OPERATION
&
SERVICE MANUAL

Model SMA8115
Model SMA8215
Model SMA8315

Brushless Amplifier System

GLENTEK

"Solutions for Motion Control"

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Introduction

Glentek's brushless DC motors and amplifiers offer the ultimate in low maintenance and high performance motion-control. Glentek offers a full line of matched motors and amplifiers to meet virtually every motion-control application.

This manual provides all the technical information necessary to install, configure, operate, and maintain our TORQUE-SWITCH™ series, brushless servo-motor amplifiers, models SMA8115, SMA8215, SMA8315, and the high power versions, models SMA8115HP, SMA8215HP, SMA8315HP. These amplifiers combine the economy of trapezoidal drive current or the high performance of sinusoidal motor current with the efficiency of pulse-width modulation (PWM).

We suggest that you take the time to read this manual from cover-to-cover before attempting to work with these amplifiers for the first time. If at any time you have questions not addressed in this manual, or have any special requirements, please feel free to call and discuss them with a Glentek applications engineer. We are happy to provide both off-the-shelf and custom products. With over three decades in the servo-motor/amplifier business, we have a vast pool of applications knowledge waiting to assist you.

Thank you for selecting Glentek for your motion-control needs. It is our goal to save you time and money, and to provide you with a superior product.

Chapter One: Description, Features and Specifications

1.1 Description:

This brushless amplifier system has been designed to offer you, our customer, a large degree of flexibility and customization with a standard, in stock product. Each amplifier module consists of a standard power output board with one of our three types of personality modules mounted on it. (To help you understand the various brushless amplifier and motor system combinations and their respective advantages and disadvantages, please refer to chapter two of this manual which describes the theory of operation). Following is a brief description of these three personality modules and their mode(s) of operation:

Trapezoidal Mode (SMA8115/SMA8115HP) - In this mode of operation, which is also commonly referred to as six step, the brushless motor is commutated by hall sensors or an encoder which contains these commutation signals. This personality module can be configured for the following three different types of operation:

VELOCITY MODE - In this mode of operation, a velocity signal from a brushless or brush type tachometer is used to close a velocity loop in the amplifier. Please see section 2.3, 2.7, 2.8 of this manual for more detailed information.

SIMULATED VELOCITY MODE - In this mode of operation, a circuit on the personality module looks at the hall sensors and generates a simulated velocity signal which is used to close a velocity loop in the amplifier. This mode of operation offers an extremely cost effective velocity mode system for medium to high velocity applications. Please see section 2.6 of this manual for more detailed information.

CURRENT MODE - In this mode of operation, which is also commonly referred to as torque mode, a current in the motor is produced which is directly proportional to the input signal. Please see section 2.2, 2.5, 2.7 of this manual for more detailed information.

Sine/Resolver Mode (SMA8215/SMA8215HP) - In this mode of operation, a brushless motor with an integral resolver is required. The personality module contains a resolver to digital converter which provides the positional information to the amplifier that is required to commutate the motor. This positional information is also used by the personality module to emulate a quadrature encoder output. This personality module can be configured for the following two different types of operation:

VELOCITY MODE - In this mode of operation, the personality module generates a tachometer signal which is used to close a velocity loop in the amplifier. Please see section 2.3, 2.5, 2.8 of this manual for more detailed information.

CURRENT MODE - In this mode of operation, which is also commonly referred to as torque mode, sine wave currents in the motor are produced that are directly proportional to the input signal. Please see section 2.5, 2.7, 2.9 of this manual for more detailed information.

Two/Three Phase Input Current Mode (SMA8315/SMA8315HP) - In the two phase current mode, the amplifier generates three sine wave currents that are proportional to two input signals. This third command is generated on the personality module as the negative sum of the other two signals. In the three phase current mode, the amplifier generates three sine wave currents that are proportional to three input signals. Please see section 2.5, 2.9 of this manual for more detailed information.

These brushless amplifiers come with all industry standard inputs such as +/-limit, fault output, etc. They are available in the following types of configurations:

As amplifier modules where you supply the DC Buss voltage, cooling fan(s), fusing and shunt regulator. Please see section 1.2.1 for more detailed information.

For multi-axis applications, the multi-axis baseplate power supply can supply DC power, cooling fans, zero crossing solid state relays, fusing and a shunt regulator for up to 4 axis or 60 amperes continuous. Please see section 1.2.3 for more detailed information.

1.2 Features:

1.2.1 Single Amplifier Module (SMA8X15-1):

• Ergonomic design:	Easy access to connections, adjustments, and test points.
• Wide operating buss voltage:	70-340VDC.
• Complete isolation:	Complete isolation from input to output.
• Dual signal inputs:	Two single-ended or one differential. Both single-ended inputs may be used simultaneously. All inputs have up to 15,000 A/V gain, and all inputs will accept ±13VDC.
• Dual mode operation: (8115 & 8215 only)	The standard amplifier may be configured for velocity (RPM) control or current (torque) control.
• Current limit:	Maximum motor current is adjustable.
• Silent operation:	Carrier frequency is 20KHz.
• Short circuit protection:	Complete short circuit and ground fault protection.
• LED diagnostics:	Red LED(S) illuminate to display various fault conditions and a green LED illuminates to indicate normal operating conditions.
• Encoder emulation: (8215 only)	Encoder emulation comes standard with line driver outputs, quadrature and zero index.
• Frequency response: (Velocity Loop)	750 Hz minimum.
• Frequency response: (Current Loop)	2 KHz minimum.
• Digital limit/enable Inputs:	Three separate logic inputs can stop the motor in either or both directions. Inputs may be configured for active-high or active-low, pull-up or pull-down termination, and a 0 to +5V or 0 to +15V range.
• Pseudo tach. option: (8115 only)	For medium and high-speed, unidirectional or bidirectional applications, an option allows the hall sensor inputs to produce a simulated tachometer voltage thus eliminating the need for an external tachometer.
• Encoder outputs: (8215 only)	Incremental (quadrature) position outputs with separate index. 19 different encoder counts, from 125 to 4096 counts/revolution, are available. Differential line-driver output devices sink and source 40mA.
• Tachometer output: (8115 & 8215 only)	DC output proportional to motor RPM.
• Fault input/output:	Open-collector output goes low in the event of a fault. This input is configured so that externally forcing this output low will inhibit the amplifier. This allows all fault outputs in a multi-axis system to be connected together (wire-ORed) to shut down all amplifiers should any amplifier have a fault.
• Manual and external fault reset:	Push button and a separate input is provided to reset the amplifier after a fault.
• High-Speed Electronic Circuit Breaker (HS/ECB):	Instantly shuts down the amplifier in the event of a short across the motor leads or a ground fault condition. (i.e. amplifier exceeds 80A for 10 microseconds)
• Low-Speed Electronic Circuit Breaker (LS/ECB):	Shuts down the amplifier if the amplifier is operated above the maximum continuous current rating (i.e.15A for standard 120VAC, 10A for standard 240VAC; 20A for High Power 120VAC and 15A for High Power 240VAC) for a pre-determined period (i.e. 3 seconds).

- Over/under voltage and over temperature: These circuits constantly monitor the amplifier power-supply voltages, and the motor and amplifier-heatsink temperatures. They will shut down the amplifier in the event of any out-of-specification condition. (The overvoltage protection circuit is set to turn on at +250VDC for 120VAC line input and +450VDC for 240VAC line input.)
- Multi-axis chassis: Up to four amplifier modules may be mounted on a single baseplate. Multi-axis baseplates include a DC power supply, cooling fan(s) and wiring for each respective amplifier module.

1.2.2 Multi-Axis Power Supply (GP8600-7000):

- Power supply for 2 to 4 axis amplifier baseplate.
- Line operated AC power operation: Fused single or three phase AC inputs with a solid state zero-crossing switch which limits in-rush current at turn-on. No power isolation transformer is required.
- Fused regen clamp circuit (shunt regulator) with LED indicator and 95W internal load resistor bank bleeds off excess DC Buss voltage when decelerating a large load inertia. Additional regen resistors can be connected externally.
- Bridge rectifier(s) and filter capacitor.
- Cooling fans.

1.3 Specifications:

This section contains the specifications for the brushless trapezoidal, sine/resolver and two or three phase input current mode D.C. Servo Amplifiers. These specifications also include power supplies for the amplifiers.

NOTE: All data in this section is based on the following ambient conditions: 120^{o}F (50^{o}C) maximum. Forced air cooling.

1.3.1 Single Amplifier Module (SMA8X15-1):

The amplifier module(s) require an external DC power supply which must include a bridge rectifier, buss capacitor, solid-state relay and shunt regulator. Forced air cooling is required to meet the maximum power ratings specified below.

1.3.1.1 Input and Output Power:

Input Power/ Buss Voltage(B+)	Output Power (current)			
	Standard		High Power	
	R.M.S.	Peak	R.M.S.	Peak
120VAC/170VDC	15A	25A	20A	40A
240VAC/340VDC	10A	25A	15A	35A

1.3.1.2 Signal Inputs:

Amplifier Model	Signal Input	Maximum Voltage (VDC)	Minimum Impedance Ù	Velocity Gain Amp./Volt	Current Gain Amp./Volt
8115/8215	Differential	13	10,000	15,000(min.)	0-5
8115/8215	Single-ended	±13	10,000	15,000(min.)	0-5
8315	2/3phase input	±13	10,000		0-5

1.3.1.3 Digital Inputs:

- ± Limit, Inhibit & Reset: 40/-0.5V max. Terminated by 10,000 ohms.
- Fault (as input): 40/-0.5V max. Terminated by 10,000 ohms.
- Typical for all digital inputs: Digital inputs have hysteresis with thresholds at 1/3 and 2/3 of +5V or +15V depending on range select jumper.

1.3.1.4 System:

- Drift offset over temperature reference to input: 0.01mV/ ^{o}C max.
- Frequency response (Velocity loop): 750Hz min.
- Frequency response (Current loop): 2KHz min.
- Dead band: None.
- Form factor: 1.01.

1.3.1.5 Outputs:

- Fault (as output): Active low. Open-collector output can sink 500mA max.
- Abs. motor current: 10A/V.
- Tachometer : 1000Ù source impedance, a high input impedance meter must be used (1MÙ/volt). Maximum Tachometer output voltage for 12 bit = 0.5V/KRPM, 14 bit = 2V/KRPM.
- Encoder outputs: (8215 only) Standard TTL levels with 20mA sink or source capability.

1.3.2 Multi Axis Power Supply:

The multi-axis power supply contains all items listed under 1.2.3.

1.3.2.1 Input and Output Power:

- Input Power (Buss, B+, Control Power, Fans): 120/240VAC.
- Buss Voltage, B+: 170/340VDC.
- Output Power: 60A continuous

1.3.3 Mechanical:

Model	L x W x H (inches)	Weight (lbs)
SMA8X15-1 (Single Amplifier Module)	7.125 x 1.38 x 4.53	1.28
SMA8X15-2A-2 (2 Axis Amplifier System)	9.00 x 10.50 x 7.70	9.36
SMA8X15-4A-4 (4 Axis Amplifier System)	13.00 x 10.50 x 7.70	15.12

Chapter Two: Theory of Operation

2.1 Introduction:

This chapter contains the basic control theory of how brush-type and brushless servo motors and amplifiers operate. It also compares and contrasts the advantages and disadvantages of brushless and brush type motors and amplifiers to help you select which is best suited for your application. The following is a summary of the topics:

- The theory behind an amplifer driving DC servo-motors.
- A comparison between brush-type and brushless motors.
- A comparison between trapezoidal mode and sinusoidal mode amplifier system.
- The advantages and disadvantages of trapezoidal mode amplifier systems.
- A comparasion between velocity mode and current mode.
- Various kinds of velocity feedback.
- Commutation using resolver.
- Current mode in sine/resolver or trapezoidal amplifier vs two/three phase input current amplifier.
- Protection circuits.

2.2 Driving DC Servo-Motors:

The torque of any DC motor is proportional to motor current: the stronger the magnetic field, the stronger the pull. Motor current may be controlled in two ways: linear and PWM (Pulse-Width Modulation). Linear control is achieved by simply inserting a resistance in series with the motor. This resistance is usually a partially turned-on transistor. The transistor is said to be in its "linear" region. Linear amplifiers are simple, accurate, and effective. However, they are very inefficient and they generate a lot of heat. Linear amplifiers are used when low electrical noise, high bandwidths (2KHz or higher) and or low inductance (less than 1mH) motors are used. In pulse-width modulation the control devices (output transistors) are rapidly turned full-on and full-off. The ratio of the on-time (the pulse width) and off-time determines the average motor current. Refer to figure 2.1. For example: if the output is on 25% of the time and off 75% of the time, the average motor current is approximately 25% of maximum.

A coil of wire, such as the windings of a motor, forms an inductor. Inductors resist changes in current. This resistance to change, known as reactance, acts to dampen or average the high-current spikes that would otherwise occur when the output devices are on. In fact, if motor inductance is low, external inductors may have to be added in series with each motor lead to ensure proper operation.

A brush-type motor may be run from a steady DC voltage since the brushes and commutator switch the current from winding to winding. However, a brushless motor requires that the voltage be switched from winding to winding externally; the voltage that drives a brushless motor is a constantly changing AC waveform. Section 2.5 dicusses these waveforms.

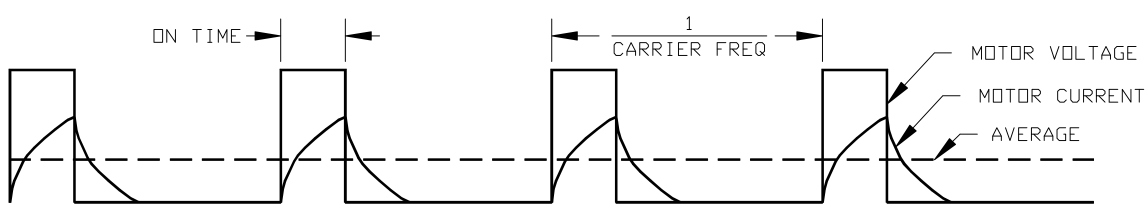


Figure 2.1
Pulse Width Modulation Waveform

2.3 Servo Loops:

A basic velocity-mode servo-loop for a brush-type motor is shown in figure 2.2a. An external controller commands a given velocity (RPM). The velocity-loop summing-amplifier compares this command with the actual motor velocity, supplied by a DC tachometer on the motor shaft, and produces an error voltage proportional to the difference between the actual and commanded velocity.

The velocity error is used to command motor current in the inner servo-loop. The current-loop summing-amplifier compares the command current (velocity error) with the actual current in the motor and produces an error voltage proportional to the difference between the actual and commanded current.

Finally, the current-error signal is used to produce an output (linear or PWM) to drive the motor.

The velocity loop may be bypassed, and an external current command fed directly to the current loop. In this case, the external command signal controls the torque of the motor, rather than the velocity. This is known as current-mode operation.

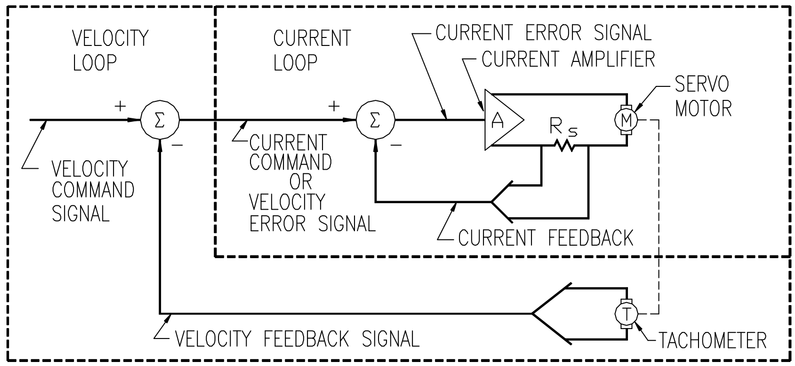


Figure 2.2a
Velocity-mode sevo loop for a brush-type motor

The servo-loops of a brushless amplifier (figure 2.2b) operate in much the same way, except there are now three current loops, one for each phase of the motor.

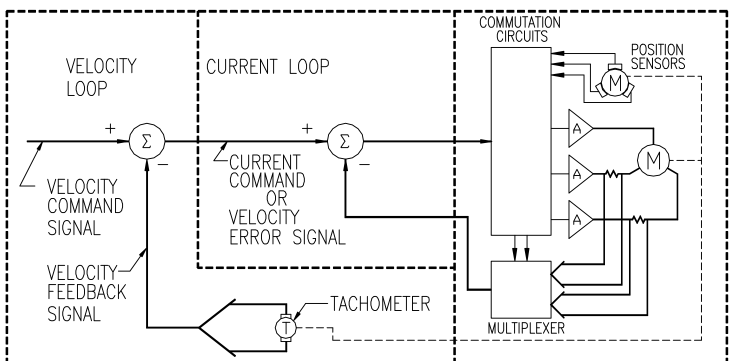


Figure 2.2b
Velocity-mode sevo loop for a brushless motor

2.4 Brushed Motors vs Brushless Motors:

There are two basic types of motor design that are used for high-performance motion control systems: brush-type PM (permanent magnet), and brushless-type PM. As you can see in figure 2.3, a brush-type motor has windings on the rotor (shaft) and magnets in the stator (frame). In a brushless-type motor, the magnets are on the rotor and the windings are in the stator.

To produce optimal torque in a motor, it is necessary to direct the flow of current to the appropriate windings with respect to the magnetic fields of the permanent magnets. In a brush-type motor, this is accomplished by using a commutator and brushes. The brushes, which are mounted in the stator, are connected to the motor wires, and the commutator contacts, which are mounted on the rotor, are connected to the windings. As the rotor turns, the brushes switch the current flow to the windings which are optimally oriented with respect to the magnetic field, which in turn produces maximum torque.

In a brushless motor there is no commutator to direct the current flow through the windings. Instead, an encoder, hall sensors or a resolver on the motor shaft senses the rotor position (and thus the magnet orientation). The position data is fed to the amplifier which in turn commutates the motor electronically by directing the current through the appropriate windings to produce maximum torque. The effect is analogous to a string of sequencing Christmas lights: the lights seem to chase each other around the string. In this case, the magnets on the rotor "chase" the magnetic fields of the windings as the fields "move" around the stator.

The relative advantages and/or disadvantages of a brush-type motor/amplifier combination vs. a brushless motor/amplifier combination can be significant. On the next page is a summary of advantages and disadvantages of brush type motor/amplifiers and brushless type motor/amplifiers to help you decide which type to select for your applications.

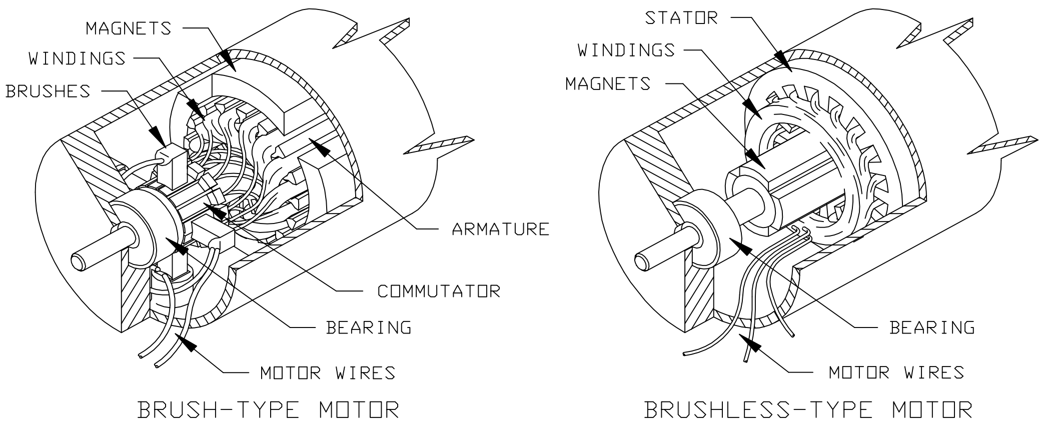


Figure 2.3 Brush-type and Brushless-type Motors

Brushless Motors/Amplifiers	**Brushed Motors/Amplifiers**
Advantages	**Disadvantages**
No scheduled maintenance and no brush dust is generated.	Motor brushes must be checked periodically for wear and excess brush dust.
Higher RPM limits.	Approximately 3000RPM maximum.
Lower inertia/torque ratio.	Higher inertia to torque ratio.
Dissipates heat more efficiently due to windings being located in stator.	Not as efficient at dissipating heat. Heat is trapped at rotor and shortens bearing life.
Safer for explosive atmospheres. Quieter and less electrical noise generated.	Brushes spark and generate electrical and audible noise.
Disadvantages	**Advantages**
Amplifiers are complicated and expensive.	Amplifiers are simpler and less expensive.
Higher torque ripple.	Lower torque ripple.
No Industry standard packaging.	Industry standard packaging.

2.5 Sinusoidal vs Trapezoidal:

Figure 2.4 shows the two most common waveforms used to drive a brushless motor. Note that in each case, there are actually three different waveforms. Each waveform drives a motor winding and is 120^{o} out-of-phase with the other two. Again, the waveform may be generated from a DC source by linear or PWM techniques.

The first waveform is known as trapezoidal or six-step since the voltage is literally stepped from winding to winding (like the Christmas-light analogy). This is the simplest and least expensive method of driving a brushless motor. Its principal disadvantage is that the large current steps produce high torque ripple. (Torque ripple is a repetitive fluctuation in torque as the motor turns and is independent of load.) The SMA8115 trapezoidal mode amplifier produces a trapezoidal output.

The second waveform is known as sinusoidal. To minimize torque ripple, the motor current needs to be constantly varied according to the orientation of the magnets and windings. As it happens, this is a sine function. In fact, a sine wave is defined as a rotating radius (like a motor shaft) revolving through time (see figure 2.4). A sine wave is the most natural way to drive a motor and produces the minimum torque ripple.

The SMA8215 sine/resolver mode amplifier produces a sinusoidal output.

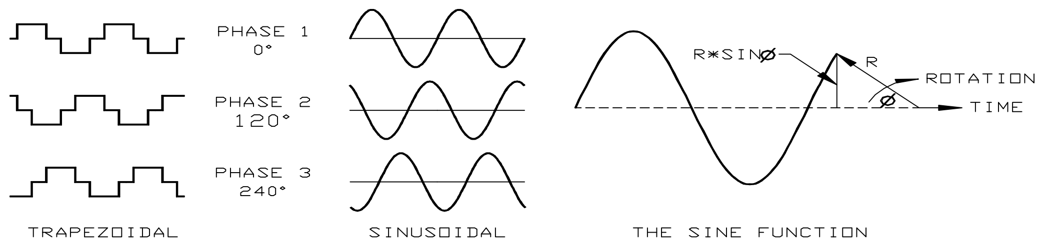


Figure 2.4
Trapezoidal and sinusoidal waveform used to drive brushless motor.

2.6 The Advantages and Disadvantages of a Trapezoidal Amplifier System:

A trapezoidal motor has three stator windings and together with the rotor magnets are designed so that the magnetic flux coupling between them produce a constant torque. The torque of the motor is proportional to the three stator phase currents which are 120° out-of-phase to the other two. Shaft position sensors are required to provide the commutation signals to commutate the motor. The two most common sensor types are Hall-effect sensors and an optical encoder with commutation tracks.

A common class of applications for trapezoidal amplifiers is for motor speed control. Classically, this is implemented by adding a brushless DC tachometer to the motor shaft and driving the motor through a velocity controlled servo loop. A high performance velocity loop can be implemented in this manner.

Another way of implementating the motor speed control is by using a simulated digital tachometer synthesized by the motor commutation signals. The commutation signals are used to trigger an one shot signal at every transition of the commutation signals. After smoothing, a voltage proportional to velocity (RPM) is obtained.

Two additional system features were implementated in the synthesized tachometer design:

1.) At 100% of full RPM, the PSEUDO-TACH voltage is limited by the power supply voltage. If an RPM is commanded above 100% RPM, the servo will run away. To prevent this from occuring, the absolute value of the PSEUDO-TACH signal is compared to a 95% of full RPM reference. If the PSEUDO-TACH signal exceeds this value, an over speed latch is set and the servo is disabled.

2.) The PSEUDO-TACH one shot pulse is buffered and brought to the control interface. The controller can use this signal to determine the exact velocity (RPM) of the motor.

The SMA8115 is a trapezoidal brushless amplifier which contains the necessary electronics for motor commutation and also has the PSEUDO-TACH option for better speed control.

2.7 Current Mode vs Velocity Mode:

The fundamental difference between current mode and velocity mode is that in current mode, an external command signal controls the torque of the motor, rather than the velocity. In velocity mode, an external command signal controls the velocity (RPM) of the motor, rather than the torque. In a current mode amplifier, the command signal is proportional to the motor current, thus it is also proportional to the torque of the motor. In a velocity mode amplifier, the current loop amplifier stage is preceded by a high gain error amplifier which compares the command signal and the tachometer feedback signal.

Current mode amplifiers are usually used in Position Control Systems where no tachometer feedback is required. While velocity mode amplifiers are usually used in Classic Cascaded Contol Systems where there are position, velocity and current loops in the system. Velocity loops tend to have a higher bandwidth and operate better near zero speed.

2.8 Tachometer (Velocity Mode) Feedback Options:

The following is a list of ways one can choose to implement tachometer feedback in order to drive the motor through a velocity controlled servo loop:

- Brush-type and brushless DC mechanical tachometer.

- Simulated tachometer using the motor commutation signals (PSEUDO-TACH).
- Sinusoidal resolver.
- Simulated tachometer using the encoder signals.

The simplest way to simulate the actual velocity of the motor is by installing a mechanical brush-type or brushless DC tachometer on the motor shaft which converts the velocity of the motor into DC voltage.

The second method is to synthesize a digital tachometer using the motor commutation signals (refer to section 2.6). The SMA8115 provides this option.

In the third method, with a sine/resolver amplifier (SMA8215) an analogue tachometer signal is generated as part of the Resolver-to-Digital conversion process and is immediately available for use thru the dip-switch options for velocity mode (S1-7).

The fourth method is to have an optical encoder installed on the motor shaft to determine the direction and position of the motor as it runs. The incoming encoder signals are converted into quadrature clock pulses. The frequency of this clock pulses changes with the velocity of the motor and the up/down clock output signals change with the direction of which the motor is running at. The frequency of the clock is then converted into the tach DC voltage signal using the Frequency-to-Voltage converter.

2.9 Commutation Using A Resolver:

The Resolver-to-Digital converter in the SMA8215 generates the necessary excitation for the resolver, and converts the resolver's sine and cosine signals into position data. This position information is used to amplitude modulate the velocity error signal into three-phase, sinusoidal and current-error signals like the one in section 2.5.

2.10 Current Mode in Sine/Resolver or Trapezoidal Amplifier vs Two/Three Phase Input Current Mode Amplifier:

The fundamental difference between the current mode in sine/resolver or trapezoidal amplifiers and the two or three phase input current mode amplifiers is that in the former case, the commutation of the command and feedback signals is done within the amplifier itself. The latter case accepts two or three 120^{o} out of phase commutated drive signals. In other words, the user's controller has to do the commutation of the command and feedback signals themselves. The user can either input two or three commutated drive signals. If the user has chosen two phase input, the third phase is generated as the negative sum of the other two inputs.

2.11 Protection Circuit:

The High- and Low-Speed Electronic Circuit Breakers (HS/ECB and LS/ECB) protect the amplifier and motor from being damaged by high motor current (specified max. peak and rms current values). The Over Temperature and Over Voltage detection circuits will shut off the amplifier when the temperature of the amplifier or the buss (B+) voltage exceeds a specified limit. Also, there are circuits which limit the motor from running in either or both directions.

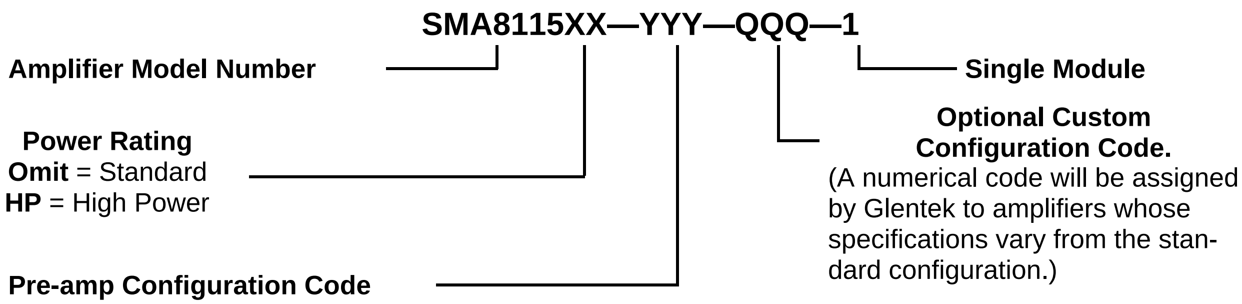
Chapter Three: Model Numbering

3.1 Introduction:

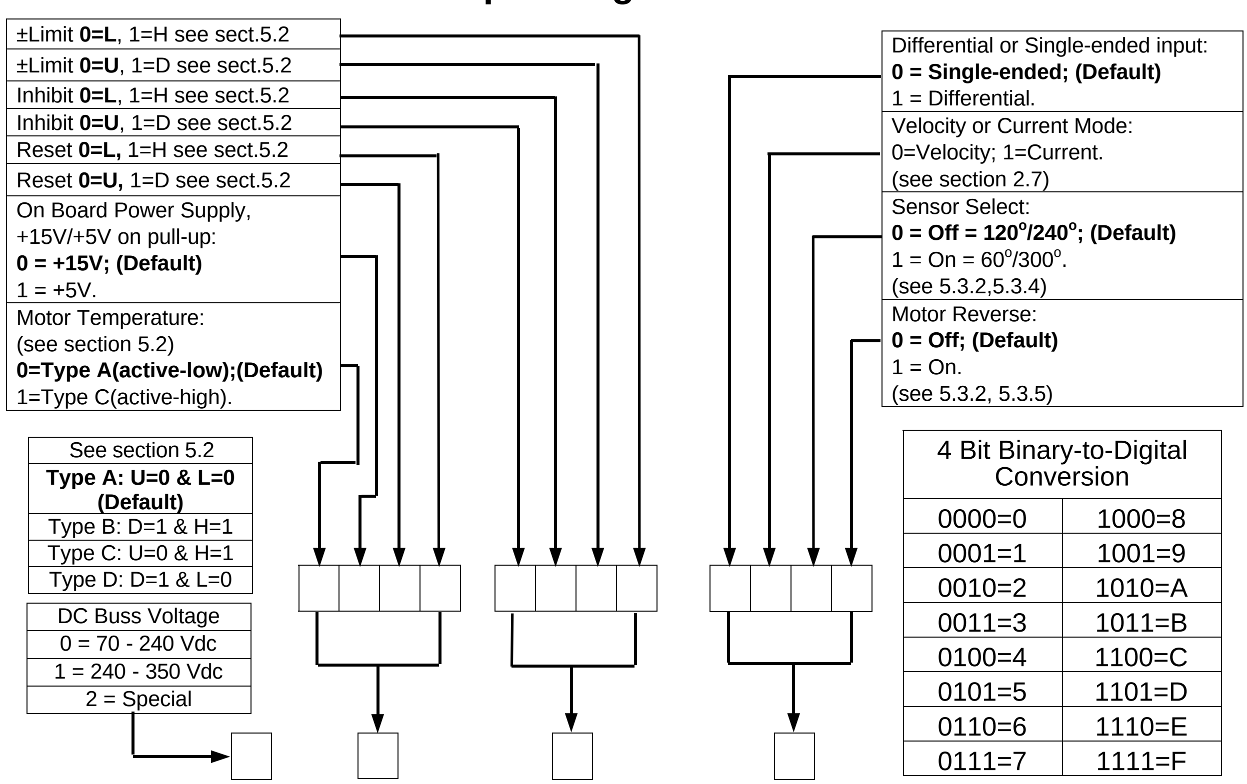
This chapter contains the model numbering system for the SMA8115, SMA8215 and SMA8315 single module and multi-axis applications. The model numbering system is designed so that you, our customer will be able to create the correct model number of the product that you need as quick and as accurately as possible.

3.2 Single Amplifier Modules:

3.2.1 Trapezoidal Mode:



Pre-amp Configuration Code



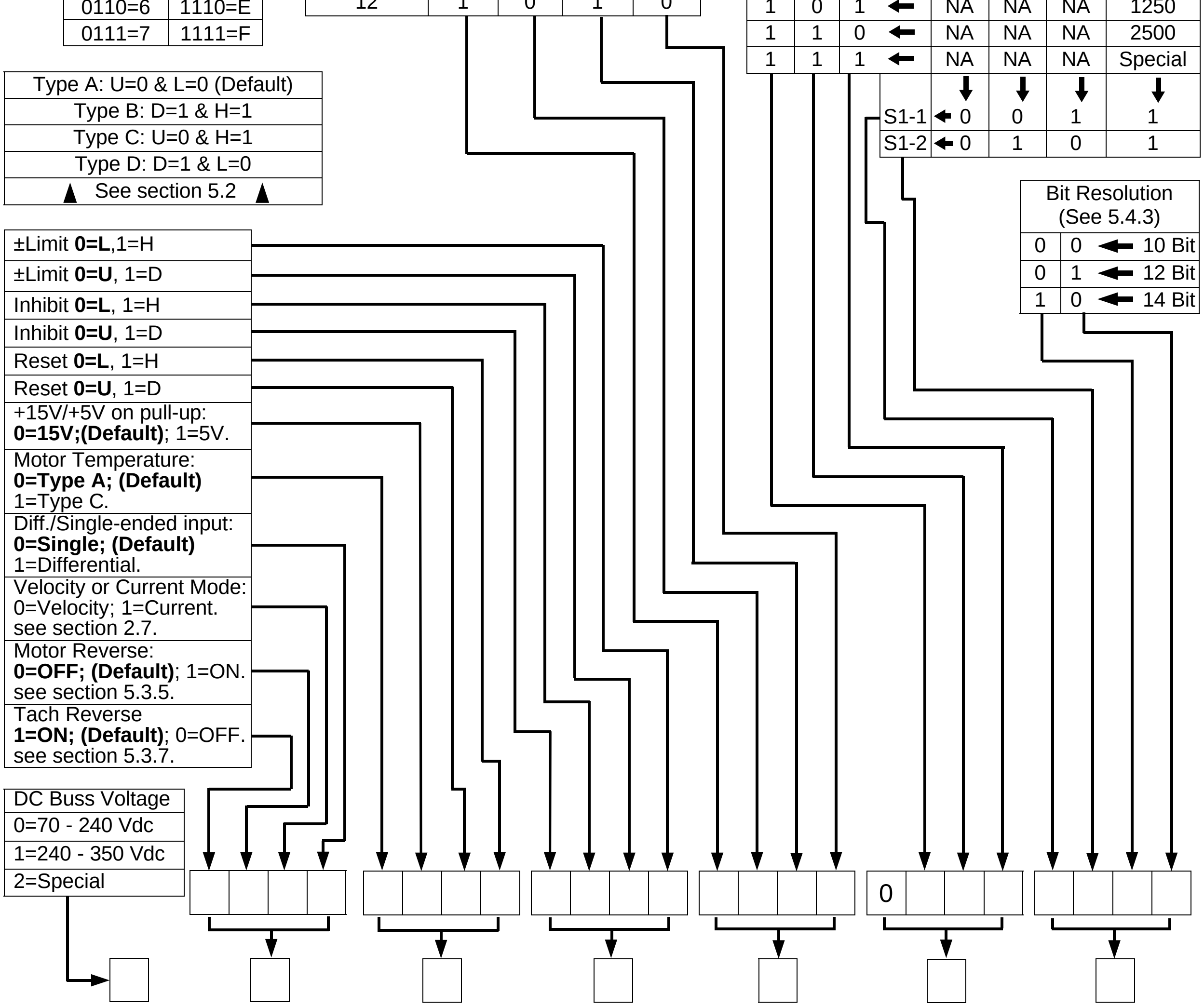
4 Bit Binary-to-Digital Conversion	
0000=0	1000=8
0001=1	1001=9
0010=2	1010=A
0011=3	1011=B
0100=4	1100=C
0101=5	1101=D
0110=6	1110=E
0111=7	1111=F

3.2.2 Sine/Resolver Mode:

SMA8115XX—YYYYYYY—QQQ—1

- **Amplifier Model Number**
- **Power Rating**
  Omit = Standard
  HP = High Power
- **Pre-amp Configuration Code**
- **Optional Custom Configuration Code.**
  (A numerical code will be assigned by Glentek to amplifiers whose specifications vary from the standard configuration.)
- **Single Module**

Pre-amp Configuration Code



4 BIT Binary-to-digital Conversion	
0000=0	1000=8
0001=1	1001=9
0010=2	1010=A
0011=3	1011=B
0100=4	1100=C
0101=5	1101=D
0110=6	1110=E
0111=7	1111=F

Number of Motor Poles	S3-1	S3-2	S3-3	S3-4
See section 5.4.4				
2	1	1	1	1
4	1	1	1	0
6	1	1	0	1
8	1	1	0	0
10	1	0	1	1
12	1	0	1	0

PLD Device Code (See 5.4.3)				Encoder Resolution (See section 5.4.3)			
0	0	0	←	256	250	128	125
0	0	1	←	1024	1000	512	500
0	1	0	←	4096	4000	2048	2000
0	1	1	←	3600	2160	720	360
1	0	0	←	NA	NA	NA	625
1	0	1	←	NA	NA	NA	1250
1	1	0	←	NA	NA	NA	2500
1	1	1	←	NA	NA	NA	Special
			S1-1 ←	0	0	1	1
			S1-2 ←	0	1	0	1

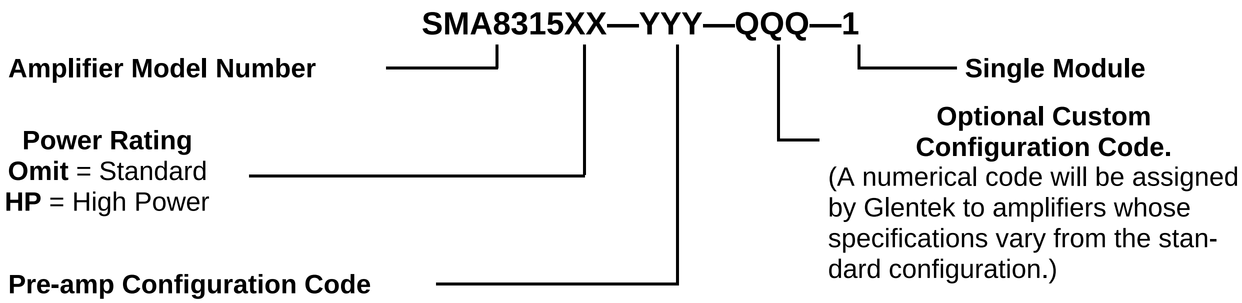
Bit Resolution (See 5.4.3)		
0	0	← 10 Bit
0	1	← 12 Bit
1	0	← 14 Bit

Type A: U=0 & L=0 (Default)
Type B: D=1 & H=1
Type C: U=0 & H=1
Type D: D=1 & L=0
▲ See section 5.2 ▲

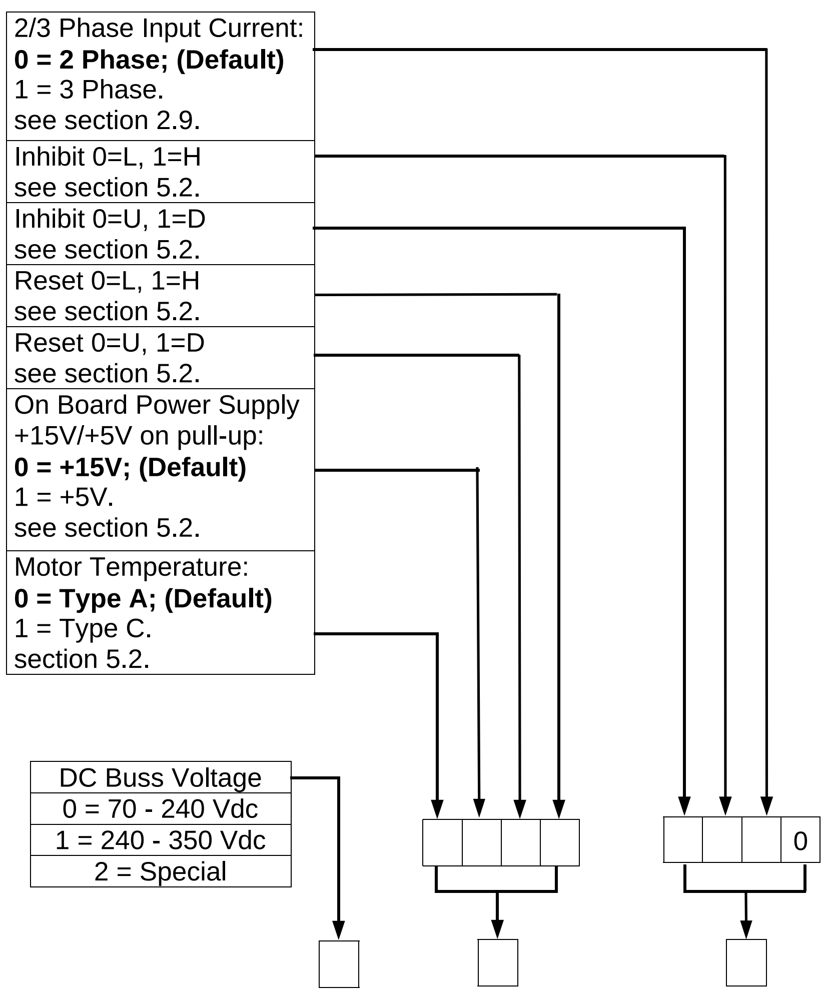
- ±Limit **0=L**,1=H
- ±Limit **0=U**, 1=D
- Inhibit **0=L**, 1=H
- Inhibit **0=U**, 1=D
- Reset **0=L**, 1=H
- Reset **0=U**, 1=D
- +15V/+5V on pull-up: **0=15V;(Default)**; 1=5V.
- Motor Temperature: **0=Type A; (Default)** 1=Type C.
- Diff./Single-ended input: **0=Single; (Default)** 1=Differential.
- Velocity or Current Mode: 0=Velocity; 1=Current. see section 2.7.
- Motor Reverse: **0=OFF; (Default)**; 1=ON. see section 5.3.5.
- Tach Reverse **1=ON; (Default)**; 0=OFF. see section 5.3.7.

DC Buss Voltage
0=70 - 240 Vdc
1=240 - 350 Vdc
2=Special

3.2.3 Two/Three Phase Input Current Mode:



Pre-amp Configuration Code



Type A: U=0 & L=0 Default
Type B: D=1 & H=1
Type C: U=0 & H=1
Type D: D=1 & L=0
↑ See section 5.2 ↑

4 Bit Binary-to-Digital Conversion	
0000=0	1000=8
0001=1	1001=9
0010=2	1010=A
0011=3	1011=B
0100=4	1100=C
0101=5	1101=D
0110=6	1110=E
0111=7	1111=F

3.3 Multi Axis Amplifier:

SMA8_15XX - __ - 8_15XX/_ - ___ - _A - _ - ZZ - RRR

Type of Amplifier Model
1 = Trapezoidal Mode
2 = Sine / Resolver Mode
3 = Two / Three Phase Input Current Mode

Power Rating
Omit = Standard
HP = High Power

Pre-amp & Custom Configuration Code
(See sect. 3.2.1, 3.2.2, 3.2.3)

Second type of amplifier module on baseplate.

Number of this type of amplifier module(s) used

Pre-amp configuration code for second type of amplifier if it is different from the first amplifier's configuration code. NOTE: This will be omitted if they are the same.

When there is only one type of amplifier used on the baseplate, this part of the model number will be omitted. If there are more than two types of amplifier modules on the baseplate, this part of the model number will be repeated for each amplifier type.

Maximum number of amplifier modules the baseplate will hold.
2 = 2 axis baseplate
4 = 4 axis baseplate

The total number of amplifier modules mounted on the baseplate

Power Supply Configuration Code
00 = 110-130VAC
01 = 208-240VAC
02 = Special

Optional Custom Configuration Code for the Power Supply and Regen Circuit

NOTE: The multi-axis amplifier label will be mounted on the baseplate and each amplifier module will contain its own label and serial number.

Chapter Four: Installation

4.1 Introduction:

This chapter provides the necessary information to make all the wiring connections for the amplifiers to operate properly.

4.2 Mounting:

Appendix A contains all the wiring diagrams, assembly drawings, and mechanical information necessary to install the amplifiers. The amplifier package should be mounted in a clean, dry enclosure, free of dust, oil, or other contaminants.

NEVER INSTALL THE AMPLIFIER PACKAGE IN ANY LOCATION WHERE FLAMMABLE OR EXPLOSIVE VAPORS ARE PRESENT.

IMPORTANT: Muffin fan(s) are mounted along one edge of the baseplate to provide cooling. At least 3 inches must be allowed between the fan side and the side opposite the fans and any other surface. The clearance to any other side of the amplifier package is not critical, although sufficient space should be allowed for easy wiring and servicing.

4.3 Wiring:

4.3.1 RFI/EMI and Wiring Technique:

IMPORTANT: All PWM equipment inherently generates radio-frequency interference (RFI), and wiring acts as antennae to transmit this interference. In addition, motors inherently generate electromagnetic interference (EMI). Unless the wiring is very short, some sort of shielding on the motor wires is necessary to meet FCC RFI/EMI guidelines and to protect other equipment from the effects of RFI/EMI. We recommend that shielded wire be used, or the wires should be run in metallic conduit. The shield or conduit should be connected to the amplifier baseplate, which in turn must be earth grounded. In addition, a conductor of the same gauge as the motor wires must be connected from the motor case to the amplifier baseplate to provide protection from shock hazard. The earth grounding is necessary to meet National Electrical Code (NEC) requirements as well as suppressing RFI/EMI.

Additional RFI suppression may be obtained by placing inductors in each motor lead near the amplifier. Consult a Glentek applications engineer for inductor recommendations. Glentek stocks a complete line of inductors for virtually every application.

IMPORTANT: The signal wiring to hall-sensors for the SMA8115, resolver for SMA8215 (if used) and the signal inputs to the amplifier are susceptible to noise pickup. Excessive noise pickup will cause erratic amplifier operation. We urge that each signal input be run in a twisted-pair, shielded cable. The hall-sensor signal lines, the resolver excitation lines, and the resolver output lines should be run in a three twisted-pair, shielded cable. In each case the shield should be terminated at the amplifier end only to a common terminal. We also recommend that the signal lines be kept as far as possible from any power or motor wires.

4.3.2 Wire Size and Type:

IMPORTANT: To ensure safe operation, Glentek strongly recommends that all wiring conform to all local and national codes.

Recommended Wire Size and Type:

- Motor Wires: 14AWG, shielded - Standard.
  12AWG, shielded - High Power.
- Motor Case Ground: Same as motor wires, or use metallic conduit.
- Main Power: Same as motor wires.
- Signal Input: 22AWG, twisted-pair, shielded.
- Logic Inputs/Outputs: 22AWG, shielded with its return lead.
- External Tachometer: 22AWG, twisted-pair, shielded.
- Hall Sensors (SMA8115) 22AWG, three twisted-pairs, over-all shielded.
- Resolver Outputs and Excitation (SMA8215): 22AWG, three twisted-pairs, over-all shielded.

4.3.3 Connector Size and Type:

4.3.3.1 The Power Connector of the Single Amplifier Modules - (J2) of Main Amplifier:

All amplifiers are shipped with the right angle AUGAT terminal block mounted as it power connector . The vertical angle AUGAT terminal block and the PHOENIX connector are two options one can choose to use for the power connector. The specifications of these connectors are listed as follow:

- AUGAT® RDI 6 Series Tri-Barrier Terminal Blocks(PART# 6PCR-05) - **Default**:
    - Screw Size/Spacing: 6 (#6-32 on .375" centers).
    - Terminal Style: PC (Printed Circuit Pin).
    - Terminal Orientation: R (**Right Angle**).
    - Number of Screw Terminals: 05 (5 screw positions).
    - Terminal lugs: Thomas & Betts (PART# A116 for 18AWG wire, PART# B19 for 14AWG wire and PART# C133 for 12/10AWG wire).

- AUGAT®RDI 6 Series Tri-Barrier Terminal Blocks(PART# 6PCV-05):
    - Screw Size/Spacing: 6 (#6-32 on .375" centers).
    - Terminal Style: PC (Printed Circuit Pin).
    - Terminal Orientation: V (**Vertical Angle**).
    - Number of Screw Terminals: 05 (5 screw positions).
    - Terminal lugs: Thomas & Betts (PART# A116 for 18AWG wire, PART# B19 for 14AWG wire and PART# C133 for 12/10AWG wire).

- PHOENIX CONTACT®, COMBICON Headers and Plugs with 7.62mm pitch
  (Header P/N: GMSTBA 2,5/5-G-7,62, Plug P/N: GMSTB 2,5/5-ST-7,62):
    - Header with side panels, plug-in direction parallel to PCB.
    - 5 positions.
    - Color: green.

4.3.3.2 The Signal Connector:

The signal connectors are supported by the molex® KK .100" (2,54mm) Centerline Connector System.

- J1 of the Main Amplifier:
  Mating Connector: molex® 2695 Series .100 (2.54mm) Center Crimp Terminal Housing(P/N: 22-01-3175):
    - red nylon housing.
    - 15 positions.
    - with polarizing rib.

- J4 of the Trapezoidal Pre-amp:
  Mating Connector: molex® 2695 Series (P/N: 22-01-3107).

- J4 and J5 of the Sine/Resolver Pre-amp:
  Mating connector for J4: molex® 2695 Series (P/N: 22-01-3077).
  Mating connector for J5: molex® 2695 Series (P/N: 22-01-3057).
    - Crimp Terminals for the above mating connector: molex® Crimp Terminals (P/N: 08-55-0102):
    - 15 microinch select gold plated.
    - with vertical plug-in direction to the conductor axis.
    - 4 positions.
    - Color: green.

Signal Name	Terminal	Notes
B -	J2-1	DC Buss -
B +	J2-2	DC Buss+
MOTOR T	J2-3	Phase T of the motor.
MOTOR S	J2-4	Phase S of the motor.
MOTOR R	J2-5	Phase R of the motor.

4.4 Single Amplifier Module Connections(SMA8X15-1):

4.4.1 Buss and Motor Connections - J2:

Signal Name	SMA8115/SMA8215 Terminal	Notes
SIGNAL 1+	J1-1	Differential signal input.
SIGNAL 1-	J1-2	Differential signal return.
SIGNAL 2+	J1-3	Single-ended signal 2 in.
COMMON	J1-4	Single common.
TACH OUT	J1-5	DC output proportional to RPM.
COMMON	J1-6	Tachometer common.
ABS. I	J1-7	Absolute value of the motor current (10A/V)
LIMIT +	J1-8	Inhibits the motor in + direction.
LIMIT -	J1-9	Inhibits the motor in - direction.
INHIBIT	J1-10	Inhibits the motor in both directions.
FAULT	J1-11	Goes low for a fault on this amplifier, or inhibits the amplifier when forced low.
COMMON	J1-12	Digital common.
RESET IN	J1-13	Resets fault latch.
MTR TEMP	J1-14	Motor over temperature switch input.
DIG. TACH(SMA8115) N/C(SMA8215)	J1-15	Digital tach output in trapezoidal mode or Auxillary in sine/resolver mode.

4.4.2 Signal Connections for the Trapezoidal & Sine/Resolver Mode Amplifier - J1:

4.4.3 Signal Connections for the Two/Three Phase Current Mode Amplifier:

Signal Name	Terminal	Notes
PHASE R+	J1-1	Sinusoidal input phase R.
PHASE R-	J1-2	Sinusoidal input phase R return.
PHASE S+	J1-3	Sinusoidal input phase S.
PHASE S-	J1-4	Sinusoidal input phase S return.
PHASE T+	J1-5	Sinusoidal input phase T.
COMMON	J1-6	Signal common.
ABS I	J1-7	Absolute value of the motor current (10A/V).
N/C	J1-8	No connection.
N/C	J1-9	No connection.
INHIBIT	J1-10	Inhibits the motor in both directions.
FAULT	J1-11	Goes low for a fault on this amplifier, or inhibits the amplifier when forced low.
COMMON	J1-12	Digital common.
RESET IN	J1-13	Resets fault latch.
MTR TEMP	J1-14	Motor over temperature switch input.
N/C	J1-15	No connection.

4.4.4 Signal connections for the Trapezoidal Mode Pre-amp:

Signal Name	Terminal	Notes
+15 VDC	J4-1	+15V for external brushless tachometer.
-15 VDC	J4-2	-15V for external brushless tachometer.
TACH	J4-3	External tachometer input (if used).
COMMON	J4-4	External tachometer common.
HALL +15	J4-5	+15V power for Hall-effect sensors.
HALL +5	J4-6	+5V power for Hall-effect sensors.
HALL 1	J4-7	Hall sensor 1. Check motor data for phasing.
HALL 2	J4-8	Hall sensor 2. Check motor data or phasing.
HALL 3	J4-9	Hall sensor 3. Check motor data for phasing.
COMMON	J4-10	Common for hall sensors.

4.4.5 Signal connections for the Sine/Resolver Mode Pre-amp:

Signal	Terminal	Notes
Encoder Output (J4):		
A	J4-A	Phase A signal output.
$\overline{A}$	J4-B	Negative phase A signal output.
B	J4-C	Phase B signal output.
$\overline{B}$	J4-D	Negative phase B signal output.
Z	J4-E	Phase Z signal output.
$\overline{Z}$	J4-F	Negative phase Z signal output.
COM	J4-G	Common ground.
Resolver Input (J5):		
SIN	J5-A	Sine signal input.
COM	J5-B	Sine/Cosine return.
COS	J5-C	Cosine signal input.
COM	J5-D	Excitation return.
EXC	J5-E	Excitation signal input.

4.5 Multi Axis Power Supply Connections (GP8600-70):

Connector TB1 is shown in the following drawing: 8600-7030, It is located in Appendix B.

Signal Name	Terminal	Notes
AC - MAIN	TB1-1	AC main power input.
AC - MAIN	TB1-2	AC main power input (1Ø).
AC - MAIN	TB1-3	AC main power input (1Ø).
CHASSIS GND	TB1-4	Chassis ground.
AC - FAN	TB1-5	AC fan power input.
AC - FAN	TB1-6	AC fan power input.

Chapter Five: Configuration

5.1 Introduction:

Each amplifier has several configuration options. This chapter describes these options and how to implement them. If desired, Glentek will be happy to pre-configure your amplifiers.

NOTE: Each amplifier module and multi-axis amplifier is configured and shipped according to the model number (instructions to construct a model number is in chapter three) when the order is placed. It is important for the user to realize that any adjustment on the dip-switches by the user will result in discrepancies between the model number and the actual configuration of the amplifier.

5.2 Logic Input Configuration:

There are five logic inputs: Limit +, Limit -, Inhibit, Reset In, Motor Temp. The first four may be configured for active-high or active-low signals, and pulled-up or pulled-down termination (type A, B, C, and D). The motor-temp may be configured for active-high or active-low signals, and is always pulled-up (type A, and C). All five logic inputs have a selectable 0 to +5VDC or 0 to +15VDC range.

- Type "A": Requires grounding of input to disable the amplifier (pull-up, active-low).
- Type "B": Requires a positive voltage at input to disable the amplifier (pull-down, active-high).
- Type "C": Requires grounding of input to enable the amplifier (pull-up, active-high).
- Type "D": Requires a positive voltage at input to enable the amplifier (pull-down, active-low).

5.3 Trapezoidal Mode Amplifier Configuration:

The following table shows the dip switches that need to be configured for the Type A, B, C, and D configurations. The standard configuration is shown in bold.

	Type A	Type B	Type C	Type D
LIMIT±	**S1-8 - OFF** **S1-5 - ON**	S1-8 - ON S1-5 - OFF	S1-8 - OFF S1-5 - OFF	S1-8 - ON S1-5 - ON
INHIBIT	**S1-7 - OFF** **S1-4 - ON**	S1-7 - ON S1-4 - OFF	S1-7 - OFF S1-4 - OFF	S1-7 - ON S1-4 - ON
RESET IN	**S1-6 - OFF** **S1-3 - ON**	S1-6 - ON S1-3 - OFF	S1-6 - OFF S1-3 - OFF	S1-6 - ON S1-3 - ON
MTR TEMP	**S1-2 - ON**	not available	S1-2 - OFF	not available
FAULT	standard	not available	not available	not available

5.3.1 +15V/+5V Logic Level Configuration (Default: S1-1=OFF):

- +15V: S1-1 = OFF.
- +5V: S1-1 = ON.

5.3.2 Standard Configuration for Trapezoidal Velocity Mode, Simulated Velocity Mode and Current Mode:

Dip Switch (S2)	Name	Velocity Mode (with External Tachometer)	Simulated Velocity Mode	Current Mode
S2-10	CUR MODE	OFF	OFF	ON
S2-9	VEL MODE	ON	ON	OFF
S2-8	INTEGRATOR	See section 5.3.3 (normally OFF)		
S2-7	SENSOR SEL	See section 5.3.4 (normally OFF)		
S2-6	MTR REVERSE	See section 5.3.5 (normally OFF)		
S2-5	TACH LEAD	ON	OFF	OFF
S2-4	SIM. TACH - ON/OFF	OFF	ON	OFF
S2-3	SIM. TACH - DISABLE	ON	See section 5.3.6 (normally OFF)	OFF
S2-2	SIM. TACH - REVERSE	OFF	See section 5.3.7 (normally OFF)	OFF
S2-1	SIM. TACH - SPEED	OFF	See section 5.3.8 (normally ON)	OFF

5.3.3 Integrator Configuration (Default: S2-8=OFF):

The integrator switch is turned ON to lower the integration proportional break point in the velocity Proportional Integral Derivative (PID) loop. The lower break point may be required with motors having high inductance amatures. This switch should remain off unless instructed to turn on by a Glentek engineer.

5.3.4 Hall-Sensor Configuration (Default: S2-7=OFF):

There are four standard sensor configurations: 60^o, 120^o, 240^o, and 300^o. The $60^o/300^o$, and $120^o/240^o$ sensor spacing are identical except for the direction of motor rotation which results.

To configure the amplifiers for $60^o/300^o$ sensor configuration: S2-7 (ON).
To configure the amplifiers for $120^o/240^o$ sensor configuration: S2-7 (OFF).

5.3.5 Motor Reverse Configuration (Default: S2-6=OFF):

The motor reverse switch is turned ON to reverse the spinning direction of the motor for both current and velocity mode. It can also solve the problem when a motor running away by reversing the polarity of the motor lead without physically reversing the motor lead.

5.3.6 Simulated Tach - Disable Configuration(Default: S2-3=ON):

The simulated tachometer disable is turned ON when an external tachometer is used.

5.3.7 Simulated Tach - Reverse Configuration (Default: S2-2=OFF):

The simulated tachometer reverse switch is turned ON to reverse the spinning direction of the motor or prevent the motor from running away in case of incorrect polarity of the feedback signal.

5.3.8 Simulated Tach - Speed Configuration (Default: S2-1=ON):

The simulated tach speed switch should be ON unless the user cannot reach the maximum rpm required per the following formula: **Low Speed Applications (S2-1:ON) -** MAX. RPM at **25500/number of motor poles, High Speed Applications (S2-1:OFF) -** MAX. RPM at **51000/number of motor poles**.

5.4 Sine/Resolver Mode Amplifier Configuration:

The following table shows the dip switches that need to be configured for the Type A, B, C, and D configurations. The standard configuration is shown in bold.

	Type A	Type B	Type C	Type D
LIMIT±	**S2-8 - OFF** **S2-5 - ON**	S2-8 - ON S2-5 - OFF	S2-8 - OFF S2-5 - OFF	S2-8 - ON S2-5 - ON
INHIBIT	**S2-7 - OFF** **S2-4 - ON**	S2-7 - ON S2-4 - OFF	S2-7 - OFF S2-4 - OFF	S2-7 - ON S2-4 - ON
RESET IN	**S2-6 - OFF** **S2-3 - ON**	S2-6 - ON S2-3 - OFF	S2-6 - OFF S2-3 - OFF	S2-6 - ON S2-3 - ON
MTR TEMP	**S2-2 - ON**	not available	S2-2 - OFF	not available
FAULT	standard	not available	not available	not available

5.4.1 +15V/+5V Logic Level Configuration (Default: S2-1=OFF):

- +15V: S2-1 - OFF.
- +5V: S2-1 - ON.

5.4.2 Standard Configuration for Sine/Resolver Velocity Mode and Current Mode:

Dip-switch	Name	Velocity Mode	Current Mode
S1-1	ENCODE / 2	See section 5.4.3	
S1-2	ENCODE * 125 / 128	See section 5.4.3	
S1-3	(NOT USED)	OFF	OFF
S1-4	MTR REVERSE	See section 5.3.5 (normally OFF)	
S1-5	TACH REVERSE	See section 5.3.7 (normally ON)	
S1-6	INTEGRATOR	See section 5.3.3 (normally OFF)	
S1-7	VEL MODE	ON	OFF
S1-8	CUR MODE	OFF	ON

5.4.3 Encoder Output Resolution Configuration:

Refer to Appendix C drawing 8000-2230 and 8000-2231. There are nineteen standard resolutions. Up to four resolutions are contained in a single PLD. To configure the pre-amp for a given resolution, ensure that you have the correct PLD (U13) and then configure the dip-switches S1-1, S1-2, S3-7 and S3-8 as shown below. The PLD code refers to the table in the model numbering chapter and the PLD part number is marked on the part.

Resolution	PLD Code	PLD Part Number	S1-1	S1-2	Bits Min.	S3-7	S3-8	Max. RPM (S3-5:ON)	Tach. Volts V/1000RPM
125	000	8000-1212	ON	ON	10	ON	ON	62,400	0.13
128	000	8000-1212	ON	OFF	10	ON	ON	62,400	0.13
250	000	8000-1212	OFF	ON	10	ON	ON	62,400	0.13
256	000	8000-1212	OFF	OFF	10	ON	ON	62,400	0.13
500	001	8000-1213	ON	ON	12	OFF	ON	15,600	0.5
512	001	8000-1213	ON	OFF	12	OFF	ON	15,600	0.5
1000	001	8000-1213	OFF	ON	12	OFF	ON	15,600	0.5
1024	001	8000-1213	OFF	OFF	12	OFF	ON	15,600	0.5
2000	010	8000-1214	ON	ON	14	ON	OFF	3,900	2
2048	010	8000-1214	ON	OFF	14	ON	OFF	3,900	2
4000	010	8000-1214	OFF	ON	14	ON	OFF	3,900	2
4096	010	8000-1214	OFF	OFF	14	ON	OFF	3,900	2
360	011	8000-1218	ON	ON	12	OFF	ON	15,600	0.5
720	011	8000-1218	ON	OFF	12	OFF	ON	15,600	0.5
2160	011	8000-1218	OFF	ON	14	ON	OFF	3,900	2
3600	011	8000-1218	OFF	OFF	14	ON	OFF	3,900	2
625	100	8000-1215	ON	ON	12	OFF	ON	15,600	0.5
1250	101	8000-1216	ON	ON	14	ON	OFF	3,900	2
2500	110	8000-1217	ON	ON	14	ON	OFF	3,900	2

The BITS refer to the Resolver-to-Digital resolution which must be factory configured. Encoder resolution may be changed at any time to a resolution which requires the same or fewer bits. Increasing the bits increases the possible encoder resolution, but decreases the maximum motor RPM(refer to the table above). The Tach. Volts (V/1000RPM) are given for the MAX. RPM of the BIT resolution. The higher the bits, the higher the tach voltage. You want the highest bits (14, if possible) as long as the max. RPM is ok for your application. Consult a Glentek applications engineer should you have any questions.

NOTE: The MAX. RPM in the above table is valid when RANGE (S3-5) is ON. The MAX. RPM is half of what is shown in the table when RANGE (S3-5) is OFF.

5.4.4 Motor Pole Configuration:

Dip-switch S3-1, S3-2, S3-3 and S3-4 configures the pre-amp for the number of poles in the motor. They are also used to set up certain calibration modes. Refer to the chart below and set the dip switches for the correct number of poles.

Motor:	S3-1	S3-2	S3-3	S3-4
2 Pole	ON	ON	ON	ON
4 Pole	ON	ON	ON	OFF
6 Pole	ON	ON	OFF	ON
8 Pole	ON	ON	OFF	OFF
10 Pole	ON	OFF	ON	ON
12 Pole	ON	OFF	ON	OFF
Zero	ON	OFF	OFF	ON
Index	ON	OFF	OFF	OFF

5.5 Two/Three Phase Input Current Mode Amplifier Configuration:

The following table shows the dip switches that need to be configured for the Type A, B, C, and D configurations. The standard configuration is shown in bold.

	Type A	Type B	Type C	Type D
INHIBIT	**S1-5 - OFF** **S1-3 - ON**	S1-5 - ON S1-3 - OFF	S1-5 - OFF S1-3 - OFF	S1-5 - ON S1-3 - ON
RESET IN	**S1-4 - OFF** **S1-2 - OFF**	S1-4 - ON S1-2 - ON	S1-4 - OFF S1-2 - ON	S1-4 - ON S1-2 - OFF
MTR TEMP	**S1-1 - OFF**	not available	S1-1 - ON	not available

5.5.1 +15V/+5V Logic Level Configuration:

- +15V: S1-6 - OFF.
- +5V: S1-6 - ON.

5.5.2 Standard Configuration for Two/Three Phase Input Current Mode:

Dip-switch	Switch Name	2Ø current mode	3Ø current mode
S1-8	2 phase input	ON	OFF
S1-7	3 phase input	OFF	ON

Chapter Six: Start up and Calibration

6.1 Introduction:

This chapter contains the procedure required for initial start up and amplifier calibration. Both trapezoidal and sine/resolver modes can be configured to run in velocity mode and current mode operations.

Required Equipment: Oscilloscope, voltmeter & battery box. The battery box serves as a step input voltage command, applying and removing a flashlight battery can also be used for this function. Glentek sells a battery box BB-700 which is ideal for this function.

6.2 Initial Start Up:

When applying power to start up your amplifier system for the first time, we recommend you follow this procedure. If you have already gone through this procedure you can skip to the appropriate calibration procedure.

1. Check for any loose or damaged components.
2. Check that all connections are tight.
3. Be sure that the motor mechanism is clear of obstructions. If the mechanism has limited motion, e.g: a lead-screw, set the mechanism to mid-position.
4. Disconnect the signal and auxiliary inputs.
5. Be sure the Loop-Gain pot(s) are fully CCW.
6. Apply main power. Check for the correct AC voltage at the power supply AC input. The DC Bus (amplifier supply-voltage) will be 1.4 times this value. If voltage is correct, remove power and reinstall fuses.
7. Work on only one amplifier at a time.

6.3 Trapezoidal Mode Amplifier Calibration:

The following pots will be set during calibration:
Note: RV1-RV6 are 12-turn pots and RV7 is a single turn pot.

Pots	Name of Pot	Note
RV1	SIG 1 (Differential Input Signal Gain)	Sets the input voltage to RPM ratio, e.g. 10V=2000RPM (velocity mode) or input voltage to torque ratio, e.g. 10V=25A (current mode) required by your system for the differential signal input.
RV2	SIG 2 (Single-ended Input Signal Gain)	Same as Signal 1 input, except it is for the single-ended signal input.
RV3	TACH (Tach Gain)	Used in conjunction with the compensation pot to set the system bandwidth. Not used in current mode. Shipped set at 100%.
RV4	BAL (Balance)	Used to null any offsets in system.
RV5	COMP (Compensation)	Used in conjunction with the TACH pot to set the system bandwidth. Not used in current mode. Shipped set at full CW (minimum bandwidth).
RV6	I LIMIT (Current Limit)	Sets the maximum motor current. Shipped set at full CW (maximum current limit).
RV7	LOOP (Loop Gain)	Used to shut off uncalibrated amplifiers. When the loop gain is CCW, no current is delivered to the motor. Shipped set at full CCW.

6.3.1 Trapezoidal Mode Amplifier Calibration Procedure - Velocity Mode and Simulated Velocity Mode:

The amplifier, in this configuration, receives an analog, bi-polar input command which is proportional to the required motor velocity. The amplifier receives velocity feedback from a tachometer which is usually mounted to the rear of the motor.

1. Turn Current Limit (RV6) to mid position and the Loop Gain (RV7) full CCW.

2. Apply main power and fan power.

3. Slowly turn the Loop Gain (RV7) CW. Motor should be stopped or turning slowly. If the motor starts running away, turn Loop Gain (RV7) full CCW, switch MTR REVERSE (S2-6) from OFF to ON (or vice versa) or reverse the TACH OUT and COMMON at J1-5 and J1-6 and retest. Leave the Loop Gain (RV7) full CW for all remaining adjustments.

4. Set Balance (RV4) for zero motor rotation.

5. Connect the oscilloscope to ABS I (J1-7) and the battery box to Signal 2 (J1-2 and 3) for single-ended signal input. The voltage at J1-7 is a function of motor current: 1V=10A for SMA8X15. While applying a step input voltage, adjust the Current Limit (RV6) for the desired peak current. If the desired peak current cannot be achieved with the pot (RV6) full CW, increase the input voltage or increase the corresponding Signal 2 Gain (RV2).

   The purpose of the following procedure is to set the system bandwidth to obtain a critically-damped response with the maximum possible tach gain. There are many possible settings of Tach Gain and Compensation which will yield a critically damped waveform. The optimum setting will occur when the Tach Gain is as CW as possible and the Compensation is as CCW as possible. However, the servo-loop may become unstable (the motor oscillates or hunts) with a very low (near CCW) setting of the Compensation. In this case, stability is the limiting factor. At no time should the servo-loop be allowed to be unstable.

   Amplifiers are normally shipped with the Tach Gain (RV3) set at 100%. This is a good place to start. If you are unsure of where the Tach Gain is set, turn the Tach Gain fully CW (up to 12 turns).

6. Move the oscilloscope to the TACH OUT (J1-5), set the battery box for a steady DC voltage and adjust the input voltage or Signal 2 Gain for about 400RPM.

7. Pulse the input and compare the waveform with figure 6.1.

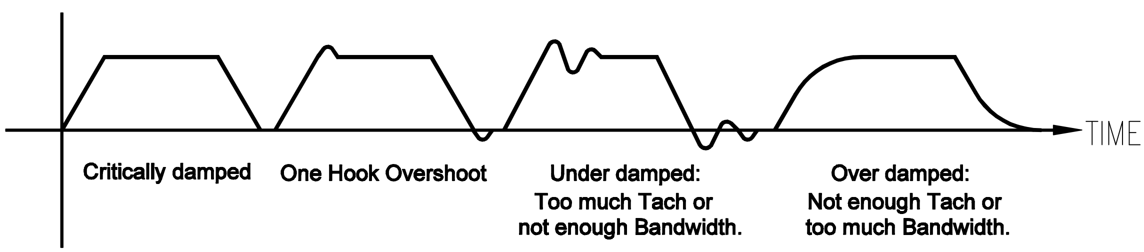


Figure 6.1
Critically damped, One Hook Overshoot, Under and Over damped waveforms

8. Adjust the Compensation pot CCW until the waveform is critically damped or one hook overshoot. Then proceed to step 10.

9. If the desired waveform cannot be obtained by adjusting the Compensation pot, back off(CCW) the Tach Gain pot a few turns and repeat step 8.

10. Do not adjust the Tach Gain or Compensation for the rest of the calibration procedure.

11. With battery box still connected at J1-3 and J1-4 for single-ended input (or if your system uses the differential input, move battery box to J1-1 and J1-2), set battery box for a known DC voltage. Adjust Signal Gain, RV2 (or RV1 for differential input) to obtain the desired motor velocity.

12. If the motor is rotating in the wrong direction for a given input polarity, turn the Loop Gain pot full CCW. Switch the MTR REVERSE (S2-6) from OFF to ON (or vice-versa) or reverse the TACH input leads. Turn the Loop Gain pot back to full CW.

13. Remove the battery box, and repeat only step 4.

14. Calibration complete. Reconnect signal wires.

6.3.2 Trapezoidal Mode Amplifier Calibration Procedure - Current Mode:

The amplifier in this configuration, receives an analog, bi-polar input command which is proportional to the required motor current (motor torque).

1. Turn the current limit (RV6) to mid position and the Loop Gain (RV7) full CCW.
2. Apply main power and fan power.
3. Slowly turn the Loop Gain (RV7) pot CW. Motor should be stopped or turning slowly. Set the Balance (RV4) for zero motor rotation.
4. Connect the oscilloscope to ABS I (J1-7), and the battery box to the Signal 2(single-ended) Input, J1-3 (J1-4 as common). The voltage on J1-7 is a function of motor current: 1V=10A. While pulsing a step input voltage, adjust the Current Limit for desired peak current. If the desired peak current cannot be achieved with Current Limit pot full CW, increase either the input voltage or Signal Gain (RV2) for single-ended Input or Differential Gain (RV1) for differential input.
5. With battery box still connected at J1-3 and J1-4 for single-ended input (or if your system uses the differential input, move battery box to J1-1 and J1-2), set battery box for a known DC voltage. Apply)input signal pulses and adjust the Signal Gain (RV2) pot or (RV1 for differential input) to obtain the desired current gain of the amplifier.
6. If the motor is rotating in the wrong direction for a given polarity, turn the Loop Gain pot full CCW. Switch MTR REVERSE (S1-6) from OFF to ON (or vice-versa). Turn the Loop Gain pot back to full CW.
7. Remove the battery box, and repeat step 3.
8. Calibration complete. Reconnect the signal wires.

6.4 Sine/Resolver Mode Amplifier Calibration:

The following pots will be set during calibration:
Note: RV1 and RV8 are single turn pots; RV2-RV7 and RV9-RV14 are 12-turn pots.
Note: RV9-RV14 are factory set and should not be adjusted. Adjusting these pots voids warranty.

Pots	Name of Pot	Note
RV2	SIG 1 (Differential Input Signal Gain)	Sets the input voltage to RPM ratio, e.g. 10V=2000RPM (velocity mode) or input voltage to torque ratio, e.g. 10V=25A (current mode) required by your system for the differential input.
RV3	SIG 2 (Single-ended Input Signal Gain)	Same as Signal 1 input, except this is for single-ended input.
RV4	TACH (Tach Gain)	Used in conjunction with the compensation pot to set the system bandwidth. Not used in current mode. Shipped set at 100%.
RV5	BAL (Balance)	Used to null any offsets in system.
RV6	COMP (Compensation)	Used in conjunction with the TACH pot to set the system bandwidth. Not used in current mode. Shipped set at full CW (minimum bandwidth).
RV7	I LIMIT (Current Limit)	Sets the maximum motor current. Shipped set at full CW (maximum current limit).
RV8	LOOP (Loop Gain)	Used to shut off uncalibrated amplifiers. When the loop gain is CCW, no current is delivered to the motor. Shipped set at full CCW.

6.4.1 Sine/Resolver Mode Amplifier Calibration Procedure - Velocity Mode:

The amplifier, in this configuration, receives an analog, bi-polar input command which is proportional to the required motor velocity.

1. Turn the Current Limit (RV7) to mid position and the Loop Gain (RV8) full CCW.
2. Apply main power and fan power.

3. Slowly turn the Loop Gain (RV8) CW. The motor should be stopped or turning slowly. If the motor starts running away, turn Loop Gain pot (RV8) CCW, switch TACH REVERSE (S1-5) from OFF to ON (or vice versa) and retest. Leave the Loop Gain (RV8) full CW for all remaining adjustments.

4. Set the Balance (RV5) for zero motor rotation.

5. Connect the oscilloscope to ABS I (J1-7) and the battery box to Signal 2 Input. The voltage at J1-7 is a function of motor current: 1V=10A for SMA8X15. While applying a step input voltage, adjust the Current Limit (RV7) for the desired peak current. If the desired peak current cannot be achieved with the pot full CW, increase the input voltage or increase the Signal Gain (RV3).

   The purpose of the following procedure is to set the system bandwidth to obtain a critically-damped response with the maximum possible tach gain. There are many possible settings of Tach Gain and Compensation which will yield a critically damped waveform. The optimum setting will occur when the Tach Gain is as CW as possible and the Compensation is as CCW as possible.

   However, the servo-loop may become unstable (the motor oscillates or hunts) with a very low (near CCW) setting of Compensation. In this case, stability is the limiting factor. At no time should the servo-loop be allowed to be unstable.

   Amplifiers are normally shipped with the Tach Gain (RV4) set at 100%. This is a good place to start. If you are unsure of where the Tach Gain is set, turn the Tach Gain fully CW (up to 12 turns).

6. Move the oscilloscope to the TACH OUT (J1-5), set the battery box for a steady DC voltage and adjust the input voltage or Signal 2 gain for about 400RPM.

7. Pulse the input and compare the waveform with figure 6.1.

8. Adjust the Compensation pot CCW until the waveform is critically damped or one hook overshoot. Then proceed to step 10.

9. If the desired waveform cannot be obtained by adjusting the Compensation pot, back off (CCW) the Tach Gain pot a few turns and repeat step 8.

10. Do not adjust the Tach Gain or Compensation pots for the rest of the calibration procedure.

11. With the battery box still connected at J1-3 and J1-4 for single-ended input (or if your system uses the differential input, move battery box to J1-1 and J1-2), set battery box for a known DC voltage. Adjust Signal 1 Gain (RV3) or (RV2 for differential input) to obtain the desired motor velocity.

12. If the motor is rotating in the wrong direction for a given input polarity, turn the Loop Gain pot full CCW. Switch MTR REVERSE (S1-4) from OFF to ON (or vice-versa) and switch TACH. REVERSE (S1-5) from OFF to ON (or vice-versa). Turn the Loop Gain pot back to full CW.

13. Remove the battery box, and repeat only step 4.

14. Calibration complete. Reconnect the signal wires.

6.4.2 Sine/Resolver Mode Amplifier Calibration Procedure - Current Mode:

The amplifier in this configuration, receives an analog, bi-polar input command which is proportional to the required motor current (motor torque).

1. Turn the current limit (RV7) to mid position and the Loop Gain (RV8) full CCW.

2. Apply main power and fan power. Slowly turn the Loop Gain (RV8) full CW. Motor should be stopped or turning slowly.

3. Set Balance (RV5) for zero motor rotation.

4. Connect the oscilloscope to ABS I (J1-7), and the battery box to the Signal 2 Signal-ended Input (J1-3 and J1-4). The voltage on J1-7 is a function of motor current: 1V=10A. While pulsing a

step input voltage, adjust the Current Limit for the desired peak current. If the desired peak current cannot be achieved with the pot full CW, increase the input voltage or increase the Signal 2 Gain (RV3).

5. With battery box still connected at J1-3 and J1-4 for single-ended input (or if your system uses the differential input, move battery box to J1-1 and J1-2), set battery box for a known DC voltage. Apply ±input signal pulses and adjust the Signal 2 Gain pot (RV2) or (RV1 for differential input) to obtain the desired current gain of the amplifier.

6. If the motor is rotating in the wrong direction for a given input polarity, turn the Loop Gain pot full CCW. Switch MTR REVERSE (S1-4) from OFF to ON (or vice-versa). Turn the Loop Gain pot back to full CW.

7. Remove the battery box, and repeat step 3.

8. Calibration complete. Reconnect the signal wires.

6.5 Two/Three Phase Current Mode Amplifier Calibration:

The amplifier in this configuration, receives either two or three bi-polar phase current command signals input. The amplifier generates three sine wave currents that are proportional to the input signals. The following pots will be set during calibration:

Note: RV1 to RV4 are 12-turn pots.

Pots	Name of Pot	Note
RV1	PHASE R	Signal gain for phase R input current.
RV2	PHASE S	Signal gain for phase S input current.
RV3	PHASE T	Signal gain for phase T input current.
RV4	I LIMIT (Current Limit)	Sets maximum motor current. Shipped set CW (maximum current limit).

6.5.1 Two Phase Input Current Mode Amplifier Calibration Procedure:

1. Turn the Current Limit (RV4) to mid position, phase R (RV1) full CCW and phase S (RV2) full CCW .

2. Apply main power and fan power.

3. Slowly turn Phase R (RV1) and Phase S (RV2) full CW. (NOTE: These are 12 turn pots)

4. Connect oscilloscope to ABS I (J1-7). Slowly adjust the I LIM SET (RV4) clockwise for the desired peak current while commanding a DC voltage into Phase R in less than 1 second intervals.

5. Calibration complete.

6.5.2 Three Phase Input Current Mode Amplifier Calibration Procedure:

1. Turn the Current Limit (RV4) to mid position, phase R (RV1) full CCW, phase S (RV2) full CCW and phase T (RV3) full CCW.

2. Apply main power and fan power.

3. Slowly turn Phase R (RV1), Phase S (RV2) and Phase T (RV3) full CW. (NOTE: These are 12 turn pots)

4. Connect the oscilloscope to I Limit (J3-E), and set the current limit for (5V/A) at I LIM SET (RV4).

5. Connect oscilloscope to ABS I (J1-7), and the three modulated input waveforms at Phase R (J1-1,J1-2), Phase S (J1-3,J1-4) and Phase T (J1-5,J1-6). Adjust I LIM SET (RV4) for desired peak current.

6. Calibration complete.

6.6 Calibration Setup Record:

It is good practice to keep a record of all pot settings. Doing so will facilitate calibration on future units and repair on this unit. Although not a substitute for the calibration procedure, it will at least get you "in the ballpark." Remove the power and allow all capacitors to discharge before taking measurements. Note: The balance pot should not be measured in this fashion, set per step 4 in the calibration procedure.

Pot/Dip Switches	AMP1	AMP2	AMP3	AMP4
SIG. 1 J3-A to J3-F (Ù)				
SIG. 2 J3-B to J3-F (Ù)				
TACH J3-C to J3-F (Ù)				
COMP J3-D to J3-F (Ù)				
CURRENT LIMIT J3-E to J3-F (Ù)				
Signal input to Tach ratio: _V Signal / _V Tach				
LIMIT(PULL UP/DN) S1-8(8115), S2-8(8215)				
INHIBIT(PULL UP/DN) S1-7(8115), S2-7(8215), S1-5(8315)				
RESET(PULL UP/DN) S1-6(8115), S2-6(8215), S1-4(8315)				
LIMIT(ACTIVE HI/LOW) S1-5(8115), S2-5(8215)				
INHIBIT(ACTIVE HI/LOW) S1-4(8115), S2-4(8215), S1-3(8315)				
RESET(ACTIVE HI/LOW) S1-3(8115), S2-3(8215), S1-2(8315)				
MTR TEMP(ACTIVE HI/LOW) S1-2(8115), S2-2(8215), S1-1(8315)				
+15/+5 S1-1(8115), S2-1(8215), S1-6(8315)				

Date data taken: / / Serial number S/N:_______________

Model number SMA____

6.7 Resolver Alignment:

Note: Glentek motors with built-in resolvers are factory aligned. Consult a Glentek applications engineer prior to attempting a resolver realignment. Failure to do so may void the warranty.

Note:Consult a Glentek applications engineer before aligning a non-Glentek motor/resolver. Some motor/ resolvers require procedures other than that described here.

Note:Dip-switches S3-1, S3-2, S3-3 and S3-4 allow the converter to be operated in one of eight modes. The first six modes set the number of motor "poles". One pole corresponds to one magnet, thus a motor with two "north" and two "south" magnets has four poles. The number of electrical revolutions is equal to one-half the number of poles. An electrical revolution refers to the arc-length the motor will rotate when one complete sine-wave is applied. Therefore, a four-pole motor has two electrical revolutions and requires two sine-waves to make one mechanical (shaft) revolution. The significance of this is, any motor with more than one electrical revolution will have more than one electrical "index" (0^o position), while there is only one mechanical index. From an electrical viewpoint, any index may be used, however from a mechanical viewpoint, using a different electrical index may alter the mechanical index by as much as 180^o from its previous position. This will show itself as a change in where the encoder index (channel C) pulse occurs.Note that the emulated encoder has an index per mechanical (shaft) revolution.Of the remaining two modes, the INDEX is used to generate an index output and is used for resolver alignment.

6.7.1 Resolver Alignment Procedure:

All adjustments are made to the 8000-22 Sine/Resolver pre-amp. Refer to Appendix C, drawings 8000-2230 and 8000-2231.

Motor:	S3-1	S3-2	S3-3	S3-4
2 Pole	ON	ON	ON	ON
4 Pole	ON	ON	ON	OFF
6 Pole	ON	ON	OFF	ON
8 Pole	ON	ON	OFF	OFF
10 Pole	ON	OFF	ON	ON
12 Pole	ON	OFF	ON	OFF
Zero	ON	OFF	OFF	ON
Index	ON	OFF	OFF	OFF

1. Connect and configure the amplifier as described in the installation section. Do not apply power yet.
2. Loosen the resolver mounting-screws just enough to allow the resolver to be adjusted.
3. Note the positions of S3-1, S3-2, S3-3 and S3-4, then set S3-1, S3-2, S3-3 and S3-4 for **index** (i.e. S3-1:ON, S3-2:OFF, S3-3:OFF and S3-4:OFF).
4. Make sure the amplifier is in current mode (S1-7:OFF and S1-8:ON), and set S1-4 to the 'ON' position.
5. Apply power. Adjust the motor shaft until the red index LED lights.
6. Slowly apply signal input voltage SIGNAL 1+ and SIGNAL 1- (J1-1 & J1-2) for differential input or SIGNAL 2+ and COMMON (J1-3 & J1-4) for single-ended input until the motor shaft becomes reasonably "stiff" (then it can not be easily adjusted). **Use Caution!** This procedure is applying continuous current to the motor. An excessive CW setting may result in motor damage! The motor will rotate to the correct index position. The amount of rotation will be proportional to the alignment error.
7. Slowly rotate the resolver CW or CCW until the index LED is constantly illuminated. Tighten the resolver mounting screws, the LED should still be on.
8. Turn the power off.
9. Restore the dip-switch settings for the correct type and number of poles for the motor being used by adjusting S3-1, S3-2, S3-3 and S3-4 according to the table above. Set S1-4 back to the 'OFF' position. If the amplifier is to be operated in velocity mode, then set S1-7:ON and S1-8:OFF, otherwise proceed to step 10.
10. Turn the power back on and apply a signal input command while monitoring the DC voltage at the tach. out (J1-5) with a digital voltmeter and record this voltage. Now reverse the polarity of the signal input command and record this voltage.

NOTE: Be sure to set the tach. out voltage for 1000 RPM (12-14 bit resolution)

11. If the difference between both of the above readings is less than 100mV, the motor is ready to operate. However, if the difference is greater than 100mV, proceed to step12.
12. Loosen the resolver mounting screws.
13. Alternately apply a positive and negative signal input command while monitoring the tach. out

voltage at J1-5.

14. Rotate the resolver body slowly back and forth until the difference between both tach. out voltage readings is less than 100mV.

15. Tighten the resolver mounting screws and turn the power off.

16. Resolver alignment complete.

Chapter Seven: Maintenance, Repair, and Warranty

7.1 Maintenance:

Glentek amplifiers do not require any scheduled maintenance, although it is a good idea to occasionally check for dust build-up or other contamination.

7.2 Amplifier Faults:

If an amplifier should cease to operate and one or more of the fault LED's are lit, review the sections which follow on the fault in question for information and possible causes.

A FAULT CAN ONLY BE CAUSED BY ABNORMAL CONDITIONS. LOCATE AND CORRECT THE CAUSE OF THE FAULT BEFORE REPEATED RECYCLING OF POWER TO THE AMPLIFIER TO PREVENT POSSIBLE DAMAGE.

7.2.1 Table of Fault LED Conditions:

Input or Fault Condition	RUN LED	HS/ECB LED	LS/ECB LED	OVER VOLT LED	OVERTEMP LED	FAULT OUTPUT
Normal Operation	ON	OFF	OFF	OFF	OFF	NO
Limit + (ON)	ON	OFF	OFF	OFF	OFF	NO
Limit - (ON)	ON	OFF	OFF	OFF	OFF	NO
Inhibit (ON)	OFF	OFF	OFF	OFF	OFF	NO
Reset In (ON)	OFF	OFF	OFF	OFF	OFF	NO
Ext. Fault (ON)	OFF	OFF	OFF	OFF	OFF	YES
Undervoltage (+15V)	OFF	OFF	OFF	OFF	OFF	YES
HS/ECB (Latched)	OFF	ON	OFF	OFF	OFF	YES
LS/ECB (Latched)	OFF	OFF	ON	OFF	OFF	YES
Over-voltage B+ (Latched)	OFF	OFF	OFF	ON	OFF	YES
Overtemp (Latched)	OFF	OFF	OFF	OFF	ON	YES

7.2.2 Under Voltage Fault:

When the +15VDC is below +12VDC, a level that would cause unreliable operation, the Run LED will turn off, a Fault Output is generated, and the amplifier is inhibited. This is not a latched condition: that is, if the problem is resolved the amplifier will resume operation.

The following is a list of possible causes:
1. Main AC line voltage is too low.
2. Bad rectifier bridge.
3. Bad DC buss filter capacitor.

7.2.3 Motor Over Temp Fault:

When the motor temperature has reached a level that, if exceeded, would damage the motor, the Run LED will turn off, the OVER TEMP LED will turn on and a Fault Output is generated, and the amplifier is inhibited. Note: This is a latched condition.

The following is a list of possible causes:
1. The continuous motor current is too high.
2. Binding or stalling of motor shaft due to excessive mechanical overload.
3. Motor rating too small for the load.

7.2.4 High Speed Electronic Circuit Breaker (HS/ECB) Fault:

When the peak output of the amplifier exceeds 80A for 10 micro-seconds, the Run LED will turn off, the HS/ECB LED will turn on and a Fault Output is generated, and the amplifier is inhibited. Note: This is a latched condition.

The following is a list of possible causes:

1. Shorted motor leads.
2. Motor inductance too low.
3. Short from a motor lead to ground.

7.2.5 Low Speed Electronic Circuit Breaker (LS/ECB) Fault:

When the RMS output of the amplifier exceeds 15/10A for standard 120/240VAC or 20/15A for High Power 120/240VAC for 3 seconds, the Run LED will turn off, the LS/ECB LED will turn on and a Fault Output is generated, and the amplifier is inhibited. Note: This is a latched condition.

The following is a list of possible causes:

1. Binding or stalling of motor shaft due to excessive mechanical overload.
2. Overload of amplifier output to motor.
3. Large reflected load inertia.

7.2.6 Over Temp Fault:

When the heatsink and or motor temperature has reached a level that, if exceeded, would damage the output transistors or the motor, the Run LED will turn off, the OVER TEMP LED is latched on, a Fault Output is generated, and the amplifier is inhibited.

The following is a list of possible causes:

1. Loss of cooling air - Fans are defective or airflow is blocked.
2. Excessive rise in cooling air temperature due to cabinet ports being blocked or excessive hot air being ingested.
3. Extended operational duty cycle due to mechanical overload of motor or defective motor.
4. The motors thermal switch has been tripped due to excessive overloading.

7.2.7 Over Voltage Fault:

When the DC-Buss voltage reaches a level that, if exceeded, would harm the amplifier or motor (i.e. +250VDC for standard and +450VDC for High Power), the Run LED will turn off, the Over-voltage LED's are latched on, a Fault Output is generated, and the amplifier is inhibited.

The following is a list of possible causes:

1. Main AC line voltage is too high.
2. Decelerating a large inertial load. When decelerating, a DC motor acts as a generator. If the inertial load is large, the generated voltage can pump-up the DC-Buss. If this fault occurs, you may need a Regen Clamp. Consult Glentek.

7.2.8 Resetting A Fault:

The fault latch may be reset by pushing the Reset button, activating the Reset input J1-13 or by removing power and allowing the filter capacitor(s) to discharge. Note that the fault latch will not reset unless the fault has been cleared.

7.3 Amplifier Failure:

If an amplifier should fail, that is, if it should cease to operate with no apparent fault, the drawings in appendices A and B will enable a skilled technician to trouble-shoot an amplifier to even lower levels.

The modular construction of the amplifier allows fast and easy repair. This is especially true due to the plug-in personality module card, since all user adjustments and configuration changes are made on this card. If an amplifier module should fail, simply unplug the pre-amp and plug it into a replacement amplifier.

The lowest-level parts or modules which Glentek recommends for field replacement are:

1. Fuses in the GP8600-70 power supply sub-assembly.
2. Fans F201-F203
3. Amplifier modules A1-A4.

7.4 Factory Repair:

Should it become necessary to return an amplifier to Glentek for repair, please follow the procedure described below:

1. Reassemble the unit, if necessary, making certain that all the hardware is in place.
2. Tag the unit with the following information:

   A. Serial number and model number.

   B. Company name, phone number, and representative returning the unit.

   C. A brief notation explaining the malfunction.

   D. Date the unit is being returned.
3. Repackage the unit with the same care and fashion in which it was received. Label the container with the appropriate stickers (e.g: FRAGILE: HANDLE WITH CARE).
4. Contact a Glentek representative, confirm that the unit is being returned to the factory and obtain an RMA (Return Material Authorization) number. The RMA number must accompany the unit upon return to Glentek. Do not ship unit without RMA number. Show RMA number on outside of package.
5. Return the unit by the best means possible. The method of freight chosen will directly affect the timeliness of its return.

Glentek also offers a 24-48 hr. repair service in the unlikely event that your system is down and you do not have a replacement amplifier module.

7.5 Warranty:

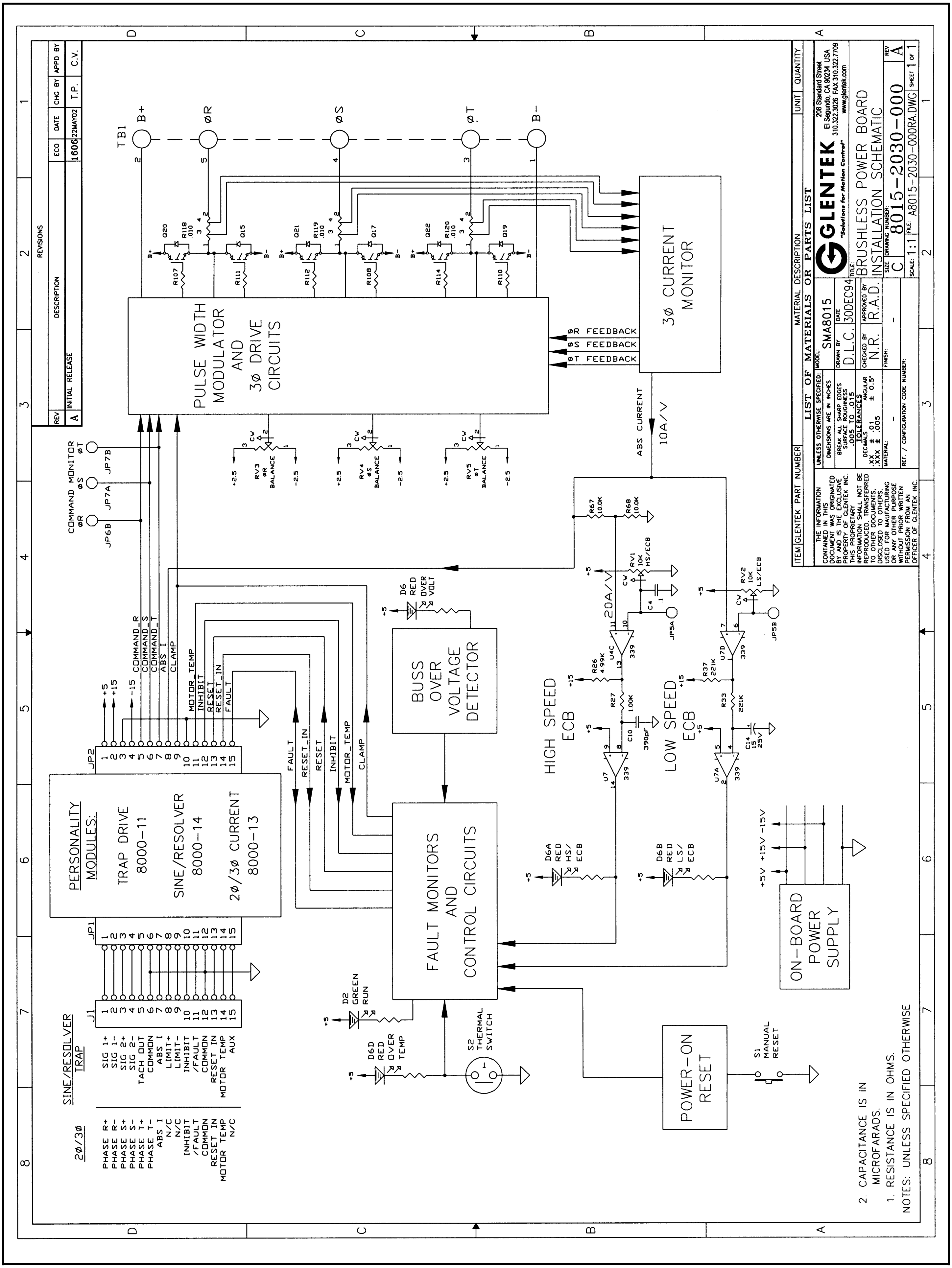
Any product, or part thereof, manufactured by Glentek, Inc., described in this manual, which, under normal operating conditions in the plant of the original purchaser thereof, proves defective in material or workmanship within one year from the date of shipment by us, as determined by an inspection by us, will be repaired or replaced free of charge, FOB our factory, El Segundo, California, U.S.A. provided that you promptly send to us notice of the defect and establish that the product has been properly installed, maintained, and operated within the limits of rated and normal usage, and that no factory sealed adjustments have been tampered with. Glentek's liability is limited to repair or replacement of defective parts.

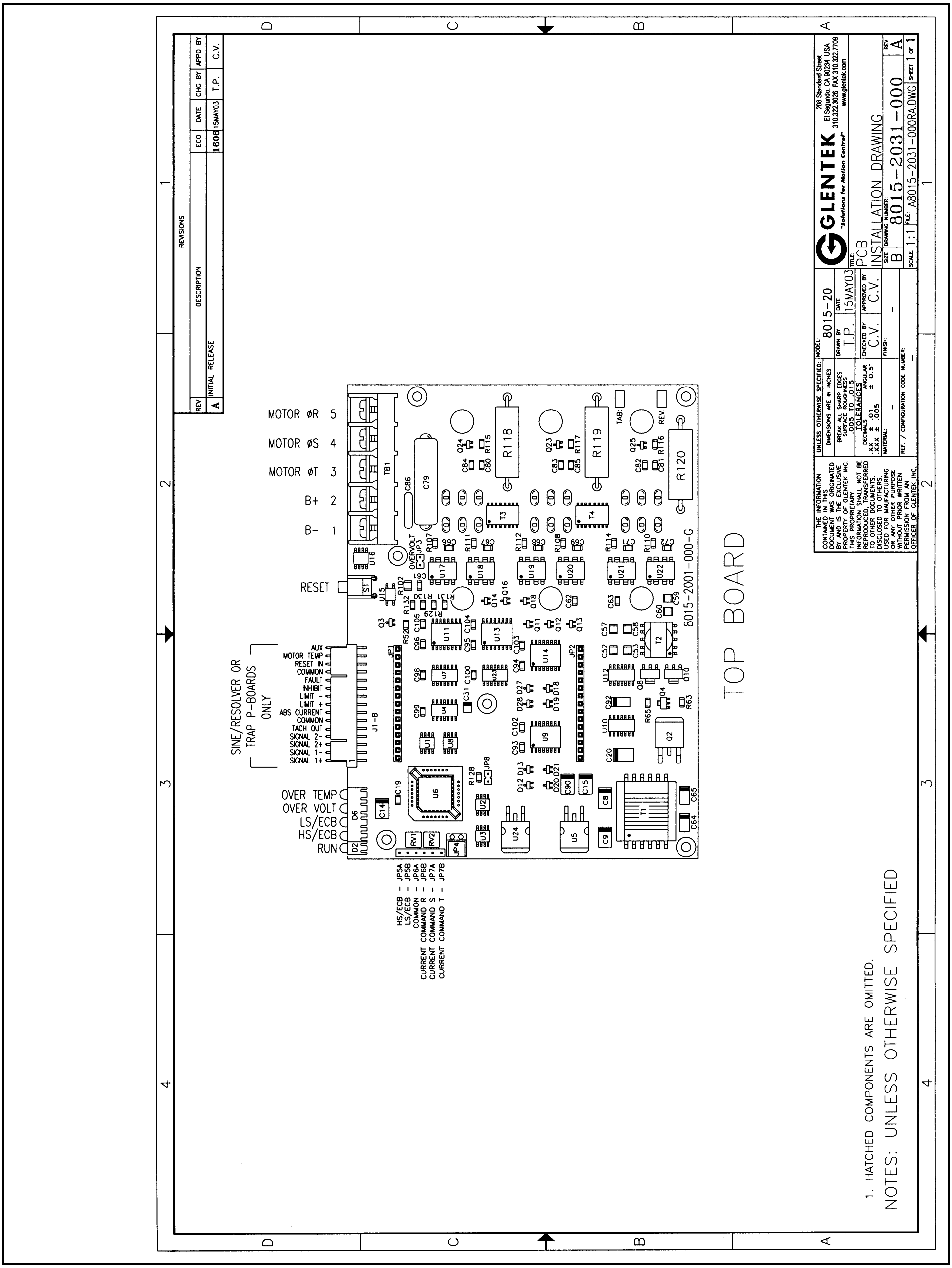
Any product or part manufactured by others and merely installed by us, such as an electric motor, etc., is specifically not warranted by us and it is agreed that such product or part shall only carry the warranty, if any, supplied by the manufacturer of that part. It is also understood that you must look directly to such manufacturer for any defect, failure, claim or damage caused by such product or part.

Under no circumstances shall Glentek, Inc. or any of our affiliates have any liability whatsoever for claims or damages arising out of the loss of use of any product or part sold to you. Nor shall we have any liability to yourself or anyone for any indirect or consequential damages such as injuries to person and property caused directly or indirectly by the product or part sold to you, and you agree in accepting our product or part to save us harmless from any and all such claims or damages that may be initiated against us by third parties.

Appendix A

Amplifier Drawings


PULSE WIDTH MODULATOR AND 3Ø DRIVE CIRCUITS
3Ø CURRENT MONITOR
BUSS OVER VOLTAGE DETECTOR
FAULT MONITORS AND CONTROL CIRCUITS
PERSONALITY MODULES:
TRAP DRIVE 8000-11
SINE/RESOLVER 8000-14
2Ø/3Ø CURRENT 8000-13
HIGH SPEED ECB
LOW SPEED ECB
ON-BOARD POWER SUPPLY
POWER-ON RESET
ØR FEEDBACK
ØS FEEDBACK
ØT FEEDBACK
ABS CURRENT
10A/V
20A/V
COMMAND MONITOR
THERMAL SWITCH
MANUAL RESET
NOTES: UNLESS SPECIFIED OTHERWISE
1. RESISTANCE IS IN OHMS.
2. CAPACITANCE IS IN MICROFARADS.
GLENTEK
BRUSHLESS POWER BOARD INSTALLATION SCHEMATIC
8015-2030-000
A8015-2030-000RA.DWG



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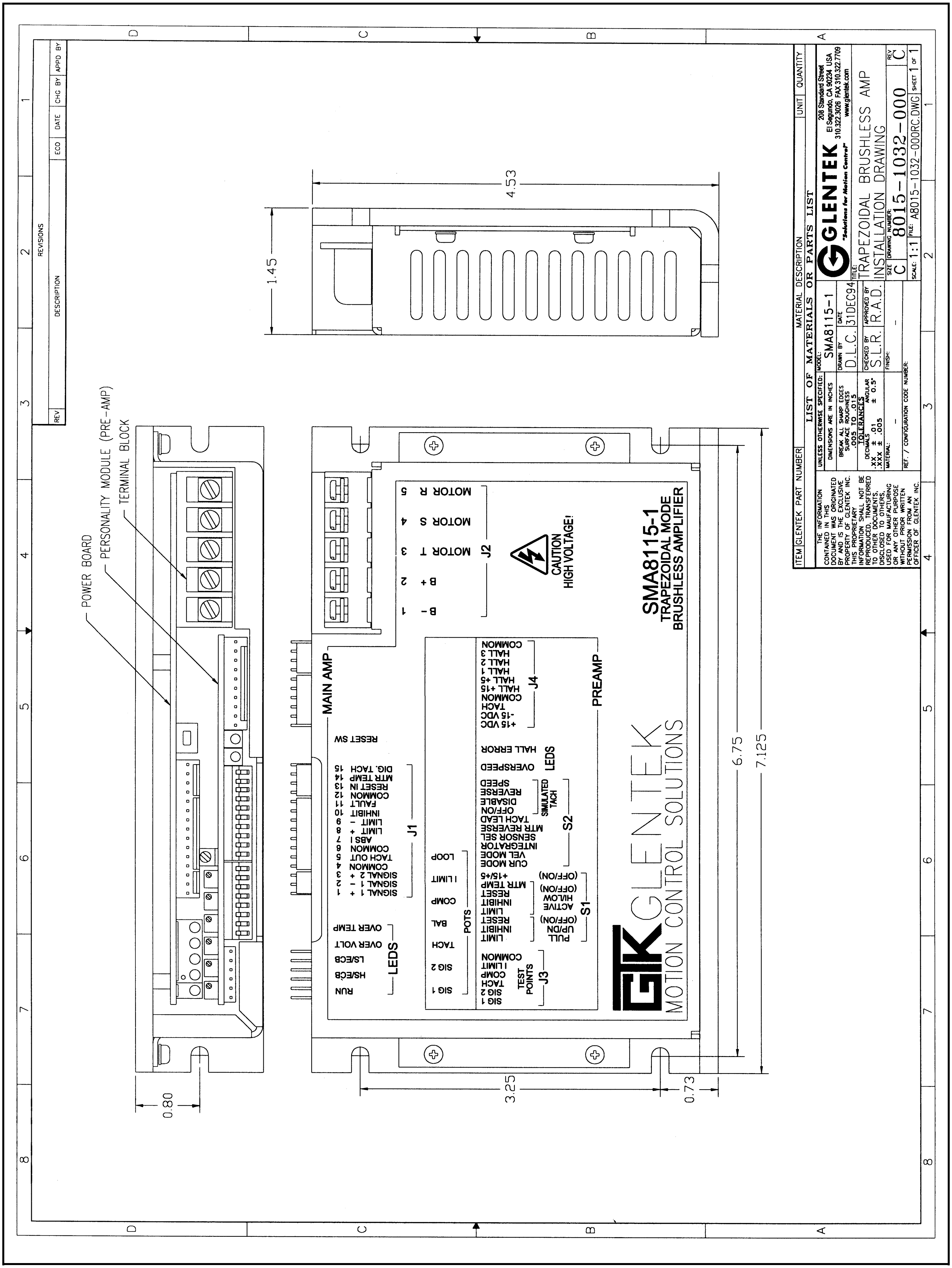
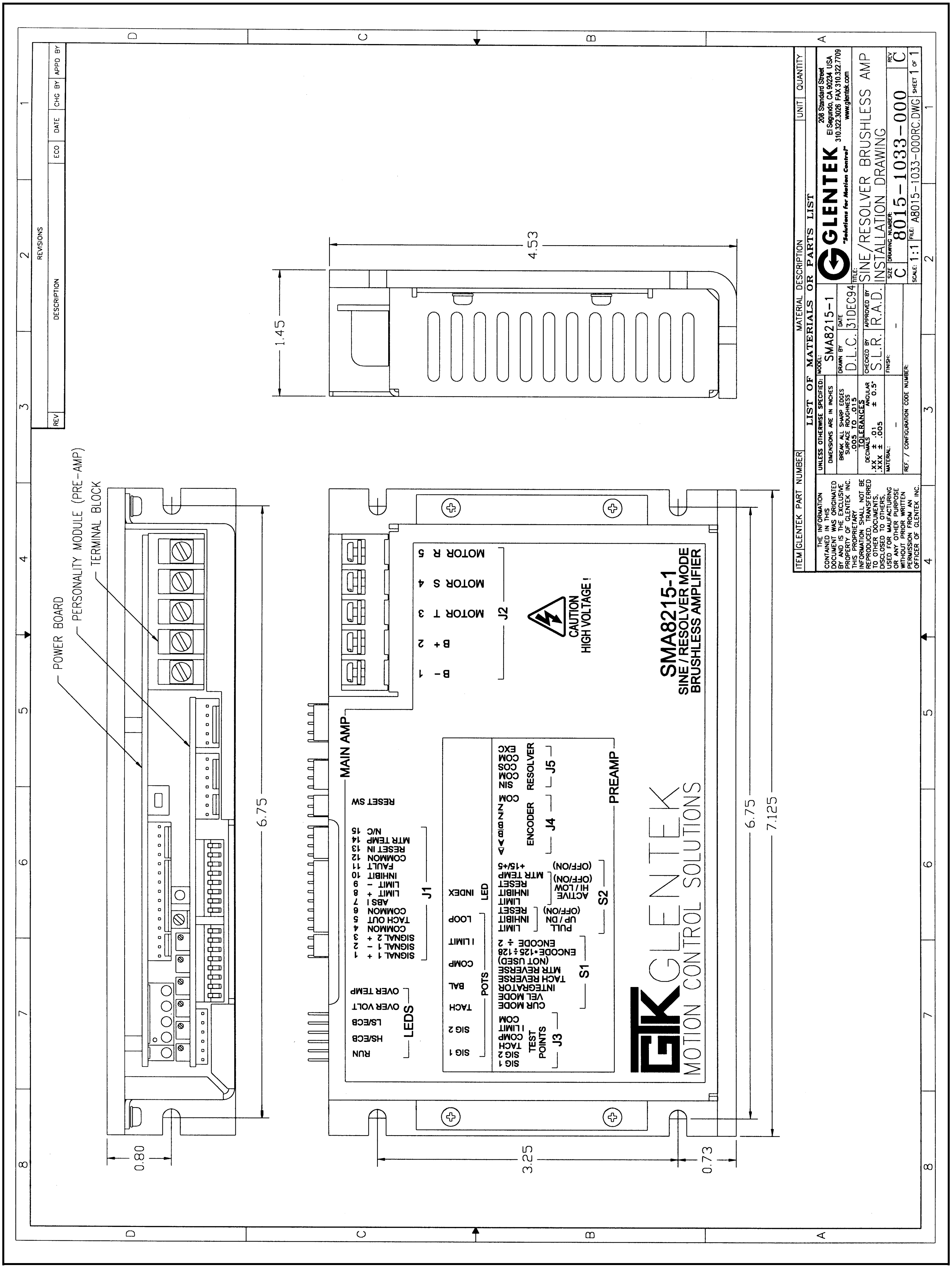
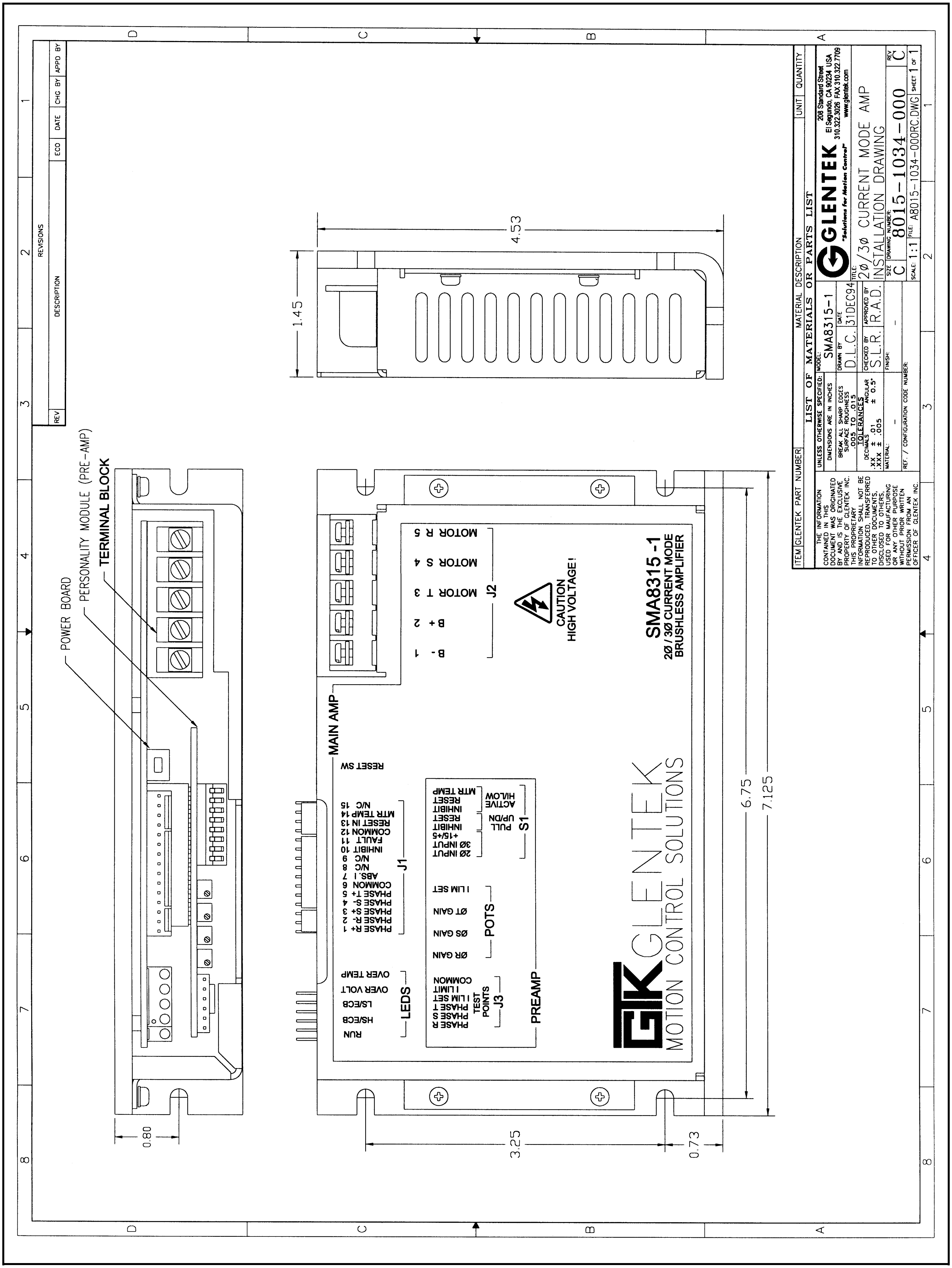
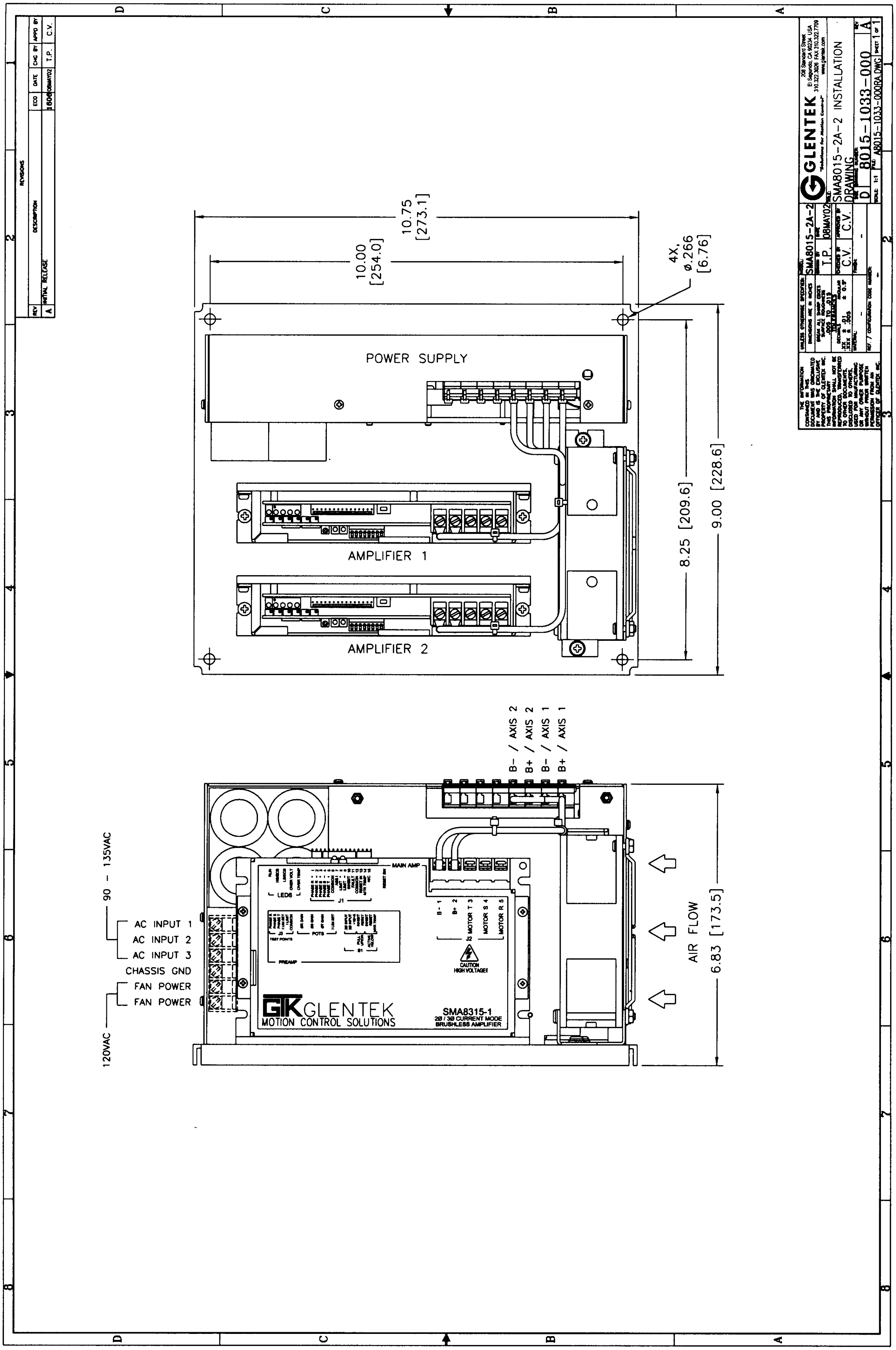
T.P.
C.V.
MOTOR ØR 5
MOTOR ØS 4
MOTOR ØT 3
B+ 2
B- 1
RESET
SINE/RESOLVER OR TRAP P-BOARDS ONLY
AUX
MOTOR TEMP
RESET IN
COMMON
FAULT
INHIBIT
LIMIT -
LIMIT +
ABS CURRENT
COMMON
TACH OUT
SIGNAL 2-
SIGNAL 2+
SIGNAL 1-
SIGNAL 1+
OVER TEMP
OVER VOLT
LS/ECB
HS/ECB
RUN
HS/ECB - JP5A
LS/ECB - JP5B
COMMON - JP6A
CURRENT COMMAND R - JP6B
CURRENT COMMAND S - JP7A
CURRENT COMMAND T - JP7B
8015-2001-000-G
TOP BOARD
NOTES: UNLESS OTHERWISE SPECIFIED
1. HATCHED COMPONENTS ARE OMITTED.
GLENTEK
"Solutions for Motion Control"
208 Standard Street
El Segundo, CA 90245 USA
310.322.3026 FAX 310.322.7709
www.glentek.com
MODEL: 8015-20
DRAWN BY T.P.
DATE 15MAY03
CHECKED BY C.V.
APPROVED BY C.V.
TITLE: PCB INSTALLATION DRAWING
SIZE B
DRAWING NUMBER 8015-2031-000
REV A
SCALE: 1:1
FILE: A8015-2031-000RA.DWG
SHEET 1 OF 1

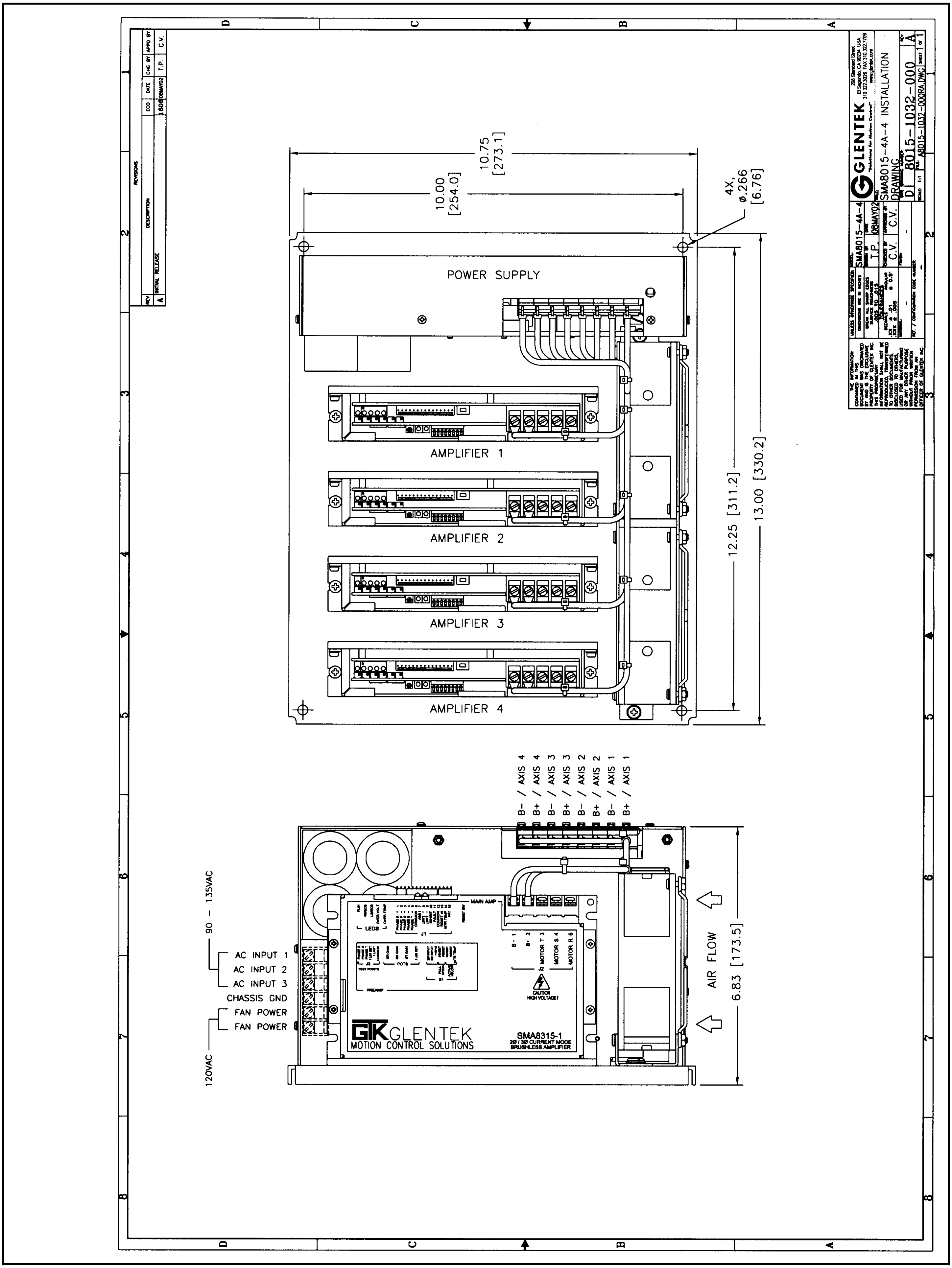

4.53
1.45
POWER BOARD
PERSONALITY MODULE (PRE-AMP)
TERMINAL BLOCK
MAIN AMP
PREAMP
MOTOR R 5
MOTOR S 4
MOTOR T 3
B + 2
B – 1
J2
CAUTION HIGH VOLTAGE!
SMA8115-1
TRAPEZOIDAL MODE
BRUSHLESS AMPLIFIER
J1
J3
J4
S1
S2
LEDS
POTS
TEST POINTS
RESET SW
GLENTEK
MOTION CONTROL SOLUTIONS
6.75
7.125
3.25
0.73
0.80
LIST OF MATERIALS OR PARTS LIST
GLENTEK
208 Standard Street
El Segundo, CA 90234 USA
310.322.3026 FAX 310.322.7709
www.glentek.com
SMA8115-1
D.L.C.
31DEC94
S.L.R.
R.A.D.
TRAPEZOIDAL BRUSHLESS AMP
INSTALLATION DRAWING
C
8015-1032-000
1:1
A8015-1032-000RC.DWG
SHEET 1 OF 1


SMA8215-1
SINE / RESOLVER MODE
BRUSHLESS AMPLIFIER
CAUTION
HIGH VOLTAGE !
MAIN AMP
PREAMP
GLENTEK
MOTION CONTROL SOLUTIONS
POWER BOARD
PERSONALITY MODULE (PRE-AMP)
TERMINAL BLOCK
4.53
1.45
6.75
7.125
0.80
3.25
0.73
MOTOR R 5
MOTOR S 4
MOTOR T 3
B + 2
B − 1
J1
J2
J3
J4
J5
S1
S2
LEDS
POTS
RESET SW
SINE/RESOLVER BRUSHLESS AMP
INSTALLATION DRAWING
8015-1033-000
SMA8215-1
D.L.C.
31DEC94
S.L.R.
R.A.D.
A8015-1033-000RC.DWG
208 Standard Street
El Segundo, CA 90234 USA
LIST OF MATERIALS OR PARTS LIST
REVISIONS


POWER BOARD
PERSONALITY MODULE (PRE-AMP)
TERMINAL BLOCK
4.53
1.45
6.75
7.125
0.80
3.25
0.73
MOTOR R 5
MOTOR S 4
MOTOR T 3
B + 2
B - 1
J2
CAUTION
HIGH VOLTAGE!
SMA8315 -1
2Ø / 3Ø CURRENT MODE
BRUSHLESS AMPLIFIER
MAIN AMP
RESET SW
J1
PHASE R+ 1
PHASE R- 2
PHASE S+ 3
PHASE S- 4
PHASE T+ 5
COMMON 6
ABS. I 7
N/C 8
N/C 9
INHIBIT 10
FAULT 11
COMMON 12
RESET IN 13
MTR TEMP 14
N/C 15
S1
2Ø INPUT
3Ø INPUT
+15/+5
INHIBIT
RESET
UP/DN
PULL
INHIBIT
RESET
MTR TEMP
ACTIVE
HI/LOW
POTS
I LIM SET
ØT GAIN
ØS GAIN
ØR GAIN
LEDS
OVER TEMP
OVER VOLT
LS/ECB
HS/ECB
RUN
J3
TEST POINTS
PHASE R
PHASE S
PHASE T
I LIM SET
I LIMIT
COMMON
PREAMP
GLENTEK
MOTION CONTROL SOLUTIONS
REVISIONS
LIST OF MATERIALS OR PARTS LIST
GLENTEK
208 Standard Street
El Segundo, CA 90234 USA
310.322.3026 FAX 310.322.7709
www.glentek.com
"Solutions for Motion Control"
MODEL: SMA8315-1
DRAWN BY D.L.C.
DATE 31DEC94
CHECKED BY S.L.R.
APPROVED BY R.A.D.
TITLE: 2Ø/3Ø CURRENT MODE AMP INSTALLATION DRAWING
SIZE C
DRAWING NUMBER: 8015-1034-000
REV C
SCALE: 1:1
FILE: A8015-1034-000RC.DWG
SHEET 1 OF 1

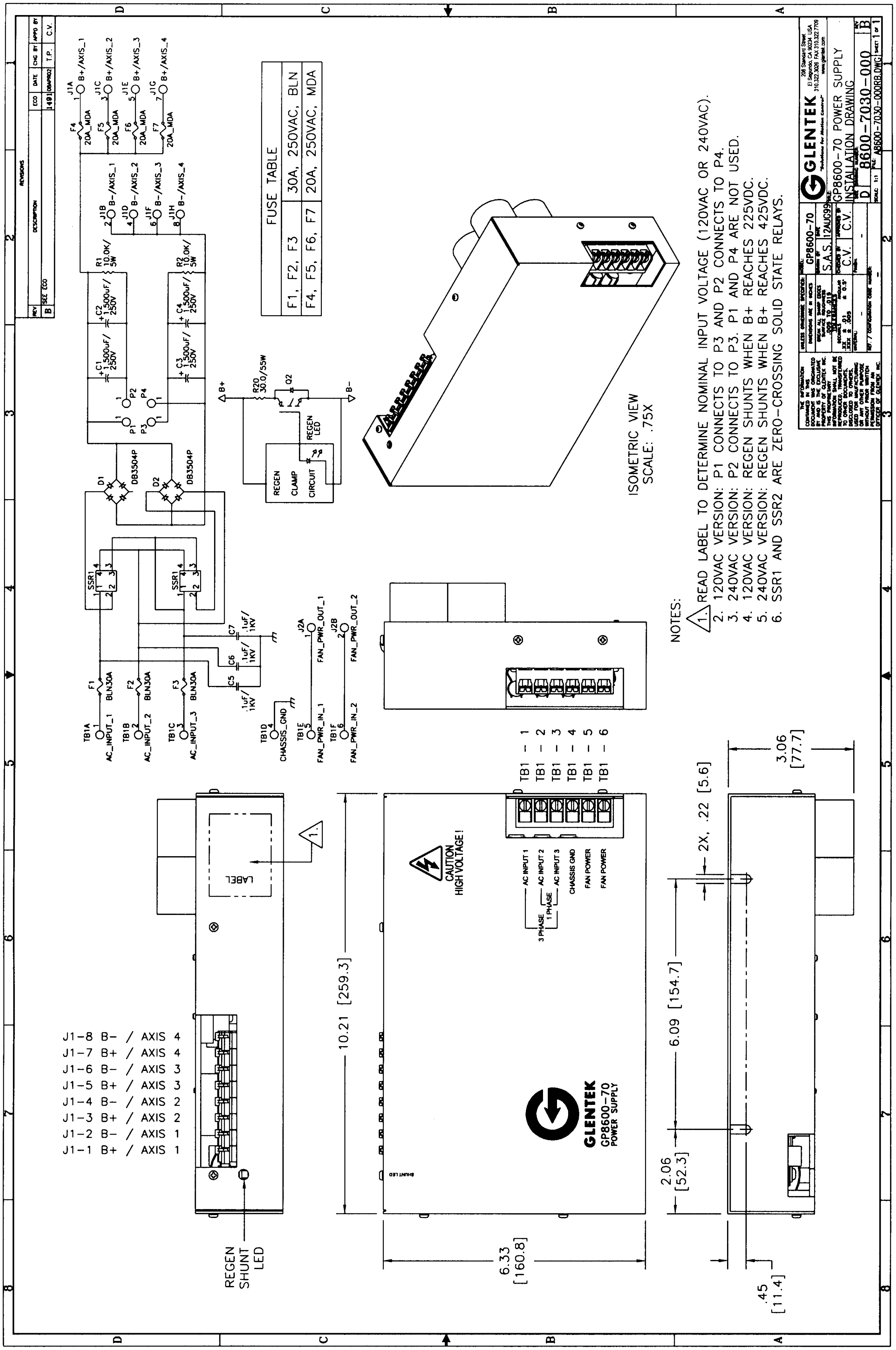


10.75 [273.1]
10.00 [254.0]
4X, ø.266 [6.76]
POWER SUPPLY
AMPLIFIER 1
AMPLIFIER 2
8.25 [209.6]
9.00 [228.6]
B- / AXIS 2
B+ / AXIS 2
B- / AXIS 1
B+ / AXIS 1
90 - 135VAC
AC INPUT 1
AC INPUT 2
AC INPUT 3
CHASSIS GND
FAN POWER
FAN POWER
120VAC
GLENTEK
MOTION CONTROL SOLUTIONS
SMA8315-1
AIR FLOW
6.83 [173.5]
SMA8015-2A-2 INSTALLATION DRAWING
8015-1033-000


POWER SUPPLY
AMPLIFIER 1
AMPLIFIER 2
AMPLIFIER 3
AMPLIFIER 4
10.75 [273.1]
10.00 [254.0]
4X, ⌀.266 [6.76]
12.25 [311.2]
13.00 [330.2]
B- / AXIS 4
B+ / AXIS 4
B- / AXIS 3
B+ / AXIS 3
B- / AXIS 2
B+ / AXIS 2
B- / AXIS 1
B+ / AXIS 1
90 - 135VAC
AC INPUT 1
AC INPUT 2
AC INPUT 3
CHASSIS GND
FAN POWER
FAN POWER
120VAC
AIR FLOW
6.83 [173.5]
GLENTEK
MOTION CONTROL SOLUTIONS
SMA8315-1
SMA8015-4A-4 INSTALLATION DRAWING
8015-1032-000

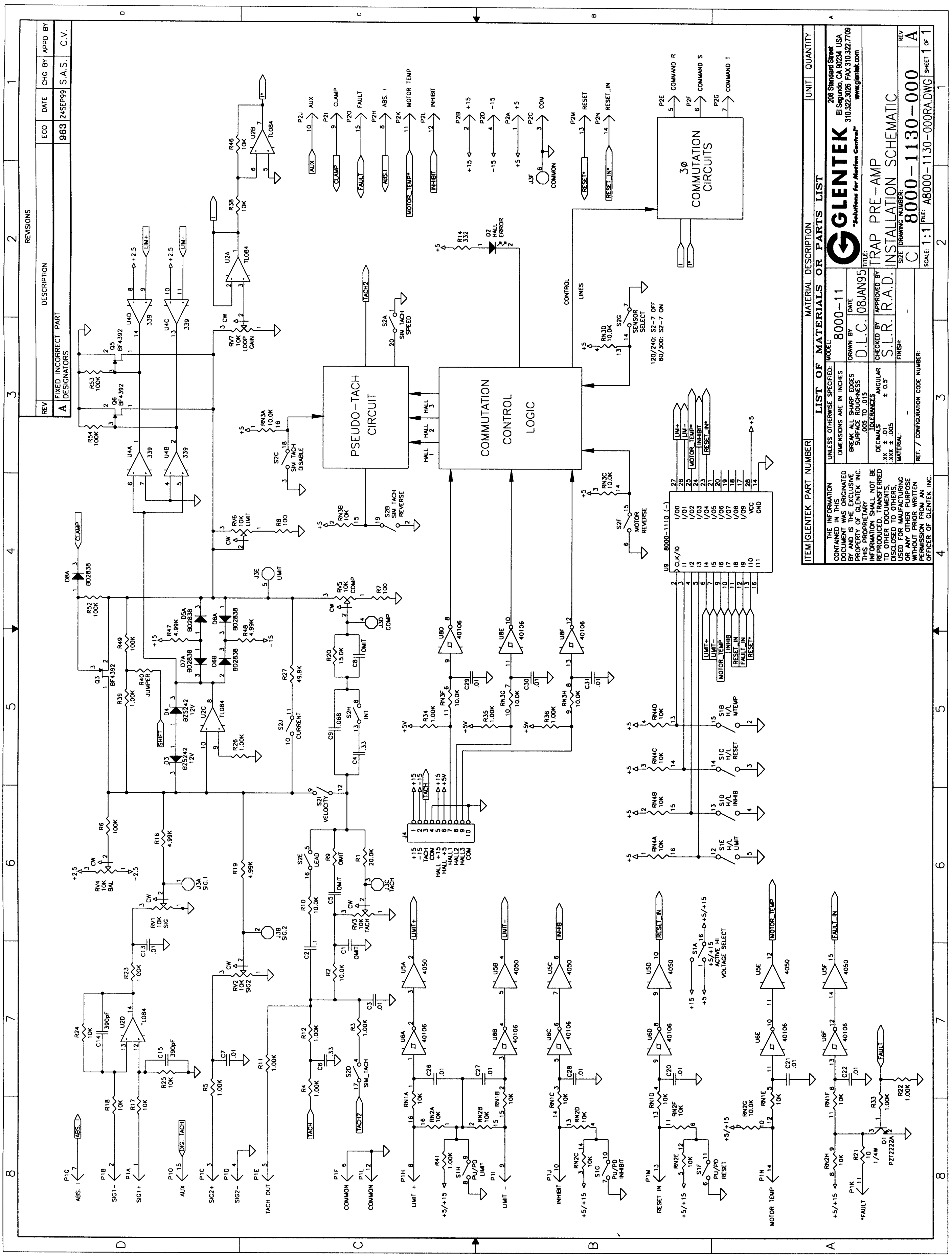
Appendix B

Multi Axis Power Supply

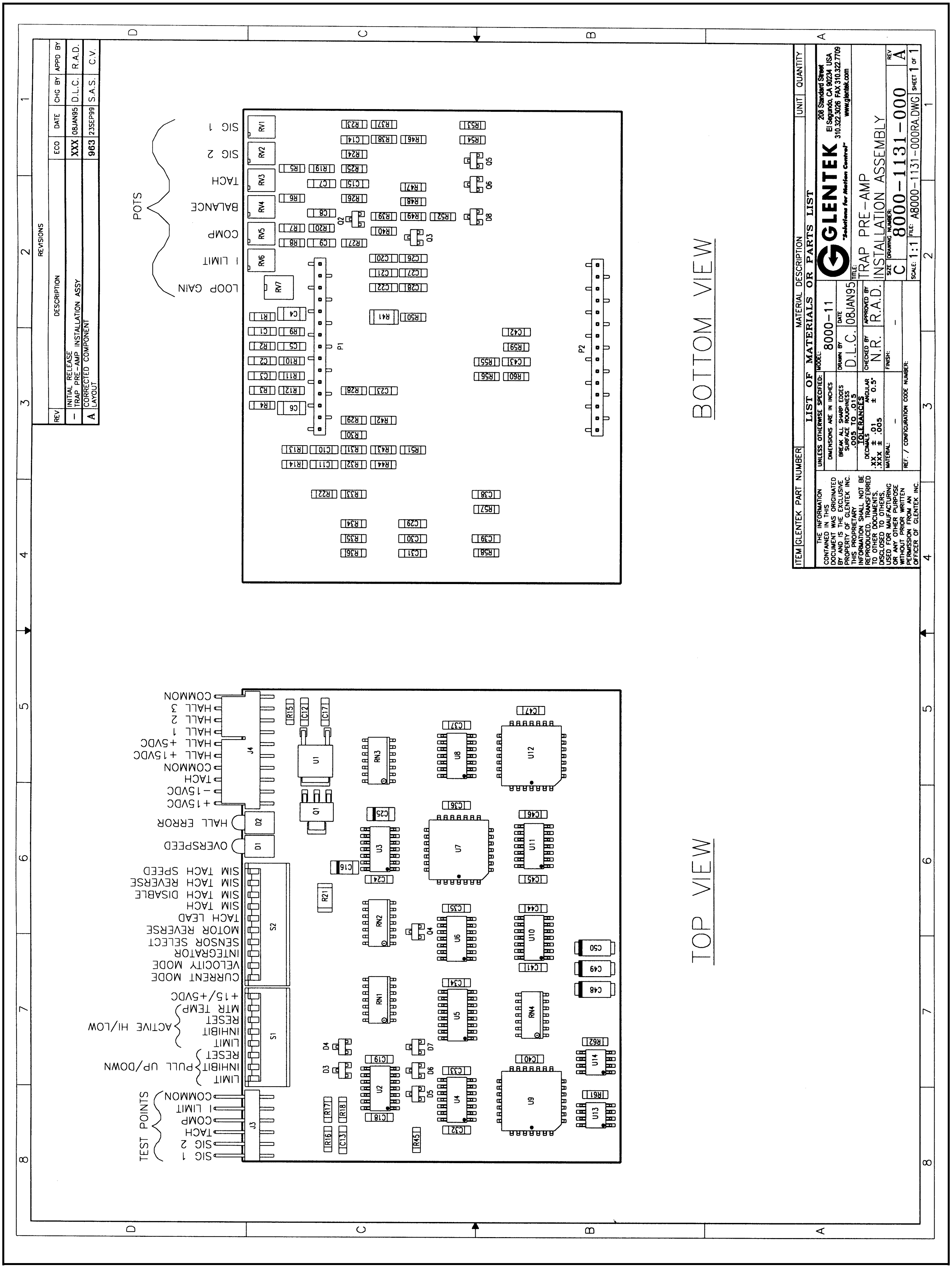

FUSE TABLE
F1, F2, F3 30A, 250VAC, BLN
F4, F5, F6, F7 20A, 250VAC, MDA
NOTES:
1. READ LABEL TO DETERMINE NOMINAL INPUT VOLTAGE (120VAC OR 240VAC).
2. 120VAC VERSION: P1 CONNECTS TO P3 AND P2 CONNECTS TO P4.
3. 240VAC VERSION: P2 CONNECTS TO P3. P1 AND P4 ARE NOT USED.
4. 120VAC VERSION: REGEN SHUNTS WHEN B+ REACHES 225VDC.
5. 240VAC VERSION: REGEN SHUNTS WHEN B+ REACHES 425VDC.
6. SSR1 AND SSR2 ARE ZERO-CROSSING SOLID STATE RELAYS.
ISOMETRIC VIEW
SCALE: .75X
J1-8 B- / AXIS 4
J1-7 B+ / AXIS 4
J1-6 B- / AXIS 3
J1-5 B+ / AXIS 3
J1-4 B- / AXIS 2
J1-3 B+ / AXIS 2
J1-2 B- / AXIS 1
J1-1 B+ / AXIS 1
REGEN SHUNT LED
LABEL
CAUTION HIGH VOLTAGE !
GLENTEK GP8600-70 POWER SUPPLY
TB1 - 1
TB1 - 2
TB1 - 3
TB1 - 4
TB1 - 5
TB1 - 6
10.21 [259.3]
6.33 [160.8]
6.09 [154.7]
2.06 [52.3]
3.06 [77.7]
2X, .22 [5.6]
.45 [11.4]
GP8600-70 POWER SUPPLY
INSTALLATION DRAWING
8600-7030-000

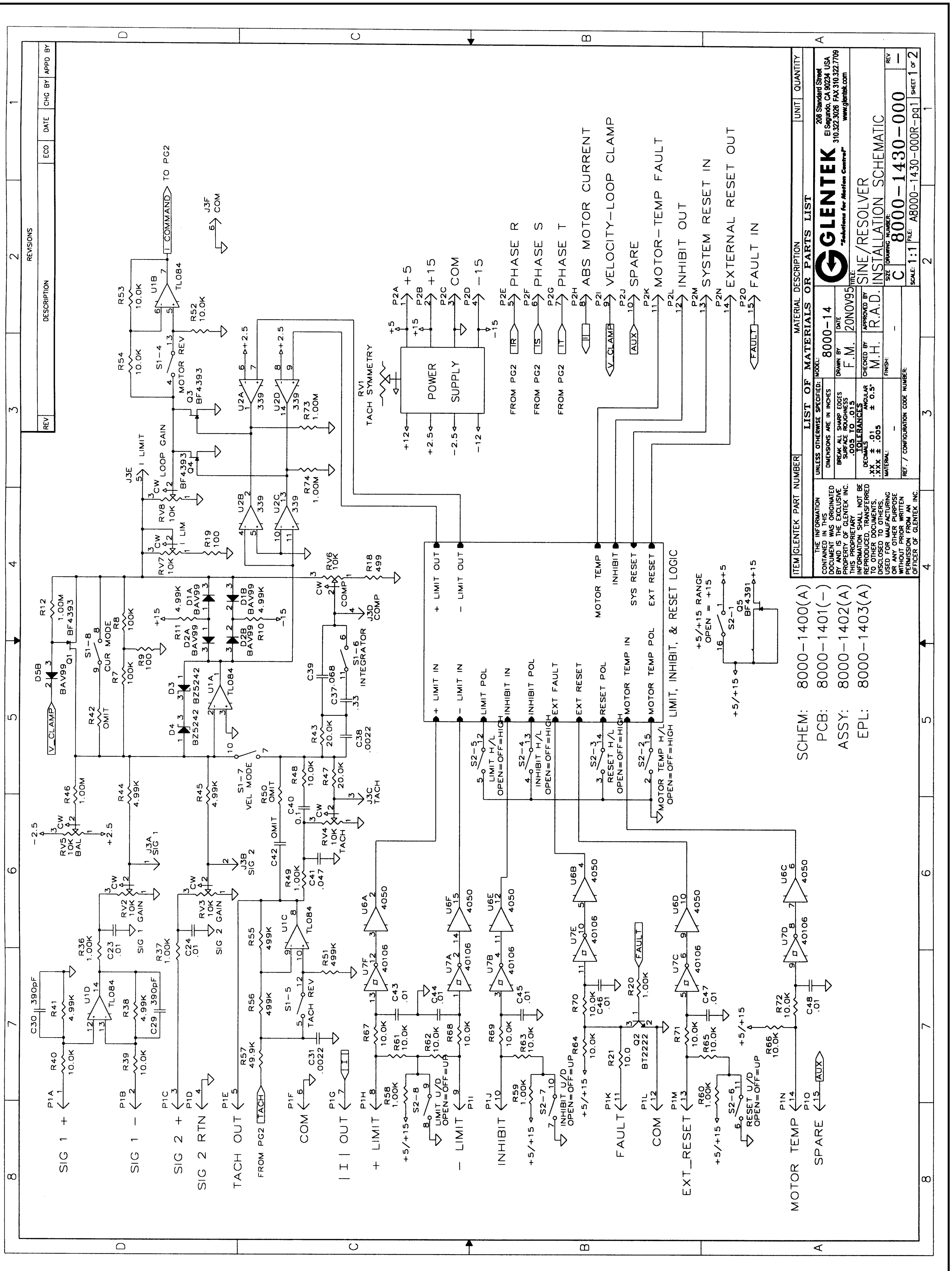
Appendix C

Personality Module



GLENTEK
208 Standard Street
El Segundo, CA 90234 USA
TRAP PRE-AMP
INSTALLATION SCHEMATIC
8000-1130-000
A8000-1130-000RA.DWG
LIST OF MATERIALS OR PARTS LIST
PSEUDO-TACH CIRCUIT
COMMUTATION CONTROL LOGIC
COMMUTATION CIRCUITS
REVISIONS
FIXED INCORRECT PART DESIGNATORS


BOTTOM VIEW
TOP VIEW
POTS
TEST POINTS
GLENTEK
TRAP PRE-AMP
INSTALLATION ASSEMBLY
8000-1131-000
A8000-1131-000RA.DWG



GLENTEK
208 Standard Street
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310.322.3026 FAX 310.322.7709
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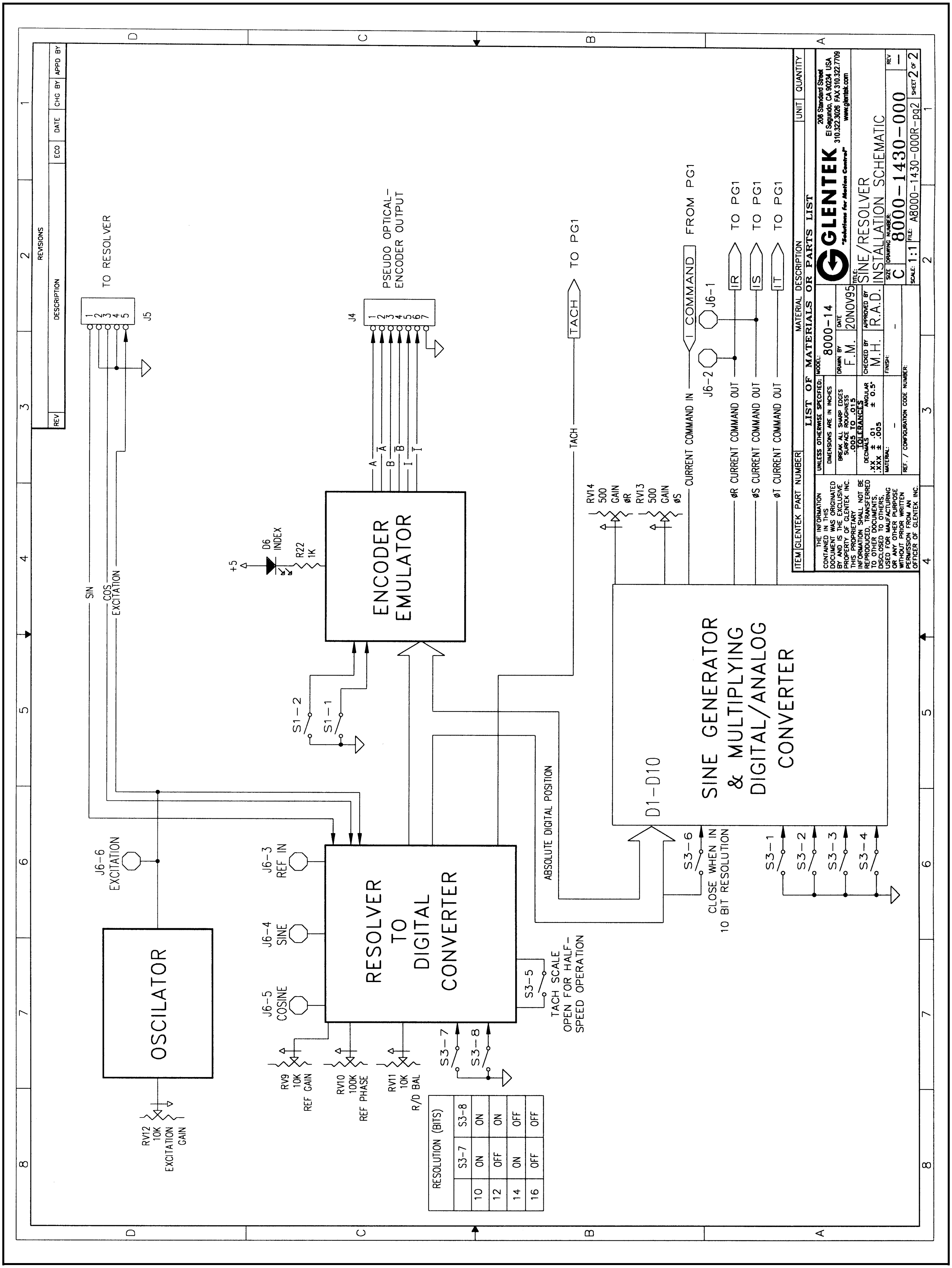
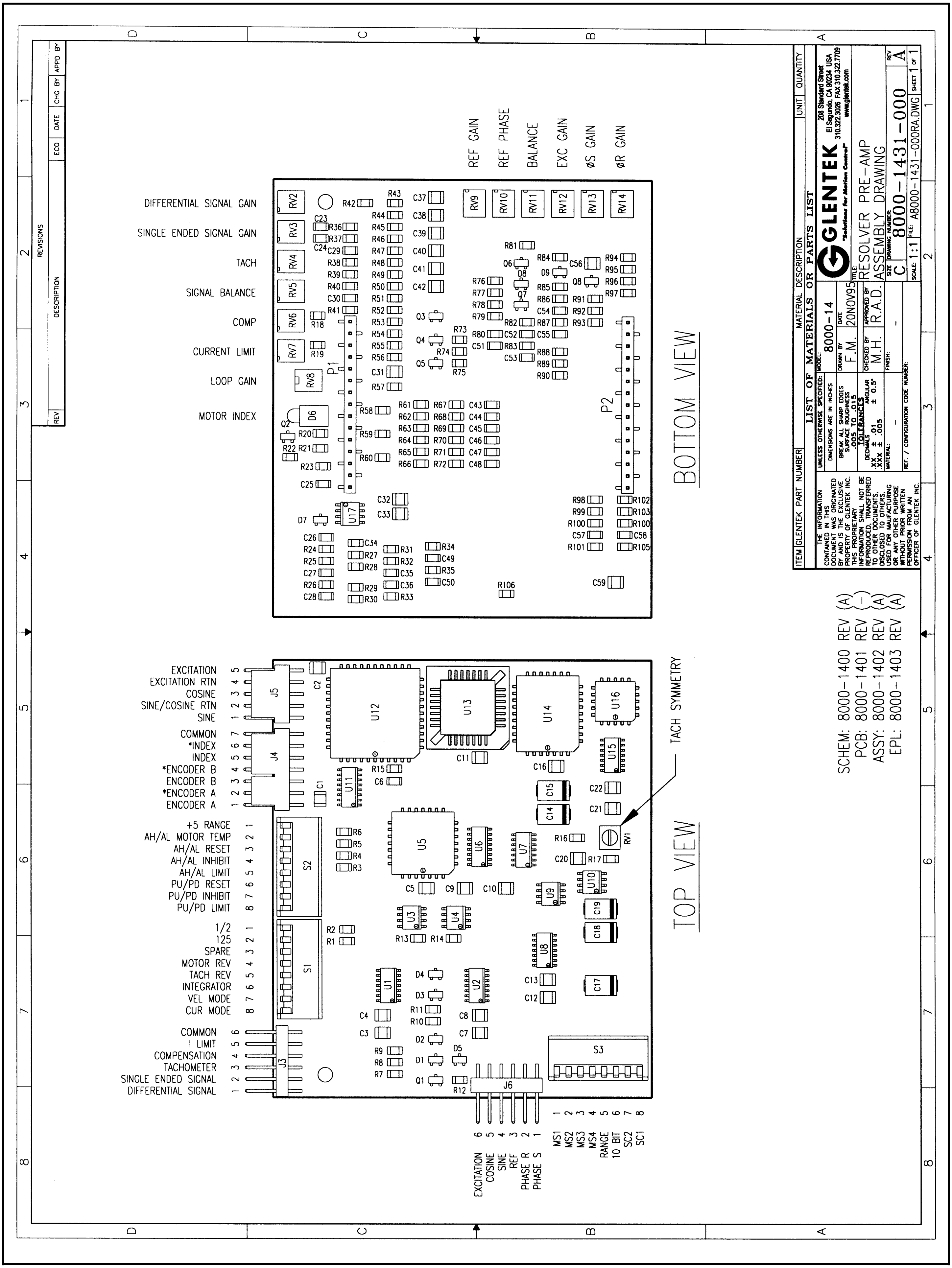
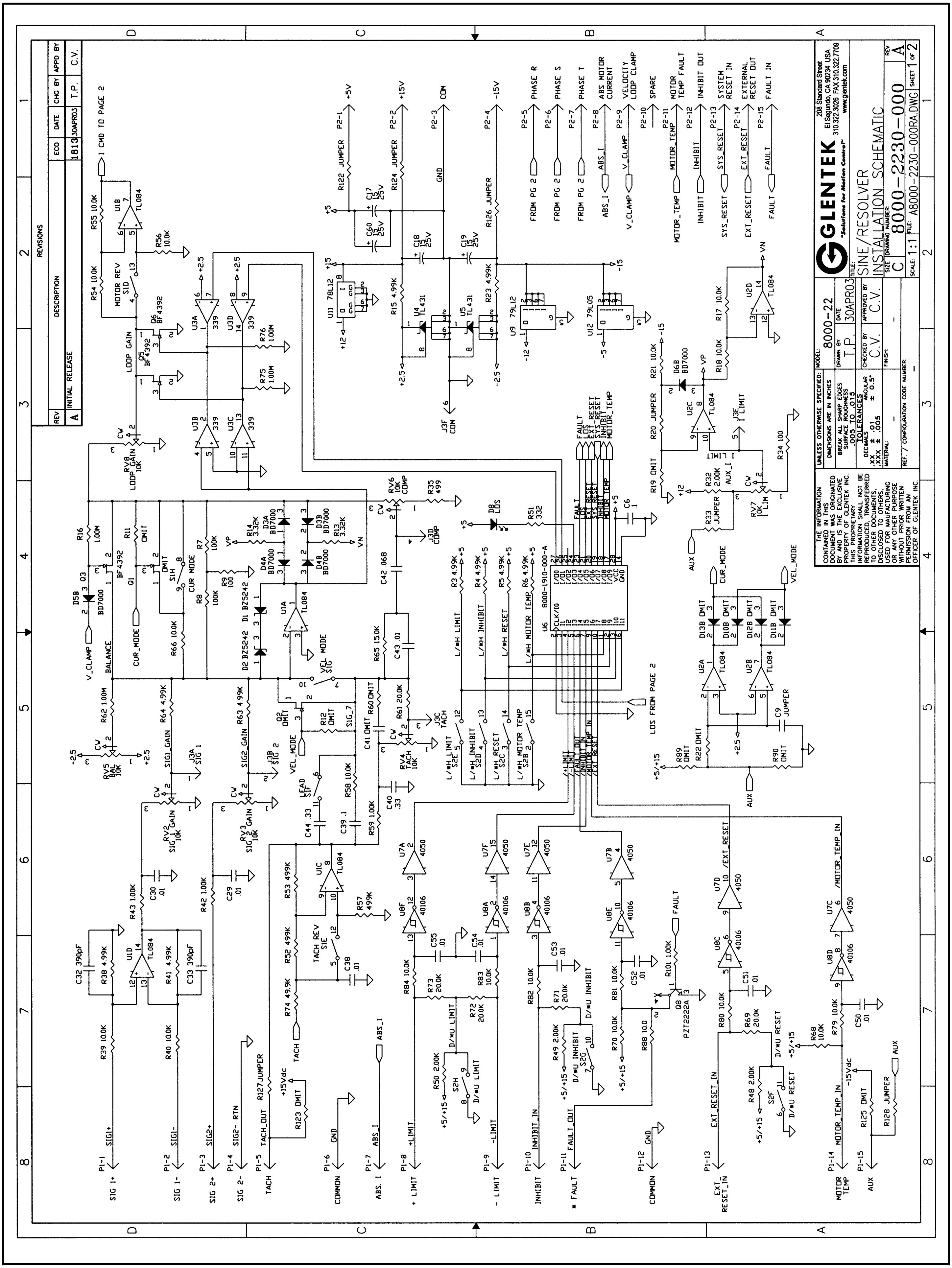
SINE/RESOLVER
INSTALLATION SCHEMATIC
8000-1430-000
A8000-1430-000R-pg1
SCHEM: 8000-1400(A)
PCB: 8000-1401(-)
ASSY: 8000-1402(A)
EPL: 8000-1403(A)
LIMIT, INHIBIT, & RESET LOGIC
POWER SUPPLY
PHASE R
PHASE S
PHASE T
ABS MOTOR CURRENT
VELOCITY-LOOP CLAMP
SPARE
MOTOR-TEMP FAULT
INHIBIT OUT
SYSTEM RESET IN
EXTERNAL RESET OUT
FAULT IN
SIG 1 +
SIG 1 -
SIG 2 +
SIG 2 RTN
TACH OUT
COM
| I | OUT
+ LIMIT
- LIMIT
INHIBIT
FAULT
EXT_RESET
MOTOR TEMP


OSCILATOR
RESOLVER TO DIGITAL CONVERTER
ENCODER EMULATOR
SINE GENERATOR & MULTIPLYING DIGITAL/ANALOG CONVERTER
TO RESOLVER
J5
PSEUDO OPTICAL-ENCODER OUTPUT
J4
TACH
TO PG1
I COMMAND
FROM PG1
IR
IS
IT
TO PG1
J6-1
J6-2
J6-3 REF IN
J6-4 SINE
J6-5 COSINE
J6-6 EXCITATION
SIN
COS
EXCITATION
ABSOLUTE DIGITAL POSITION
D1-D10
D6 INDEX
R22 1K
+5
S1-1
S1-2
S3-1
S3-2
S3-3
S3-4
S3-5
S3-6
S3-7
S3-8
CLOSE WHEN IN 10 BIT RESOLUTION
TACH SCALE OPEN FOR HALF-SPEED OPERATION
RV9 10K REF GAIN
RV10 100K REF PHASE
RV11 10K R/D BAL
RV12 10K EXCITATION GAIN
RV13 500 GAIN ØS
RV14 500 GAIN ØR
CURRENT COMMAND IN
ØR CURRENT COMMAND OUT
ØS CURRENT COMMAND OUT
ØT CURRENT COMMAND OUT
RESOLUTION (BITS) | S3-7 | S3-8
10 | ON | ON
12 | OFF | ON
14 | ON | OFF
16 | OFF | OFF
GLENTEK
SINE/RESOLVER INSTALLATION SCHEMATIC
8000-1430-000
8000-14
20NOV95
F.M.
M.H.
R.A.D.
SCALE: 1:1
SHEET 2 OF 2
A8000-1430-000R-pg2


BOTTOM VIEW
TOP VIEW
REF GAIN
REF PHASE
BALANCE
EXC GAIN
ØS GAIN
ØR GAIN
DIFFERENTIAL SIGNAL GAIN
SINGLE ENDED SIGNAL GAIN
TACH
SIGNAL BALANCE
COMP
CURRENT LIMIT
LOOP GAIN
MOTOR INDEX
TACH SYMMETRY
EXCITATION
EXCITATION RTN
COSINE
SINE/COSINE RTN
SINE
COMMON
*INDEX
INDEX
*ENCODER B
ENCODER B
*ENCODER A
ENCODER A
+5 RANGE
AH/AL MOTOR TEMP
AH/AL RESET
AH/AL INHIBIT
AH/AL LIMIT
PU/PD RESET
PU/PD INHIBIT
PU/PD LIMIT
1/2
125
SPARE
MOTOR REV
TACH REV
INTEGRATOR
VEL MODE
CUR MODE
COMMON
I LIMIT
COMPENSATION
TACHOMETER
SINGLE ENDED SIGNAL
DIFFERENTIAL SIGNAL
EXCITATION
COSINE
SINE
REF
PHASE R
PHASE S
MS1
MS2
MS3
MS4
RANGE
10 BIT
SC2
SC1
SCHEM: 8000-1400 REV (A)
PCB: 8000-1401 REV (-)
ASSY: 8000-1402 REV (A)
EPL: 8000-1403 REV (A)
LIST OF MATERIALS OR PARTS LIST
GLENTEK
208 Standard Street
El Segundo, CA 90234 USA
310.322.3026 FAX 310.322.7709
www.glentek.com
RESOLVER PRE-AMP
ASSEMBLY DRAWING
C 8000-1431-000
A
SCALE 1:1
A8000-1431-000RA.DWG
SHEET 1 OF 1
8000-14
F.M.
20NOV95
M.H.
R.A.D.



GLENTEK
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208 Standard Street
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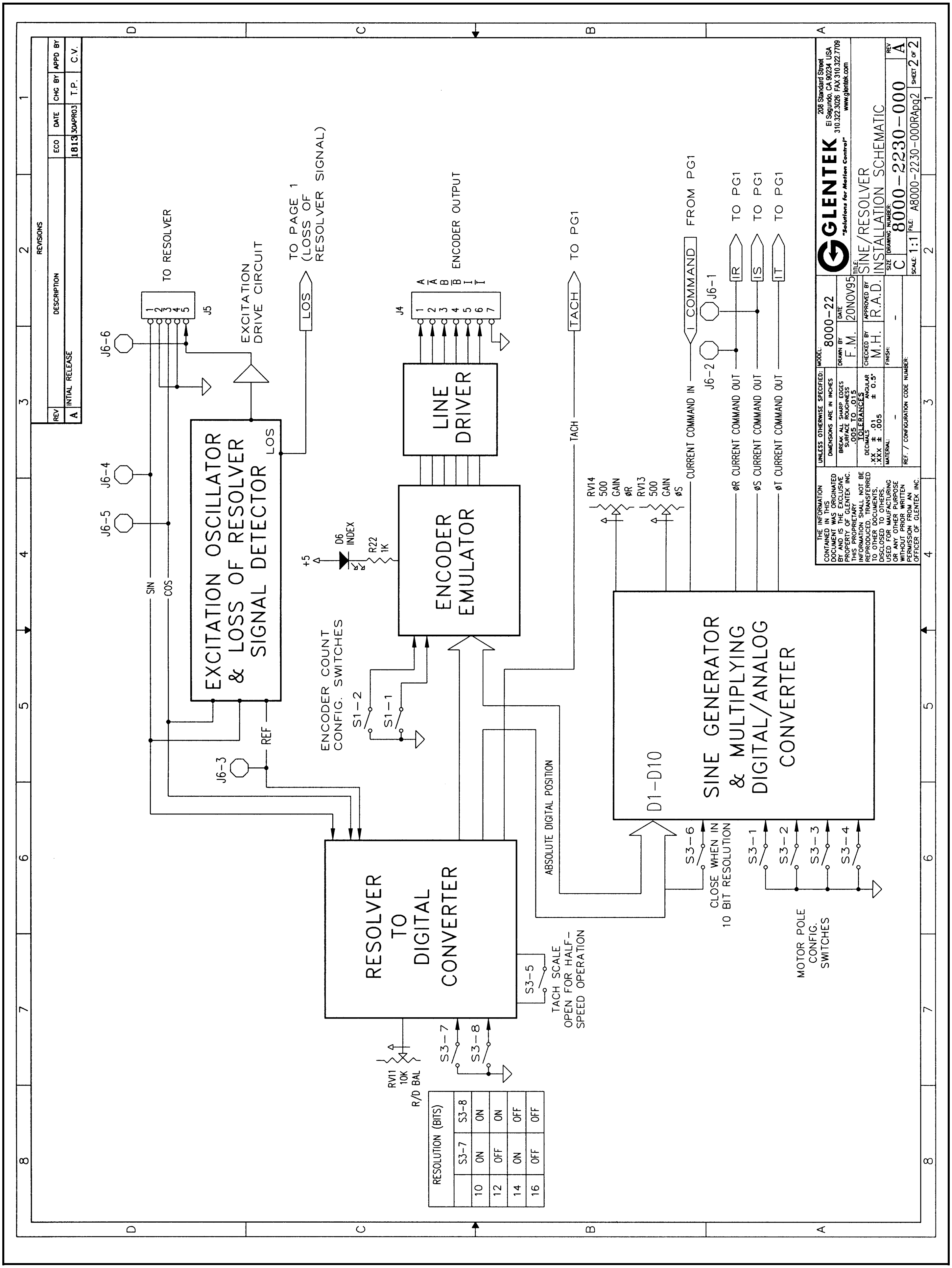
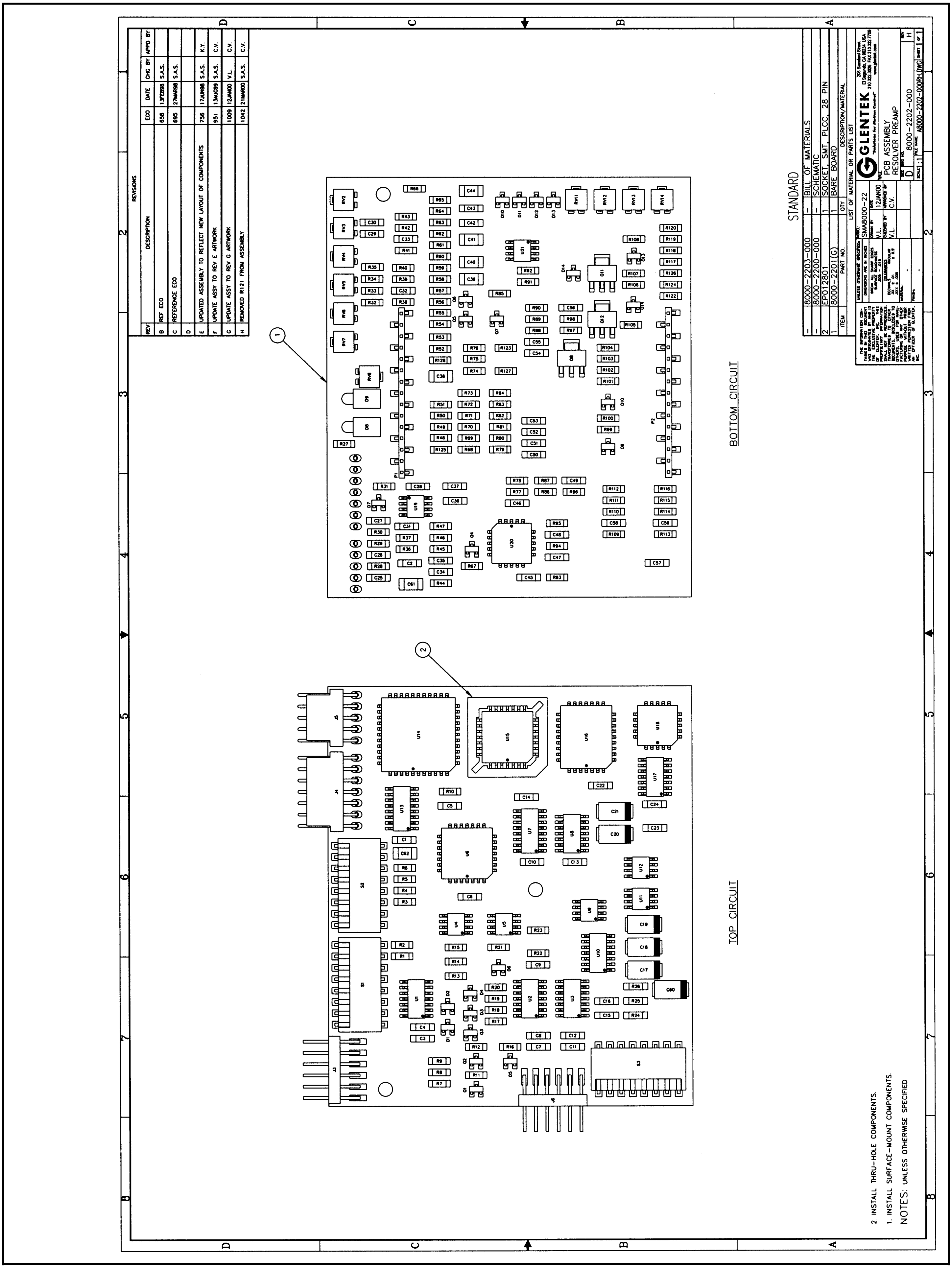
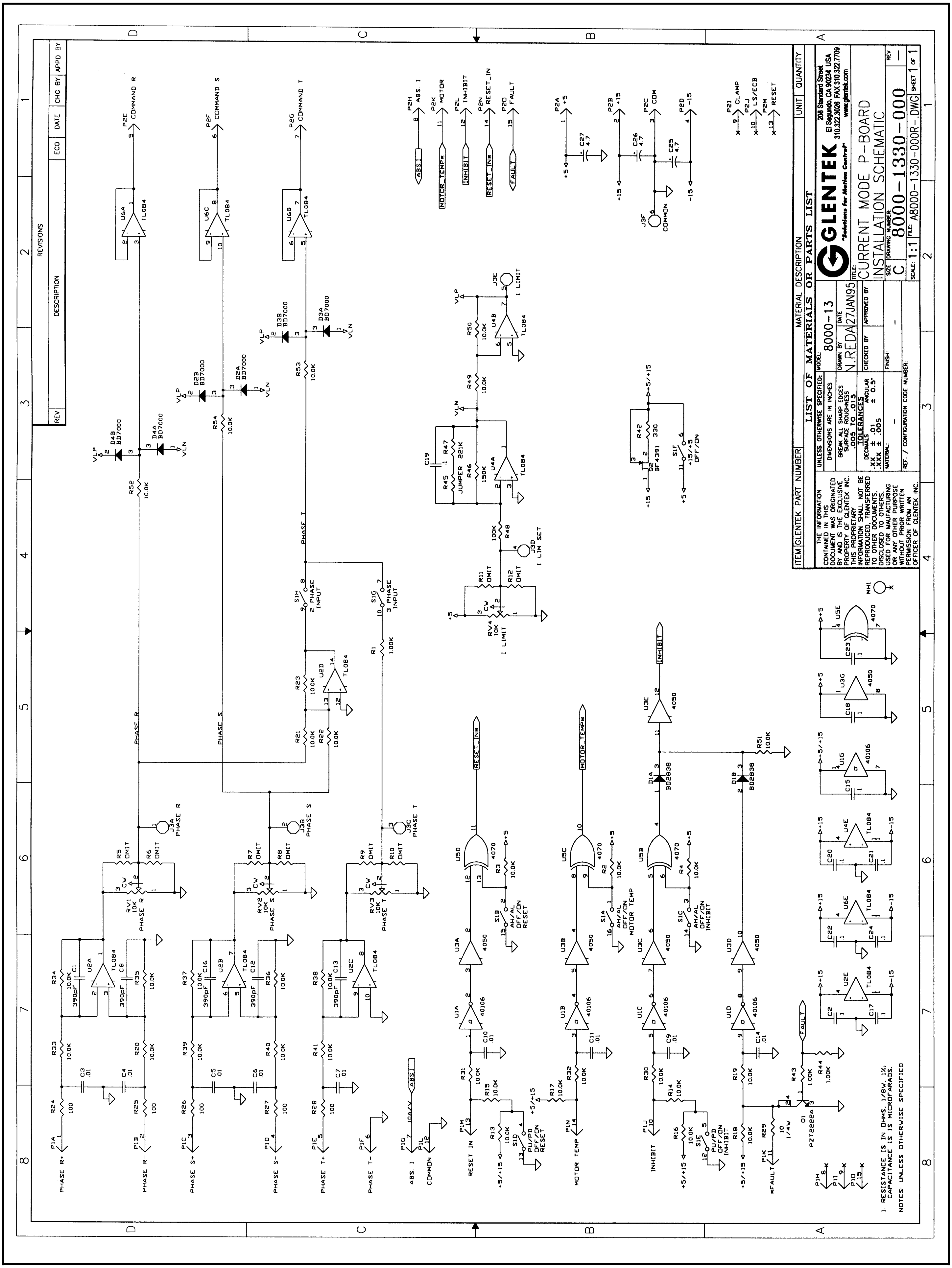
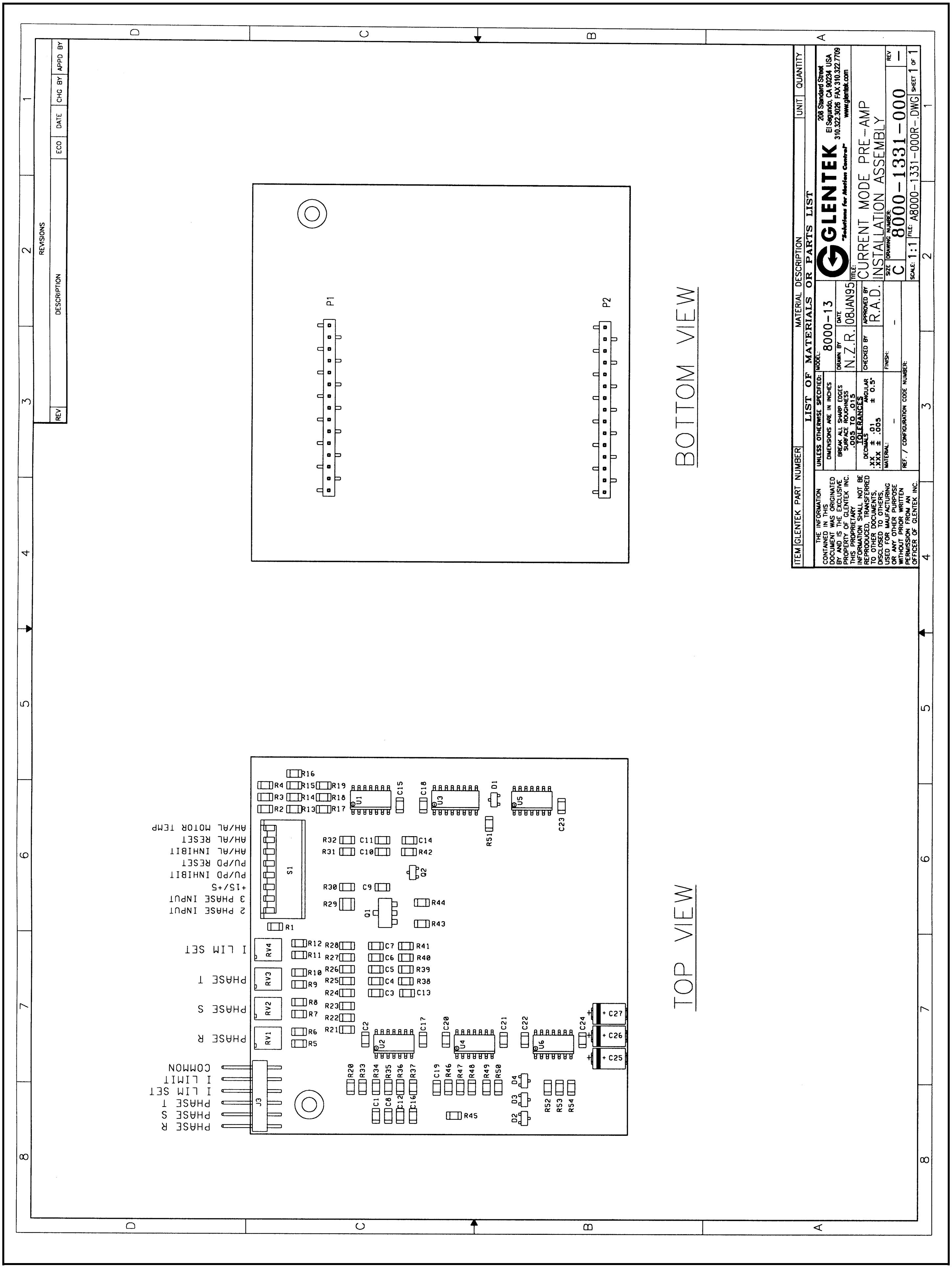
310.322.3026 FAX 310.322.7709
www.glentek.com
SINE/RESOLVER INSTALLATION SCHEMATIC
8000-2230-000
A8000-2230-000RA.DWG
MODEL: 8000-22
DRAWN BY T.P.
DATE 30APR03
CHECKED BY C.V.
APPROVED BY C.V.
REVISIONS
REV A INITIAL RELEASE 1813 30APR03 T.P. C.V.
SCALE 1:1
SHEET 1 OF 2


EXCITATION OSCILLATOR & LOSS OF RESOLVER SIGNAL DETECTOR
LOS
EXCITATION DRIVE CIRCUIT
TO RESOLVER
J5
TO PAGE 1 (LOSS OF RESOLVER SIGNAL)
LOS
LINE DRIVER
ENCODER OUTPUT
J4
ENCODER EMULATOR
D6 INDEX
R22 1K
+5
ENCODER COUNT CONFIG. SWITCHES
S1-1
S1-2
TACH
TO PG1
SIN
COS
REF
J6-3
J6-4
J6-5
J6-6
RESOLVER TO DIGITAL CONVERTER
ABSOLUTE DIGITAL POSITION
S3-5
TACH SCALE OPEN FOR HALF-SPEED OPERATION
S3-7
S3-8
RV11 10K R/D BAL
RESOLUTION (BITS)
S3-7
S3-8
10 ON ON
12 OFF ON
14 ON OFF
16 OFF OFF
SINE GENERATOR & MULTIPLYING DIGITAL/ANALOG CONVERTER
D1-D10
S3-6
CLOSE WHEN IN 10 BIT RESOLUTION
S3-1
S3-2
S3-3
S3-4
MOTOR POLE CONFIG. SWITCHES
RV14 500 GAIN ØR
RV13 500 GAIN ØS
CURRENT COMMAND IN
I COMMAND
FROM PG1
J6-1
J6-2
ØR CURRENT COMMAND OUT
ØS CURRENT COMMAND OUT
ØT CURRENT COMMAND OUT
IR
IS
IT
TO PG1
REVISIONS
REV
DESCRIPTION
ECO
DATE
CHG BY
APPD BY
A
INITIAL RELEASE
1813
30APR03
T.P.
C.V.
GLENTEK
"Solutions for Motion Control"
208 Standard Street
El Segundo, CA 90234 USA
310.322.3026 FAX 310.322.7709
www.glentek.com
MODEL: 8000-22
DRAWN BY F.M.
DATE 20NOV95
CHECKED BY M.H.
APPROVED BY R.A.D.
TITLE: SINE/RESOLVER INSTALLATION SCHEMATIC
SIZE C
DRAWING NUMBER: 8000-2230-000
REV A
SCALE: 1:1
FILE: A8000-2230-000RApg2
SHEET 2 OF 2


REVISIONS
BOTTOM CIRCUIT
TOP CIRCUIT
STANDARD
BILL OF MATERIALS
SCHEMATIC
SOCKET, SMT, PLCC, 28 PIN
BARE BOARD
LIST OF MATERIAL OR PARTS LIST
GLENTEK
PCB ASSEMBLY
RESOLVER PREAMP
8000-2202-000
NOTES: UNLESS OTHERWISE SPECIFIED
1. INSTALL SURFACE-MOUNT COMPONENTS.
2. INSTALL THRU-HOLE COMPONENTS.


GLENTEK
"Solutions for Motion Control"
208 Standard Street
El Segundo, CA 90234 USA
CURRENT MODE P-BOARD
INSTALLATION SCHEMATIC
8000-1330-000
A8000-1330-000R-DWG
LIST OF MATERIALS OR PARTS LIST
N.REDA
27JAN95
8000-13


BOTTOM VIEW
TOP VIEW
P1
P2
J3
S1
PHASE R
PHASE S
PHASE T
I LIM SET
I LIMIT
COMMON
2 PHASE INPUT
3 PHASE INPUT
+15/+5
PU/PD INHIBIT
PU/PD RESET
AH/AL INHIBIT
AH/AL RESET
AH/AL MOTOR TEMP
LIST OF MATERIALS OR PARTS LIST
GLENTEK
208 Standard Street
El Segundo, CA 90234 USA
8000-13
N.Z.R.
08JAN95
R.A.D.
CURRENT MODE PRE-AMP
INSTALLATION ASSEMBLY
8000-1331-000
A8000-1331-000R-DWG
SCALE: 1:1
SHEET 1 OF 1

Appendix C

European Union EMC Directives

Electromagnetic Compatibility Guidelines For Machine Design

This document provides background information about Electromagnetic Interference (EMI) and machine design guidelines for Electromagnetic Compatibility (EMC)

Introduction

Perhaps no other subject related to the installation of industrial electronic equipment is so misunderstood as electrical noise. The subject is complex and the theory easily fills a book. This section provides guidelines that can minimize noise problems.

The majority of installations do not exhibit noise problems. However, these filtering and shielding guidelines are provided as counter measures. The grounding guidelines provided below are simply good grounding practices. They should be followed in all installations.

Electrical noise has two characteristics: the generation or emission of electromagnetic interference (EMI), and response or immunity to EMI. The degree to which a device does not emit EMI, and is immune to EMI is called the device's Electromagnetic Compatibility (EMC).

Equipment, which is to be brought into the European Union legally, requires a specific level of EMC. Since this applies when the equipment is brought into use, it is of considerable importance that a drive system, as a component of a machine, be correctly installed.

"EMI Source-Victim Model" shows the commonly used EMI model. The model consists of an EMI source, a coupling mechanism and an EMI victim. A device such as servo drives and computers, which contain switching power supplies and microprocessors, are EMI sources. The mechanisms for the coupling of energy between the source and victim are conduction and radiation. Victim equipment can be any electromagnetic device that is adversely affected by the EMI coupled to it.

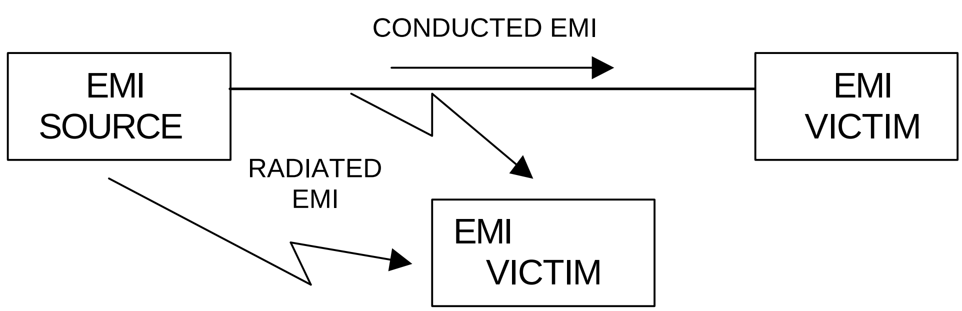


Figure 1- EMI Source-Victim Model

Immunity to EMI is primarily determined by equipment design, but how you wire and ground the device is also critical to achieving EMI immunity. Therefore, it is important to select equipment that has been designed and tested for industrial environments. The EMI standards for industrial equipment include the EN61000-4-X series (IEC 1000-4-X and IEC8O1-X), EN55011 (CISPR11), ANSI C62 and C63 and MIL-STD-461. Also, in industrial environments, you should use encoders with differential driver outputs rather than single ended outputs, and digital inputs/outputs with electrical isolation, such as those provided with optocouplers.

The EMI model provides only three options for eliminating the EMC problem:

- Reduce the EMI at the source,
- Increase the victim's immunity to EMI (harden the victim),
- Reduce or eliminate the coupling mechanism,

In the case of servo drives, reducing the EMI source requires slowing power semiconductor switching speeds. However, this adversely affects drive performance with respect to heat dissipation and speed/torque regulation. Hardening the victim equipment may not be possible, or practical. The final and often the most realistic solution is to reduce the coupling mechanism between the source and victim. Filtering, shielding and grounding can achieve this.

Filtering

As mentioned above, high frequency energy can be coupled between circuits via radiation or conduction. The AC power wiring is one of the most important paths for both types of coupling mechanisms. The AC line can conduct noise into the drive from other devices, or it can conduct noise directly from the drive into other devices. It can also act as an antenna and transmit or receive radiated noise between the drive and other devices.

One method to improve the EMC characteristics of a drive is to use isolation AC power transformer to feed the amplifier its input power. This minimizes inrush currents on power-up and provides electrical isolation. In addition, it provides common mode filtering, although the effect is limited in frequency by the interwinding capacitance. Use of a Faraday shield between the windings can increase the common mode rejection bandwidth, (shield terminated to ground) or provide differential mode shielding (shield terminated to the winding). In some cases an AC line filter will not be required unless other sensitive circuits are powered off the same AC branch circuit.

NOTE:“ Common mode” noise is present on all conductors that are referenced to ground. “Differential mode” noise is present on one conductor referenced to another conductor.

The use of properly matched AC line filters to reduce the conducted EMI emitting from the drive is essential in most cases. This allows nearby equipment to operate undisturbed. The basic operating principle is to minimize the high frequency power transfer through the filter. An effective filter achieves this by using capacitors and inductors to mismatch the source impedance (AC line) and the load impedance (drive) at high frequencies.

For drives brought into use in Europe, use of the correct filter is essential to meet emission requirements. Detailed information on filters is included in the manual and transformers should be used where specified in the manual.

AC Line Filter Selection

Selection of the proper filter is only the first step in reducing conducted emissions. Correct filter installation is crucial to achieving both EMIL attenuation and to ensure safety. All of the following guidelines should be met for effective filter use.

1) The filter should be mounted to a grounded conductive surface.

2) The filter must be mounted close to the drive-input terminals, particularly with higher frequency emissions *(5-30* MHz). If the distance exceeds 600mm (2 feet), a strap should be used to connect the drive and filter, rather than a wire.

3) The wires connecting the AC source to the filter should be shielded from, or at least separated from the wires (or strap) that connects the drive to the filter. If the connections are not segregated from each other, then the EMI on the drive side of the filter can couple over to the source side of the filter, thereby reducing, or eliminating the filter effectiveness. The coupling mechanism can be radiation, or stray capacitance between the wires. The best method of achieving this is to mount the filter where the AC power enters the enclosure. “AC Line Filter Installation” shows a good installation and a poor installation.

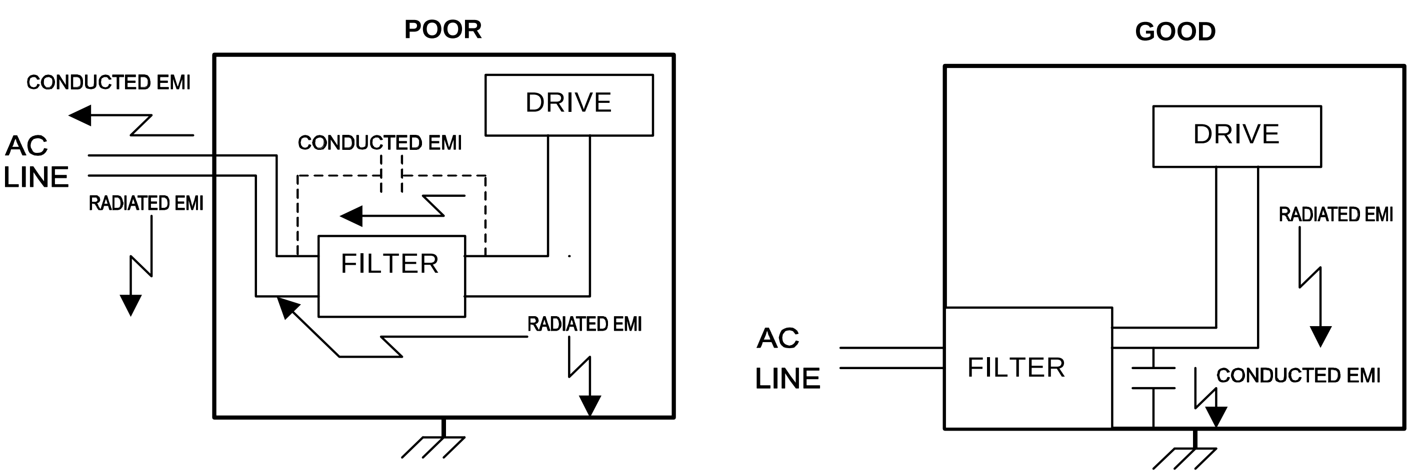


Figure 2- AC Line Filter Installation

When multiple power cables enter an enclosure, an unfiltered line can contaminate a filtered line external to the enclosure. Therefore, all lines must be filtered to be effective. The situation is similar to a leaky boat. All the holes must be plugged to prevent sinking.

WARNING

Large leakage currents exist in AC line filters. They must be grounded properly before applying power. Filter capacitors retain high voltages after power removal. Before handling the equipment, voltages should be measured to determine safe levels prior to handling the equipment. Failure to observe this precaution could result in severe bodily injury.

If the filter is mounted excessively far from the drive, it may be necessary to mount it to a grounded conductive surface, such as the enclosure, to establish a high frequency (HF) connection to that surface. To achieve the HF ground, direct contact between the mounting surface and the filter must be achieved. This may require removal of paint or other insulating material from the cabinet or panel.

The only reasonable filtering at the drive output terminals is the use of inductance. Capacitors would slow the output switching and deteriorate the drive performance. A common mode choke can be used to reduce the HF voltage at the drive output. This will reduce emission coupling through the drive back to the AC line. However, the motor cable still carries a large HF voltage and current. Therefore, it is very important to segregate the motor cable from the AC power cable. More information on cable shielding and segregation is contained in the section on shielding.

Grounding

High frequency (HF) grounding is different from safety grounding. A long wire is sufficient for a safety ground, but is completely ineffective as a HF ground due to the wire inductance. As a rule of thumb, a wire has an inductance of 8 nH/in regardless of diameter. At low frequencies it acts as constant impedance, at intermediate frequencies as an inductor, and at high frequencies as an antenna. The use of ground straps is a better alternative to wires. However the length to width ratio must be *5:1,* or better yet 3:1, to remain a good high frequency connection.

The ground system's primary purpose is to function as a return current path. It is commonly thought of as an equipotential circuit reference point, but different locations in a ground system may be at different potentials. This is due to the return current flowing through the ground systems finite impedance. In a sense, ground systems are the sewer systems of electronics and as such are sometimes neglected.

The primary objective of a high frequency ground system is to provide a well-defined path for HF currents and to minimize the loop area of the HF current paths. It is also important to separate HF grounds from sensitive circuit grounds. "Single Point Ground Types" shows single point grounds for both series (daisy chain) and parallel (separate) connections. A single point, parallel connected ground system is recommended.

Figure 3-Single Point Ground Types

A ground bus bar or plane should be used as the "single point" where circuits are grounded. This will minimize common (ground) impedance noise coupling. The ground bus bar (GBB) should be connected to the AC ground, and if necessary, to the enclosure. All circuits or subsystems should be connected to the GBB by separate connections. These connections should be as short as possible and straps should be used when possible. The motor ground conductor must return to the ground terminal on the drive, not the GBB.

Shielding and Segregation

The EMI radiating from the drive enclosure drops off very quickly over distance. Mounting the drive in an enclosure, such as an industrial cabinet, further reduces the radiated emissions. The cabinet should have a high frequency ground and the size of the openings should be minimized. In addition, the drive is considered an “open” device that does not provide the proper IP rating for the environment in which it is installed. For this reason the enclosure must provide the necessary degree of protection. An IP rating or Nema rating (which is similar to IP) specifies the degree of protection that an enclosure provides.

The primary propagation route for EMI emissions from a drive is through cabling. The cables conduct the EMI to other devices, and can also radiate the EMI. For this reason, cable segregation and shielding are important factors in reducing emissions. Cable shielding can also increase the level of immunity for a drive. For example:

Shield termination at both ends is extremely important. The common misconception that shields should be terminated at only one end originates from audio applications with frequencies ≤ 20 kHz. RF applications must be terminated with the shield at both ends, and possibly at

- Intermediate points for exceptionally long cables.
- When shielded cables are not terminated at the cable connection and pass through the wall of a cabinet, the shield must be bonded to the cabinet wall to prevent noise acquired inside the cabinet from radiating outside the cabinet, and vice versa.
- When shielded cables are terminated to connectors, the shield must be able to provide complete 360^0 coverage and terminate through the connector backshell. The shield must *not* be grounded inside the connector through a drain wire. Grounding the shield inside the connector couples the noise on the shield to the signal conductors sharing the connector and virtually guarantees failure to meet European EMC requirements.
- The shield must be continuous. Each intermediate connector must continue the shield connection through the backshell.
- All cables, both power and signal should use twisted wire pairing.

The shield termination described above provides a coaxial type of configuration, which provides magnetic shielding, and the shield provides a return path for HF currents that are capacitively coupled from the motor windings to the frame. If power frequency circulating currents are an issue, a 250 VAC capacitor should be used at one of the connections to block 50/60 Hz current while passing HF currents. Use of a properly shielded motor cable is essential to meet European EMC requirements.

The following suggestions are recommended for all installations.

1. Motor cables must have a continuous shield and be terminated at both ends. The shield must connect to the ground bus bar or drive chassis at the drive end, and the motor frame at the motor end. Use of a properly shielded motor cable is essential to meet European EMC requirements.
2. Signal cables (encoder, serial, and analog) should be routed away from the motor cable and power wiring. Separate steel conduit can be used to provide shielding between the signal and power wiring. Do <u>not</u> route signal and power wiring through common junctions or raceways.
3. Signal cables from other circuits should not pass within 300 mm (1 ft.) of the drive.
4. The length or parallel runs between other circuit cables and the motor or power cable should be minimized. A rule of thumb is 300 mm (1 ft.) of separation for each 10 m (30 ft.) of parallel run. The 300 mm (1 ft.) separation can be reduced if the parallel run is less than 1 m (3 ft.).
5. Cable intersections should always occur at right angles to minimize magnetic coupling.
6. The encoder mounted on the brushless servomotor should be connected to the amplifier with a cable using multiple twisted wire pairs and an overall cable shield. Encoder cables are offered in various lengths that have correct terminations.

Persistent EMI problems may require additional countermeasures. The following suggestions for system modification may be attempted.

1. A ferrite toroid or “doughnut” around a signal cable may attenuate common mode noise, particularly RS-232 communication problems. However, a ferrite toroid will not help differential mode noise. Differential mode noise requires twisted wire pairs.
2. Suppress each switched inductive device near the servo amplifier. Switch inductive devices include solenoids, relay coils, starter coils and AC motors (such as motor driven mechanical timers).
3. DC coils should be suppressed with a “free-wheeling” diode connected across the coil.
4. AC coils should be suppressed with RC filters (a 200 Ohm 1/2 Watt resistor in series with a *0.5* uF, 600 Volt capacitor is common).

Following these guidelines can minimize noise problems. However, equipment EMC performance must meet regulatory requirements in various parts of the world, specifically the European Union. Ultimately, it is the responsibility of the machine builder to ensure that the machine meets the appropriate requirements as installed.

RECOMMENDATIONS FOR GLENTEK AMPLIFIERS

All amplifiers installed in a NEMA 12 enclosures or equivalent with wiring in metal conduit or enclosed metal wire trough (see Shielding and segregation).

Use Glentek shielded feedback and motor cables.

An AC line filter properly installed in a NEMA 12 enclosure or equivalent (see Filtering).

AC line filters for single-phase applications

1A-15A	input current, 120-250VAC use: Corcom 15ET1 or equivalent.
15A-25A	input current, 120-250VAC use: Corcom 25FC10 or equivalent.
25A-36A	input current, 120-250VAC use: Corcom 36FC10 or equivalent.

AC line filters for 3-phase applications

1A-25A	input current, 120-250VAC use: Corcom 25FCD10 or equivalent.
25A-36A	input current, 120-250VAC use: Corcom 36FCD10 or equivalent.
36A-50A	input current, 120-250VAC use: Corcom 50FCD10 or equivalent.
50A-80A	input current, 120-250VAC use: Corcom 80FCD10 or equivalent.

EUROPEAN UNION
DECLARATION OF INCORPORATION
MOTION CONTROL SYSTEMS

Classified as Components of Machinery
Model Series SMA8X15

Council Directive 89/392/EEC Machinery Directive

The Products cited below and their accessories comply with the following Safety of Machinery Standards when installed and operated in accordance with the Instructions provided in the Operation & Installation Manuals. The products are declared to comply by virtue of Design Third Party Evaluations and Testing. EMC Testing and Product Safety Evaluations and Risk Assessments were conducted by NATIONAL TECHNICAL SYSTEMS, an independent Nationally Recognized Test Laboratory, located in Fullerton, CA 92631, USA.

As components of Machinery, please be advised that:

1. These are not individually classified as machinery within the scope of directive 89/392/EEC.
2. These are intended to be incorporated into machinery or to be assembled with other machinery to constitute machinery covered by directive 89/392/EEC, as amended.
3. As such, do therefore not in every respect comply with the provisions of directive 89/392/EEC.

SAFETY STANDARDS

EN60292 - 2	Safety of Machinery – Basic Principals	
EN60204	Electrical Equipment of Industrial Machines	
	Collateral Test Standards, Specified by EN60204	
EN50011:1991	Emissions Limits for Industrial, Scientific And Medical (ISM) RF Equipment	Class A Conducted and Radiated
EN61000-4-2	Electrostatic Discharge Immunity	Level 2
EN61000-4-3	Radiated Emission Immunity	Level 2
EN61000-4-4	Electric Fast Transients Burst	Level 3

Manufacturers Name:	GLENTEK INC.
Manufacturers Address:	208 Standard Street, El Segundo, CA 90245, USA
Description of Equipment:	Motion Control Systems including Amplifiers and Servo Motors
Model Number(s):	SMA8115, SMA8115HP, SMA8215, SMA8215HP, SMA8315, SMA8315HP The above amplifier modules packaged in the following configurations: -1, -1A-1, -2A-1, -2A-2, -4A-3, -4A-4, -6A-5, -6A-6, -3U-1 and all power supply configurations: 00, 01, 02, 03.

The undersigned hereby declares that the equipment specified above conforms to the noted Directives and Standards in accordance with "The Machinery Directives". Refer to Technical Construction File GTK 99408.

MANUFACTURER

HELEN M. VASAK
SECRETARY-TREASURER

4-19-99

Prepared By: National Technical Systems, Fullerton, CA
Confirmed By: Chuck Helton, Director of Product Safety

Omega Series Digital PWM Servo Amplifiers

- PWM (Pulse-Width-Modulated) Brushless servo amplifiers to 20KW
- PWM (Pulse-Width-Modulated) Brush servo amplifiers to 20KW

Analog Brush Type Servo Amplifiers

- Linear Brush type servo amplifiers to 2.6KW
- PWM (Pulse-Width-Modulated) Brush type servo amplifiers to 28KW

Analog Brushless Servo Amplifiers

- Linear Brushless servo amplifiers to 3.5KW
- PWM (Pulse-Width-Modulated) Brushless servo amplifiers to 51KW

Permanent Magnet DC Brush Type Servo Motors

- Continuous Torques to 335 in. lb.
- Peak Torques to 2100 in. lb.

Permanent Magnet DC Brushless Servo Motors

- Continuous Torques to 1100 in. lb.
- Peak Torques to 2200 in. lb.

GLENTEK
"Solutions for Motion Control"

MANUAL#: 8015-1040-000
REVISION: (H)
DATE: 10 May 2003

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