC. PLACES ±.005 IN.	DO NOT SCALE DWG. USE DIMENSIONS ONLY. ALL DIMENSIONS ARE MILLIMETERS WITH INCHES IN BRACKETS. UNLESS OTHERWISE SPECIFIED.

METRIC



SUPERIOR ELECTRIC

OUTLINE
S190-1X-A4

SCALE 1:6 | DWG. NO. REFERENCE: A-65422

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GLOSSARY

Acceleration

The change in velocity as a function of time. Acceleration usually refers to increasing velocity and deceleration describes decreasing velocity.

Ambient Temperature

The temperature of the cooling medium, usually air, immediately surrounding the motor or another device.

Amplifier

Electronics which convert low level command signals to high power voltages and currents to operate a servo motor.

Brushless Servo Drive

A servo drive used to control a permanent magnet synchronous AC motor. May also be referred to as an AC Servo Drive.

Drive

This is the electronics portion of the system that controls power to the motor.

Drive, Analog

Usually referring to any type of motor drive in which the input is an analog signal.

Drive, Servo

A motor drive which utilizes internal feedback loops for accurate control of motor current and/or velocity.

Efficiency

The ratio of output power to input power.

Encoder, Absolute

A digital position transducer in which the output is representative of the absolute position of the input shaft within one (or more) revolutions. Output is usually a parallel digital word.

Encoder, Incremental

A position encoding device in which the output represents incremental changes in position.

Encoder, Marker

A once-per-revolution signal provided by some incremental encoders to specify a reference point within that revolution. Also known as Zero Reference signal or index pulse.

Encoder Resolution

A measure of the smallest positional change which can be detected by the encoder.

Feedback

A signal which is transferred from the output back to the input for use in a closed loop system.

Following Error

The position error during motion resulting from use of a position control loop with proportional gain only.

Friction

A resistance to motion caused by surfaces rubbing together. Friction can be constant with varying speed (coulomb friction) or proportional to speed (viscous friction) or present at rest (static friction).

Full Load Current

The armature current of a motor operated at its full load torque and speed with rated voltage applied.

Full Load Speed

The speed of a motor operated with rated voltage and full load torque.

Gain

The ratio of system output signal to system input signal. The control loop parameter that determines system performance characteristics.

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HP: Horsepower

One horsepower is equal to 746 watts. Since Power = Torque × Speed, horsepower is a measure of a motor's torque and speed capability (e.g. a 1 HP motor will produce 35 lb-in. at 1800 rpm).

I/O: Input/Output

The reception and transmission of information between control devices. In modern control systems, I/O has two distinct forms: switches, relays, etc., which are in either an on or off state, or analog signals that are continuous in nature such as speed, temperature, flow, etc.

Inertia

The property of an object to resist changes in velocity unless acted upon by an outside force. Higher inertia objects require larger torques to accelerate and decelerate. Inertia is dependent upon the mass and shape of the object.

Inertial Match

An inertial match between motor and load is obtained by selecting the coupling ratio such that the load moment of inertia referred to the motor shaft is equal to the motor moment of inertia.

Inrush Current

The current surge generated when a piece of equipment such as a servo amplifier is connected to an AC line. This surge is typically due to the impulse charging of a large capacitor located in the equipment.

Instability

Undesirable motion of an actuator that is different from the command motion. Instability can take the form of irregular speed or hunting of the final rest position.

Limits

Motion control systems may have sensors called limits that alert the control electronics that the physical end of travel is being approached and that motion should stop.

Logic Ground

An electrical potential to which all control signals in a particular system are referenced.

Loop, Feedback Control

A control method that compares the input from a measurement device, such as an encoder or tachometer, to a desired parameter, such as a position or velocity and causes action to correct any detected error. Several types of loops can be used in combination (i.e. velocity and position together) for high performance requirements.

Master Slave Motion Control

A type of coordinated motion control where the master axis position is used to generate one or more slave axis position commands.

Motor, AC

A device that converts electrical alternating current into mechanical energy. Requires no commutation devices such as brushes. Normally operated off commercial AC power. Can be single or multiple phase.

Oscillation

An effect that varies periodically between two values.

PLC

Programmable Logic Controller. Also known as a programmable controller, these devices are used for machine control and sequencing.

Power

The rate at which work is done. In motion control, Power = Torque × Speed.

Pulse Rate

The frequency of the step pulses applied to a step-per motor driver. The pulse rate divided by the resolution of the motor/drive combination (in steps per revolution) yields the rotational speed in revolutions per second.

Ramping

The acceleration and deceleration of a motor. May also refer to the change in frequency of the applied step pulse train.

Rated Torque

The torque producing capacity of a motor at a given speed. This is the maximum continuous torque the

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motor can deliver to a load and is usually specified with a torque/speed curve.

Regeneration

The action during motor braking, in which the motor acts as a generator and takes kinetic energy from the load, converts it to electrical energy, and returns it to the amplifier.

Repeatability

The degree to which the positioning accuracy for a given move performed repetitively can be duplicated.

Resolution

The smallest positioning increment that can be achieved. Frequently defined as the number of steps or feedback units required for a motor's shaft to rotate one complete revolution.

Resolver

A position transducer utilizing magnetic coupling to measure absolute shaft position over one revolution.

RMS Current

Root mean square current. In an intermittent duty cycle application, the RMS current is equal to the value of steady state current which would produce the equivalent resistive heating over a long period of time.

Rotor

The rotating part of a magnetic structure. In a motor, the rotor is connected to the motor shaft.

Servo Amplifier/Servo Drive

An electronic device which produces the winding current for a servo motor. The amplifier converts a low level control signal into high voltage and current levels top produce torque in the motor.

Servo System

An automatic feedback control system for mechanical motion in which the controlled or output quantity is position, velocity, or acceleration. Servo systems are closed loop systems.

Shunt Resistor

A device located in a servo amplifier for controlling regenerative energy generated when braking a motor. This device dissipates of "dumps" the kinetic energy as heat.

Single Point Ground

The common connection point for signal grounds in a control wiring environment.

Slew

In motion control the portion of a move made at a constant non-zero velocity.

Speed Regulation

For a speed control system, speed regulation is the variation in actual speed expressed as a percentage of set speed.

Stiffness

Ratio of an applied force torque to change in position for a mechanical system.

Stator

The non-rotating part of a magnetic structure. In a motor the stator usually contains the mounting surface, bearings, and non-rotating windings or permanent magnets.

Tachometer

An electromagnetic feedback transducer which produces an analog voltage signal proportional to rotational velocity. Tachometers can be either brush or brushless.

Torque

The rotary equivalent to force. Equal to the product of the force perpendicular to the radius of motion and distance from the center of rotation to the point where the force is applied.

Velocity

The change in position as a function of time. Velocity has both a magnitude and direction.

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