

**OPERATION
&
SERVICE MANUAL**

Model SMA7110

Brush Type Amplifier System



GLENTEK

"Solutions for Motion Control"

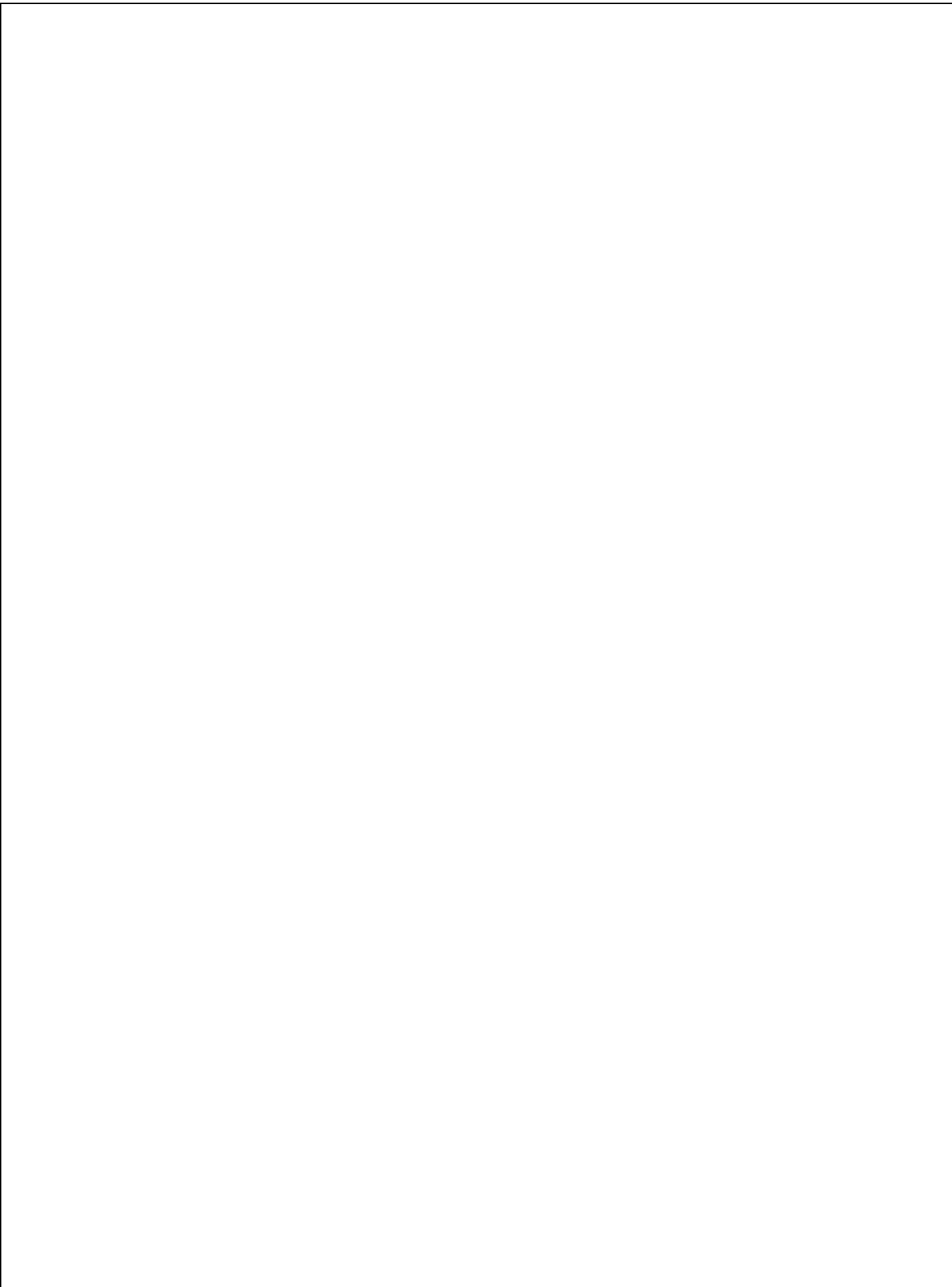


Table of Contents

Page

Introduction6

Chapter One: Description, Features and Specifications

1.1 Description7

1.2 Features7

 1.2.1 Single Amplifier Module(SMA7110-1)7

 1.2.2 Multi-Axis Power Supply(GP8600-50)8

1.3 Specifications8

 1.3.1 Single Amplifier Module (SMA7110-1)8

 1.3.1.1 Input and Output Power8

 1.3.1.2 Signal Inputs9

 1.3.1.3 Digital Inputs9

 1.3.1.4 System9

 1.3.1.5 Outputs9

 1.3.2 Multi-Axis Power Supply(GP8600-50)9

 1.3.2.1 Input and Output Power9

 1.3.3 Mechanical9

Chapter Two: Theory of Operation

2.1 Introduction10

2.2 Driving DC Servo Motors10

2.3 Servo Loops10

2.4 Brushed Motors vs Brushless Motors11

2.5 Operation of Output Switching Transistors12

2.6 “ H ” Type Output Bridge Configuration12

2.7 Pulse-Width-Modulation (PWM)13

2.8 Current-Loop Operation14

2.9 Velocity-Loop Operation14

2.10 Protection Circuits14

Chapter Three: Model Numbering

3.1 Introduction15

3.2 Single Amplifier Module15

3.3 Multi-axis Amplifier16

Chapter Four: Installation

4.1 Introduction17

4.2 Mounting17

Chapter Four: Installation (continued)	Page
4.3.1 RFI/EMI and Wiring Technique.....	17
4.3.2 Wire Size and Type	17
4.3.3 Connector Size and Type.....	18
4.3.3.1 The Power Connector of the Single Amplifier Module.....	18
4.3.3.2 The Signal Connector	18
4.3.4 Amplifier Module Connections	18
4.3.4.1 The Power Connections.....	18
4.3.4.2 The Signal Connections.....	18
4.3.5 Multi-Axis Amplifier Connections	19
Chapter Five: Configuration	
5.1 Introduction.....	20
5.2 Logic Input Configuration	20
Chapter Six: Start Up and Calibration	
6.1 Introduction.....	21
6.2 Initial Start Up	21
6.3 Calibration of the Velocity Mode Amplifier	21
6.4 Calibration of the Current Mode Amplifier.....	22
6.5 Calibration Setup Record.....	24
Chapter Seven: Maintenance, Repair, and Warranty	
7.1 Maintenance.....	25
7.2 Amplifier Faults	25
7.2.1 Table of Fault LED Conditions	25
7.2.2 High Speed Electronic Circuit Breaker (HS/ECB) Fault	26
7.2.3 Low Speed Electronic Circuit Breaker (LS/ECB) Fault.....	26
7.2.4 Over Temp Fault	26
7.2.5 Over Voltage Fault	26
7.2.6 Resetting A Fault.....	26
7.3 Amplifier Failure.....	26
7.4 Factory Repair	27
7.5 Warranty	27
Appendix A: Amplifier Drawings	
SMA7110 Power Board Assembly Drawing (7010-1032)	29
SMA7110 Power Board Installation Schematics (7010-1031).....	30
SMA7110-1 Installation Drawing for the Single Amplifier Module (7010-1030).....	31
SMA7110-2A-2 2-AXIS Amplifier Installation Drawing (7010-1033)	32
SMA7110-4A-4 4-AXIS Amplifier Installation Drawing (7010-1034)	33

Appendix B: Power Supply

GP8600-50 Power Supply Assembly Drawing (8600-5030)35

Appendix C: European Union EMC Directive

Electromagnetic Compatibility Guidelines For Machine Design37

CE Certification.....43

Introduction

Glentek's brush type and brushless DC servo 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 brush type servo amplifier, model SMA7110. There is also an informative theory-of-operation chapter.

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, 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, money, and to provide you with a superior product.

Chapter One: Description, Features, and Specifications

1.1 Description:

This brush type servo amplifier system has been designed to offer you, our customer, a large degree of flexibility and customization with a standard, in stock product. The amplifier is of a modular, 'open' construction design, for ease of installation and service.

The amplifier system is available in the following types of configurations:

- As amplifier modules, SMA7110-1, is used where you supply the DC Bus voltage, cooling fan(s), fusing and regen clamp. 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, fusing and an optional regen clamp for up to 4 axis. Please see section 1.2.2 for more detailed information.
- As a Stand-Alone, one axis amplifier, SMA7110-1A-1, which contains a DC power supply and fusing. (consult factory)

Each amplifier accepts a bipolar DC control input. The polarity of this signal determines the direction of rotation. This signal may be used to control either the velocity (RPM) or the current (torque) of the motor (see Servo Loops, section 2.3). The amplifier provides Pulse-Width Modulated (PWM) power to the motor in proportion to the input signal.

Each amplifier has several 'logic' inputs to stop the motor in one or both directions. These inputs are very useful for connecting to mechanical limit switches or digital equipment.

Each amplifier has several protection circuits to protect the amplifier, motor, and operator from almost any kind of fault. Flashing LED shows what fault has occurred, and a separate output can be used to signal other equipment.

1.2 Features:

1.2.1 Single Amplifier Module (SMA7110-1):

- Ergonomic design: Easy access to connections, adjustments, and test points.
- Wide operating bus voltage: 30-220VDC.
- Complete isolation: Complete isolation from input to output.
- Dual signal inputs: Single-ended or differential input. All inputs have up to 15,000A/V gain, and all inputs will accept ± 13 VDC.
- Dual mode operation: The amplifier may be configured for velocity (RPM) control or current (torque) control. (factory assigned option)
- Current limit: Maximum peak motor current is adjustable.
- Digital limit/enable: 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 +5VDC range. See Logic Input Configuration, section 5.2.
- Fault input/output: Open-collector output goes low in the event of a fault. Externally forcing the 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.
- Silent operation: Carrier frequency is 20KHz.
- Short circuit protection: Complete short circuit and ground fault protection.
- LED diagnostics: Red LED flashes to display various fault conditions and a green LED illuminates to indicate normal operating conditions.

- Frequency response: (Velocity Loop) 750 Hz minimum.
- Frequency response: (Current Loop) 2 KHz minimum.
- External fault reset: A separate input is provided to reset the amplifier after a fault.
- High-Speed Electronic Circuit Breaker: Instantly shuts down the amplifier in the event of a short across outputs and or ground fault condition.
- Low-Speed Electronic Circuit Breaker: Shuts down the amplifier if the amplifier is operated above the maximum continuous current rating for 3 seconds.
- Over voltage and over temperature: These circuits constantly monitor amplifier power-supply voltage, and amplifier-heatsink temperature. They will shut down the amplifier in the event of any out-of-specification condition.
- Surface mount technology: Constructed with surface mount components.
- Multi-axis chassis: Up to four amplifier modules may be mounted on a single baseplate. Multi-axis baseplate include a DC power supply, cooling fan(s) and wiring for each respective amplifier module.

1.2.2 Multi-Axis Power Supply(GP8600-50):

- Power supply for 2 to 4 axis amplifier baseplates.
- Line operated AC power operation: Fused AC input for single or three phase inputs. No power isolation transformer is required.
- Fused DC outputs for each axis.
- Regen clamp circuit (optional) with LED indicator and 30W internal load resistor bank bleeds off excess DC Buss voltage when decelerating a large load inertia.
- Bridge rectifier(s) and filter capacitor.

1.3 Specifications:

1.3.1 Single Amplifier Module (SMA7110-1):

The amplifier module requires an external DC power supply which must include a bridge rectifier, bus capacitor, and may require a 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 NOMINAL BUS VOLTAGE	OUTPUT POWER (CURRENT)	
	R.M.S.	PEAK
30-220 VDC	10A	20A

1.3.1.2 Signal Inputs:

Signal Input	Voltage VDC (maximum)	Impedance (minimum) Ohms	Velocity Gain Amp./Volt	Current Gain Amp./Volt
Differential	±13	10,000	15,000	0-5
Single-ended	±35	10,000	15,000	0-5
Tachometer input	±45	10,000	7,000	

1.3.1.3 Digital Inputs:

- ±Limit, Inhibit and Reset: ±50V max. Terminated by 10,000 Ohms.
- Fault (as input): +40V/-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.

1.3.1.4 System:

- Drift offset over temperature reference to input: 0.01mV/ °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 100mA max. through 10 ohms.
- Absolute motor current: Bipolar output. 1V = 2.5A. 10mA max. (MTR CURR; J1-8)

1.3.2 Multi-Axis Power Supply(GP8600-50):

The multi-axis power supply contains all items listed under 1.2.2 NOTE: If you do require the regen clamp, please specify at time of order.

1.3.2.1 Input and Output Specifications:

- Input Voltage(main): 21-157VAC, 50 or 60Hz.
- Fan Voltage: 110-130VAC, 50 or 60Hz, 0.12A.
- Output Voltage, (B+): 30-220VDC.
- Output Current: 30A continuous

1.3.3 Mechanical:

Model	L x W x H (inches)	Weight (lbs)
SMA7110-1 (Single Amplifier Module)	5.10 x 1.38 x 4.53	1.00
SMA7110-2A-2 (2-axis Amplifier System)	6.75 x 6.25 x 6.50	6.00
SMA7110-4A-4 (4-axis Amplifier System)	11.00 x 6.25 x 6.50	9.00

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 amplifier driving DC servo motors.
- A comparison between brush type and brushless motors.
- Operation of output switching transistors.
- "H Type" output bridge configuration.
- Pulse-Width-Modulation (PWM).
- Current-Loop and Velocity-Loop operation..
- 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 discusses these waveforms.

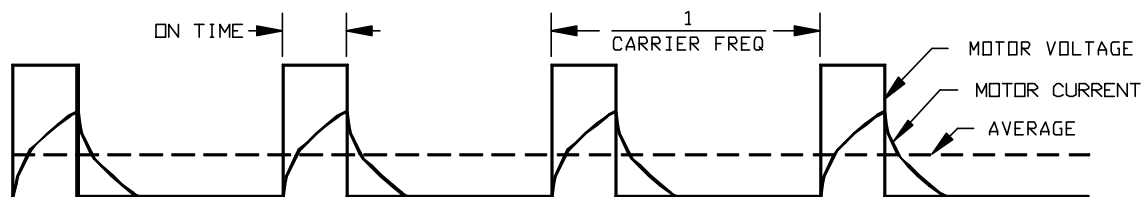


Figure 2.1
Pulse Width Modulation Waveform

2.3 Servo Loops:

A basic velocity mode servo loop for a brush type motor is shown in figure 2.2. 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.

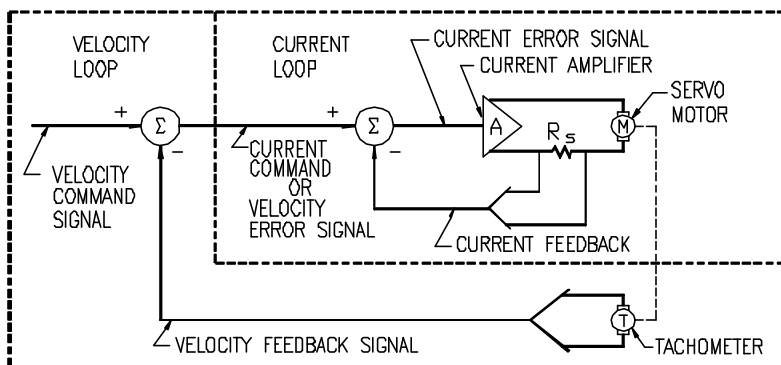


Figure 2.2
Velocity mode servo loop
for a brush type motor

The servo-loops of a brushless amplifier (figure 2.3) operate in much the same way, except there are now three current loops, one for each phase of the motor.

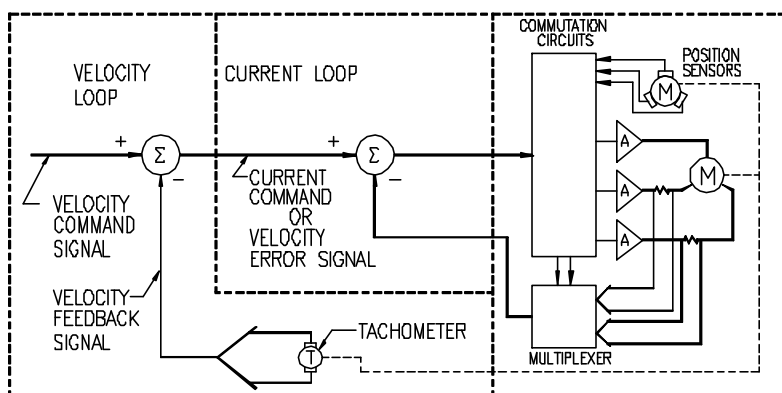


Figure 2.3
Velocity mode servo loop
for a brushless motor

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 2.4, 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.

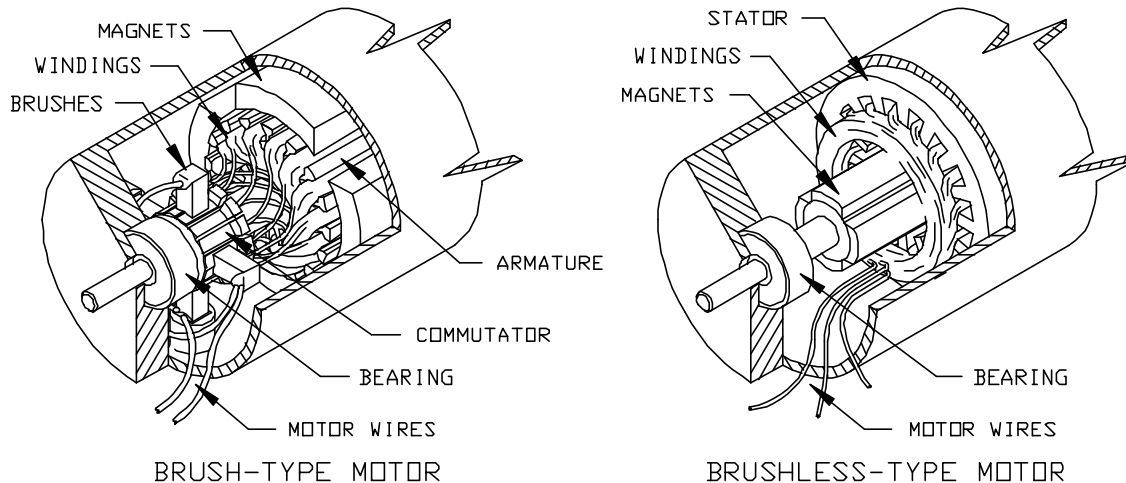


Figure 2.4
Brush type and Brushless type Motors

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

2.5 Operation of Output Switching Transistors:

The output transistors, for all intents and purposes, operate in only two states. They are analogous to ON/OFF switches. When an output transistor is OFF, there is no current flowing through it (its resistance is infinite). When an output transistor is ON, current flows through it (its resistance is near zero). When the transistor is ON, it is technically referred to as being in saturation.

2.6 “H” Type Output Bridge Configuration:

The output configuration of the amplifier is an “H TYPE” bridge (see figure 2.5 for schematic representation of an output bridge with a motor connected).

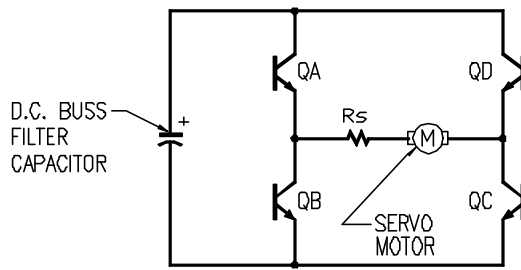


Figure 2.5
Schematic representation of an output bridge with a motor connected.

The advantage of an “H TYPE” output bridge configuration is that by controlling the switching of the opposite pairs of transistors, current can be made to flow through the motor in either direction using a single-polarity power supply.

To provide motor current in one direction, transistor A and C are turned ON, while B and D remain in the OFF state. To provide motor current in the other direction, B and D are turned ON, while A and C remain in the OFF state.

2.7 Pulse-Width-Modulation (PWM):

Pulse-width-modulation is the technique used for switching opposite pairs of output transistors ON and OFF to control the motor drive current. When zero current is commanded to the current loop, the opposite pairs of transistor are turned ON and OFF as shown in figure 2.6. Note that since the pulse widths are equal, the net DC current in the motor is equal to zero.

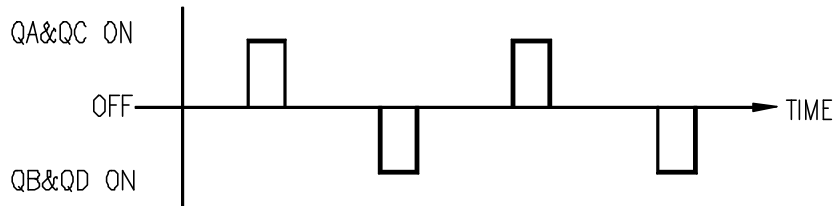


Figure 2.6
Transistor switching waveform at zero current

When a non-zero current is commanded to the current loop, the transistor switching waveform is as shown in figure 2.7. Since there is a non-zero current command, the output transistor pulse widths will change and the motor will see a net DC current flowing from A through C.

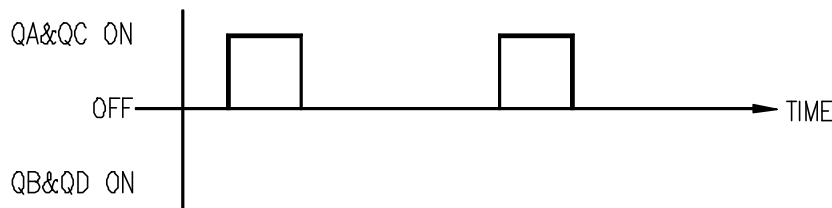


Figure 2.7
Transistor switching waveform when current flows from A through C

If the input to the current loop had been changed in polarity, the output transistor switching waveform would be as shown in figure 2.8.

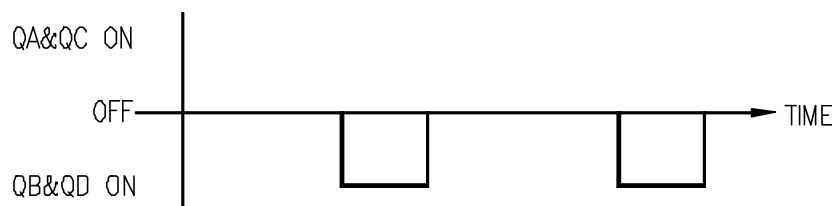


Figure 2.8
Transistor switching waveform when current flows from B through D

If a larger current of the same polarity was commanded to the output transistor (see figure 2.6B) the ON-time widths of B and D would automatically increase to provide more current.

From the previous examples it is easy to understand why this output transistor switching technique is referred to as pulse-width-modulation.

To change the magnitude and polarity of the current flow in the motor, the pulse widths of the opposite pairs of transistors are modulated. The frequency at which these output transistors are switched ON and OFF is referred to as the 'carrier frequency'.

Now that we have a good understanding of how the current is provided from an "H TYPE" pulse-width-modulated (PWM) bridge, let's analyze the operation of the current loop.

2.8 Current Loop Operation:

Please refer to figure 2.2 for a diagram of the current loop. In control electronics the symbol Sigma (with the circle around it) is referred to as a 'summing junction'. The manner in which this summing junction operates is as follows:

The current-command signal (also referred to as the velocity error signal when received from the output of the velocity loop, as shown in figure 2.2) is added to the current feedback signal. The signal resulting from this addition, is referred to as the "current error" signal. This current-error signal is fed into the current amplifier, which in turn produces a current in the motor. A voltage which is proportional to the motor current is developed across R_s (shunt resistor). This voltage is referred to as the "current feedback" signal. The current in the motor increases until the current-command signal. At this point the current error signal drops to zero, and the actual current is equal to the commanded current. If anything happens to disturb either the current command signal, or the current feedback signal, the same process occurs again until the current feedback signal is equal in magnitude to the current command signal, but opposite in polarity.

The type of loop described above is referred to as a "servo loop" because the current servos about a commanded value.

We are surrounded in our everyday lives by a multitude of servo loops. For example, many of today's luxury cars have what is called 'automatic climate control'. To operate this servo loop, you set the climate control to the temperature that you wish to be maintained in the interior of the car (current command signal). The selected temperature is then summed with the actual temperature from a thermometer (current feedback), and the output (current error signal) activates either the heater or the air conditioner until the actual temperature as measured by the thermometer (current feedback signal) is equal in magnitude, but opposite in polarity, to the set temperature.

2.9 Velocity Loop Operation:

Please refer to figure 2.2 for a diagram of a typical velocity loop. The velocity loop's operational description is analogous to the current loop description, except for the fact that the input signal is called the Velocity Command and the feedback signal from the DC tachometer is called the Velocity Feedback.

2.10 Protection Circuits:

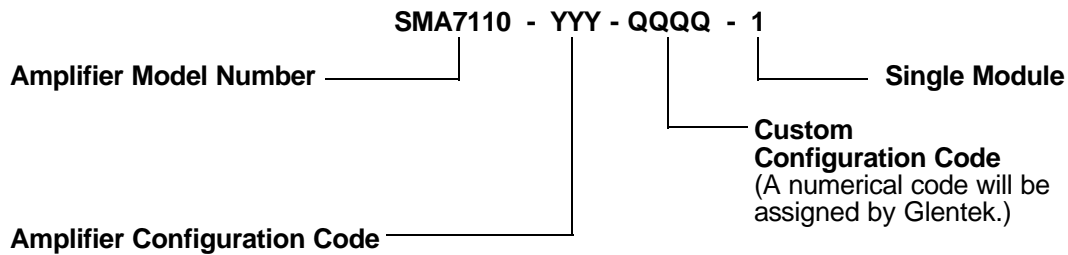
The High and Low Speed Electronic Circuit Breakers(HS/ECB and LS/ECB) protect the amplifier and motor from being damaged by high motor current(specified max. peak and rms current values). The Over Temperature and Over Voltage detection circuits will shut off the amplifier when the temperature of the 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

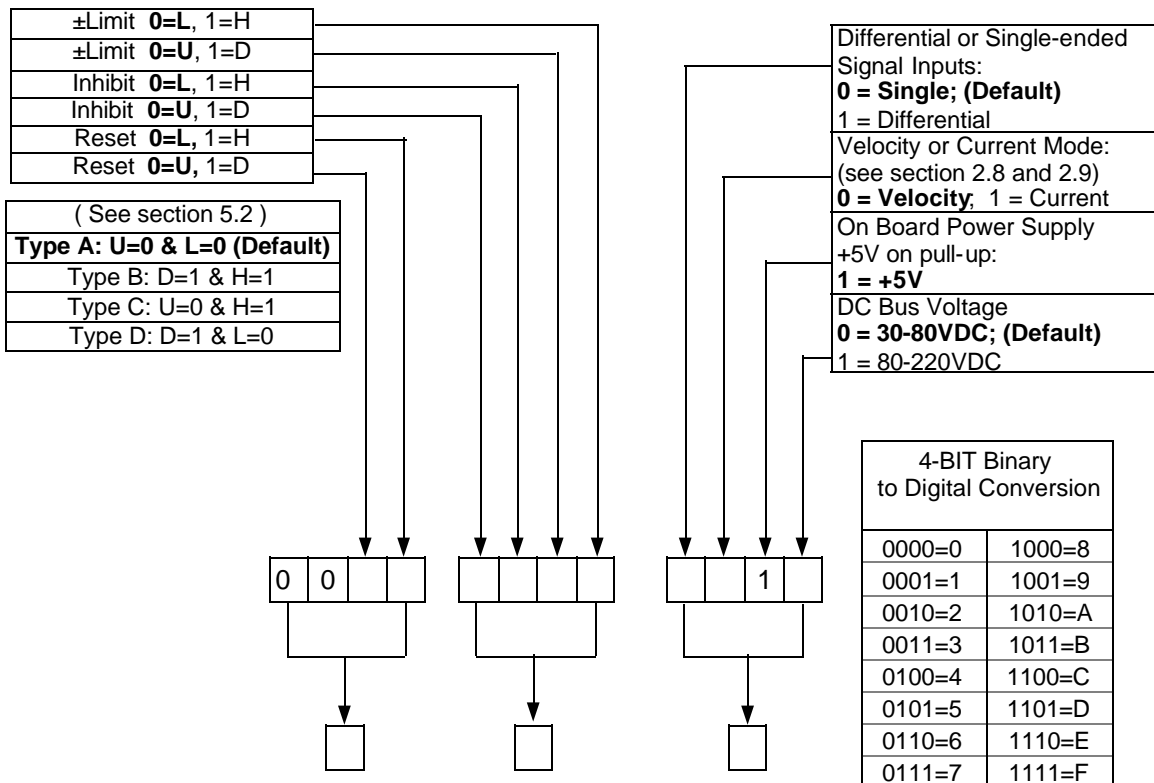
3.1 Introduction:

This chapter contains the model numbering system for the SMA7110 series single amplifier module and multi-axis amplifier system. 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 accurate as possible.

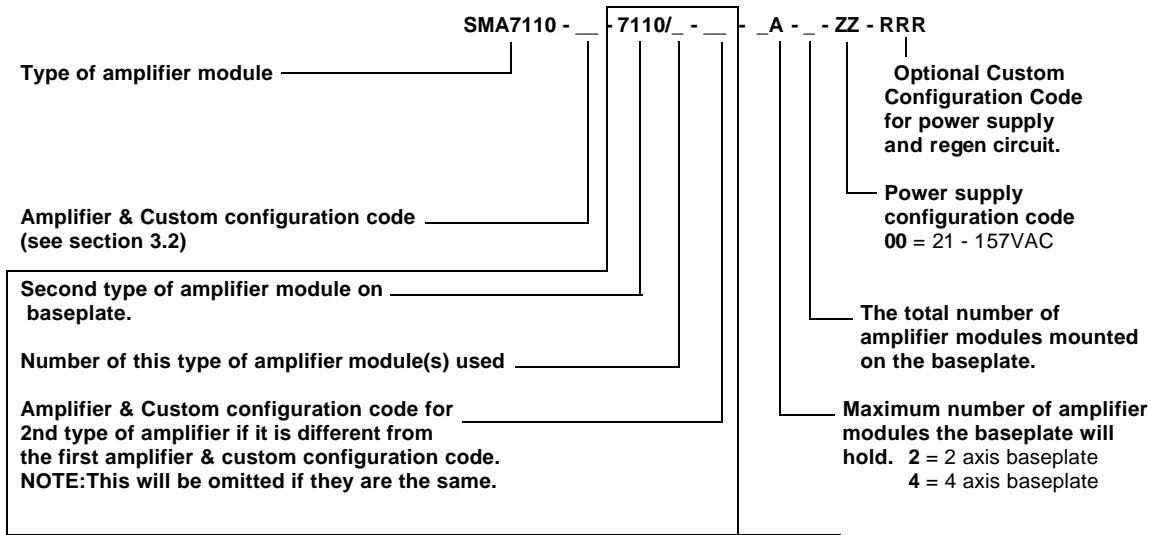
3.2 Single Amplifier Module:



Amplifier Configuration Code



3.3 Multi-Axis Amplifier:



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.

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:

DO NOT APPLY POWER UNTIL INSTRUCTED TO DO SO.

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 tachometer (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 line be run in separate, 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: 16AWG, shielded.
- Motor Case Ground: Same as motor wires, or use metallic conduit.
- Main Power: 16AWG (single axis) or 14AWG (multi-axis), twisted.
- Fan Power: 20AWG, twisted.
- Signal & Tach Input: 22AWG, twisted-pair, shielded.
- Logic Inputs/Outputs: 22AWG, shielded with its return lead.

4.3.3 Connector Size and Type:

4.3.3.1 The Power Connector of the Single Amplifier Module:

All amplifiers are shipped with the MOLEX CIF/CIM series connectors. The specifications of the mentioned connector are listed as follows:

- MOLEX, CIF/CIM SERIES *Headers and Plugs* with 5.08mm pitch (HEADER PART# CIM059P5), (GTK# EJ891M05) (PLUG PART# CIF05005), (GTK# EJ891F05):
 - header with side panels, plug-in direction parallel to PCB.
 - 5 positions.
 - color: green.

4.3.3.2 The Signal Connector - J1:

The signal connector is supported by the molex[®] KK .100" (2.54mm) Centerline Connector System.

- Mating Connector: molex[®] 2695 Series .100" (2.54mm) *Center Crimp Terminal Housing* (molex P/N: 22-01-3167):
 - red nylon housing.
 - 16 positions.
 - with polarizing rib.
- Crimp Terminals: molex[®] *Crimp Terminals* (molex P/N: 08-55-0102):
 - 16 microinch select gold plated.
 - brass.

4.3.4 Amplifier Module Connections:

4.3.4.1 The Power Connections - J2:

Signal Name	Terminal	Notes
MOTOR -	J2-1	Motor -
MOTOR +	J2-2	Motor +
BUS RETURN, B-	J2-3	DC Bus -
BUS RETURN, B-	J2-4	DC Bus -
BUS B+	J2-5	DC Bus +

4.3.4.2 The Signal Connections - J1:

Signal Name	Terminal	Notes
N/C	J1-1	No Connection
SIGNAL GND	J1-2	Common for all signals and shields.
N/C	J1-3	No Connection
SIGNAL +	J1-4	Signal input
SIGNAL -	J1-5	Signal return
TACH -	J1-6	Tachometer input
TACH + (GND)	J1-7	Tachometer input
MTR CURR	J1-8	Scale factor: 1V = 2.5 A
CURR LIMIT	J1-9	Sets the max. motor current

Signal Name	Terminal	Notes
LS/ECB	J1-10	Sets the continuous current delivered to the motor. Scale factor: 1V = 4 amps (Factory set)
INHIBIT	J1-11	Inhibits the motor in both directions.
+ LIMIT	J1-12	Inhibits the motor in the + direction.
- LIMIT	J1-13	Inhibits the motor in the - direction.
FAULT OUT	J1-14	Goes low if there is a fault in the amplifier. May be externally forced low to stop motor rotation in both directions.
EXT RESET	J1-15	Resets the fault latch. May also be used as an inhibit
N/C	J1-16	No connection

NOTE: For single ended signal input use J1-2 for common and J1-4 for Non inverting input or J1-5 for Inverting input.

4.3.5 Multi-Axis Amplifier Connections:

Main Voltage: Connect 21-157VAC line input, single or three phase to GP8600-50.

Fan Voltage: Connect 110-130VAC, 50/60Hz for fans to GP8600-50.

Chapter Five: Configuration

5.1 Introduction:

Each amplifier has several configuration options. This chapter describes these options and how to implement them.

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.

5.2 Logic Input Configuration:

There are four logic inputs: Limit +, Limit -, Inhibit and Ext. Reset . They may be configured for active-high or active-low signals, and pulled-up or pulled-down termination (type A, B, C, and D). All logic inputs have a 0 VDC to +5 VDC 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).

Chapter Six: Start Up and Calibration

6.1 Introduction:

This chapter contains the procedure required for initial start up and amplifier calibration. The SMA7110 series amplifiers can be configured to run in velocity mode (6.3) and current mode (6.4).

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. Remove input fuses on the baseplate and apply main power. Check for the correct AC voltage at fuse block. The DC Bus (amplifier supply-voltage) will be 1.4 times greater than the AC value. If the voltage is correct, remove power and reinstall fuses.
7. Work on only one amplifier axis at a time.

6.3 Calibration of the Velocity Mode Amplifier:

The amplifier, in this configuration, receives an analog, bi-polar input command which is proportional to the motor velocity. The amplifier receives velocity feedback from a tachometer which is usually mounted to the rear of the motor. The following pots will be set during calibration: (Note: RV6 is a single turn pot and RV1-RV5 are 20-turn pots.)

Note: RV7-8 are factory set and should not be adjusted. Adjusting these pots voids warranty.

Pots	Name of Pot	Notes
RV1	SIGNAL GAIN	Sets the input voltage to velocity ratio, e.g. 10V = 2000RPM
RV2	TACH GAIN	Sets the DC tachometer gain.
RV3	COMPENSATION (COMP)	Used in conjunction with tach. gain to set the system bandwidth.
RV4	BALANCE	Used to null any offset in system.
RV5	CURRENT LIMIT	Sets the maximum motor current
RV6	LOOP GAIN	Used to shut off uncalibrated amplifiers. When the loop gain is fully CCW, no current is delivered to the motor.

PROCEDURE:

1. Apply the main power and fan power.
2. Slowly turn the Loop Gain pot (RV6) CW. Motor should be stopped or turning slowly. If the motor starts running away, turn the Loop Gain pot full CCW, remove the power, reverse the tach leads, and retest.
3. Set the Balance (RV4) for zero motor rotation.
4. Connect an oscilloscope to J1-8 (MTR CURR) and a battery box to J1-4 (J1-2 is common for both). The voltage on J1-8 is a function of motor current: 1V = 2.5A. While applying a step input voltage, adjust the Current Limit pot (RV5) for desired peak current.

The purpose of the following procedure is to set the system bandwidth to obtain a critically-damped response or a one hook overshoot response with the maximum possible Tach. Gain. There are many possible settings of Tach. Gain and Compensation which will yield the desired waveform. The optimum setting will occur when Tach Gain is as CW as possible and 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 pot (RV2) set at 100%. This is a good place to start. If you are unsure of where the Tach. Gain pot is set, turn the Tach Gain pot (RV2) fully CW (up to 20 turns).

5. Connect oscilloscope to J1-6 (TACH -) and J1-2 or 7 is common. Set battery box for a DC signal output to obtain approximately 400RPM. The RPM may be set by measuring the tach voltage at J1-6, e.g., 2.8VDC for a 7V/KRPM tach is 400RPM.
6. Pulse the input and compare the waveform with figure 6.1.

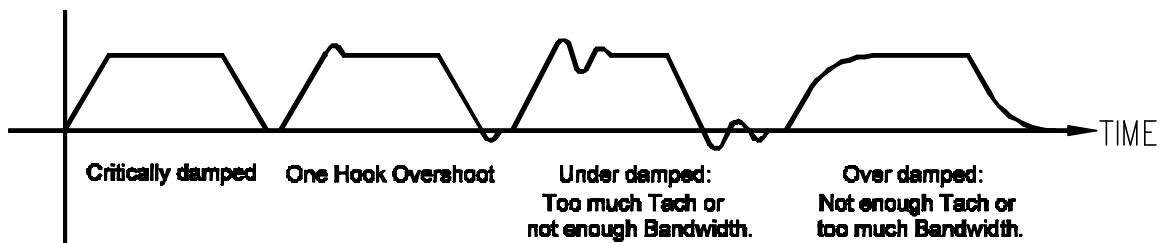


Figure 6.1
Critically damped, One Hook Overshoot,
Under and Over damped waveforms

7. Adjust the Compensation pot (RV3) CCW until the waveform is critically damped or one hook overshoot. Then proceed to step 9.
8. If the desired waveform cannot be obtained by adjusting the Compensation pot, back off the Tach Gain pot (CCW) a few turns and repeat step 7.9. Do not adjust the Tach Gain or Compensation pots for the rest of the calibration procedure.
10. With the battery box still connected at J1-4 and J1-2, set the battery box for a known DC voltage. Adjust the Signal Gain pot (RV1) to obtain the desired motor velocity.
11. If the motor is rotating in the wrong direction for a given input polarity, remove the power and reverse both the motor leads and the tach leads.
12. Remove the battery box, and repeat step 3.
13. Calibration complete. Reconnect signal wires.

6.4 Calibration of the Current Mode Amplifier:

The amplifier in this configuration, receives an analog, bi-polar input command which is proportional to the required motor current (motor torque). The following potentiometers (pots) will be set during calibration: (Note: RV6 is a single turn pot and RV1-RV5 are 20-turn pots.)

Pots	Name of Pot	Notes
RV1	SIGNAL GAIN	Sets the input voltage to current ratio, e.g. 10V = 20A.
RV4	BALANCE	Used to null any offsets in system.
RV5	CURRENT LIMIT	Sets the maximum motor current.
RV6	LOOP GAIN	Used to shut off uncalibrated amplifiers. When the loop gain is fully CCW, no current is delivered to the motor.

Note: RV7-8 are factory set and should not be adjusted. Adjusting these pots voids warranty.

PROCEDURE:

1. Apply the main power and fan power.
2. Slowly turn the Loop Gain pot (RV6) CW. The Motor should be stopped or turning slowly. Set the Balance pot (RV4) for zero motor rotation.
3. Connect an oscilloscope to J1-8 (MTR CURR) and a battery box to J1-4 (J1-2 is common). The voltage on J1-8 is a function of motor current: $1V = 2.5A$. While applying a step input voltage, adjust the Current Limit pot (RV5) for the desired peak current. If the desired peak current cannot be achieved with the Current Limit pot full CW, increase either the input signal or the Signal Gain pot (RV1).
4. With the battery box still connected at J1-4 and J1-2, set the battery box for a known DC voltage. Apply \pm input signal pulses and adjust the Signal Gain pot (RV1) pot to obtain the desired current gain of the amplifier.
5. If the motor is rotating in the wrong direction for a given input polarity, remove the power and reverse the motor leads.
6. Remove the battery box, and repeat step 2.
7. Calibration complete. Reconnect signal wires.

6.5 Calibration Setup Record:

It is good practice to keep a record of all the 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 directions in the calibration procedure.

Pot/Test Point	AMP1	AMP2	AMP3	AMP4
Signal Gain pot wiper TP-1 to TP-4 common (ohms):				
Tach Gain pot wiper TP-2 to TP-4 common (ohms):				
Compensation pot wiper TP-3 to TP-4 common (ohms):				

Note: Tach voltage is measured at J1-6. Common for all measurements is at TP-4 or J1-2.

Date data taken: / /

Serial number S/N: _____

Model number: SMA7110_____

Note any changes to components or any special features in the space below:

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 the fault LED flashes, 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	RED LED FLASHES	GREEN LED	FAULT OUTPUT
NORMAL OPERATION	OFF	ON	PULL-UP
OVER TEMP (LATCHED)	ONCE	OFF	LOW
OVER VOLT (LATCHED)	TWICE	OFF	LOW
LS/ECB (LATCHED)	THREE TIMES	OFF	LOW
HS/ECB (LATCHED)	FOUR TIMES	OFF	LOW
EXT. FAULT OR POWER ON RESET	ON	OFF	LOW

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

When the peak output of the amplifier exceeds 40A for 10 microseconds, the Run LED will turn off, the red LED will flash four times 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:

- Shorted motor leads.
- Motor inductance too low.
- Short from a motor lead to ground.

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

When the RMS output of the amplifier exceeds 10A for 3 seconds, the Run LED will turn off, the red LED will flash three times 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:

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

7.2.4 Over Temp Fault:

When the amplifier heatsink temperature has reached a level that, if exceeded, would damage the output transistors, the Run LED will turn off, the red LED will flash once, a Fault Output is generated, and the amplifier is inhibited. NOTE: This is a latched condition.

The following is a list of possible causes:

- Loss of cooling or fans are defective or airflow is blocked.
- Excessive rise in cooling air temperature due to cabinet ports being blocked or excessive hot air being ingested.
- Extended operational duty cycle due to mechanical overload of motor or defective motor.

7.2.5 Over Voltage Fault:

When the DC Bus voltage reaches 220VDC, the Run LED will turn off, the red LED will flash twice, a Fault Output is generated, and the amplifier is inhibited. NOTE: This is a latched condition.

The following is a list of possible causes:

- Main AC line voltage is too high.
- Decelerating too large of an 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-Bus. If this fault occurs, you may need a Regen Clamp. Consult Glentek.

7.2.6 Resetting A Fault:

The fault latch may be reset by activating the Ext. Reset input J1-15 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 appendix will enable a skilled technician to troubleshoot an amplifier to even lower levels. The modular construction of the amplifier allows fast and easy repair.

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

- Fuses in the power supply. (AC input, DC output)
- Fans.
- Amplifier modules.

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.
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:

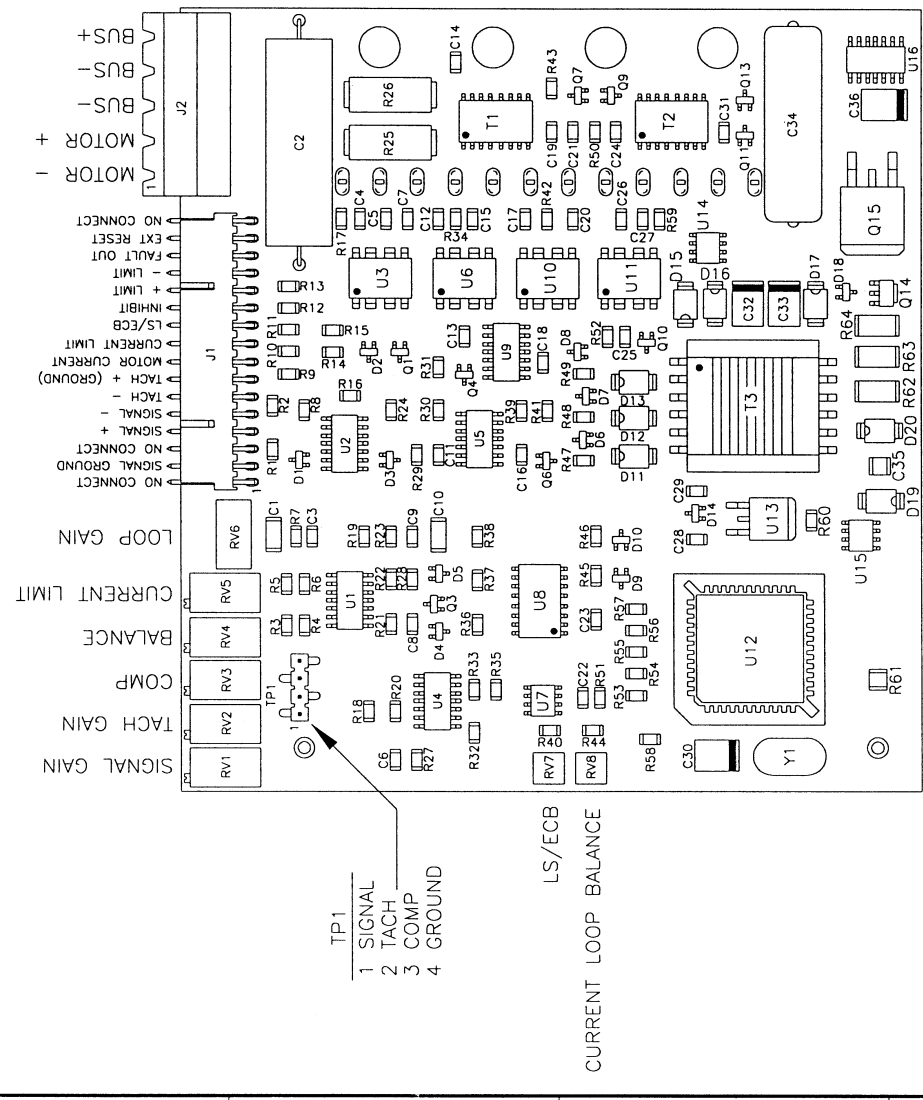
Any product, or part thereof, manufactured by Glentek, Inc., described in this manual, which, under normal operating conditions in the plant of the original purchaser thereof, proves defective in material or workmanship within one year from the date of shipment by us, as determined by an inspection by 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

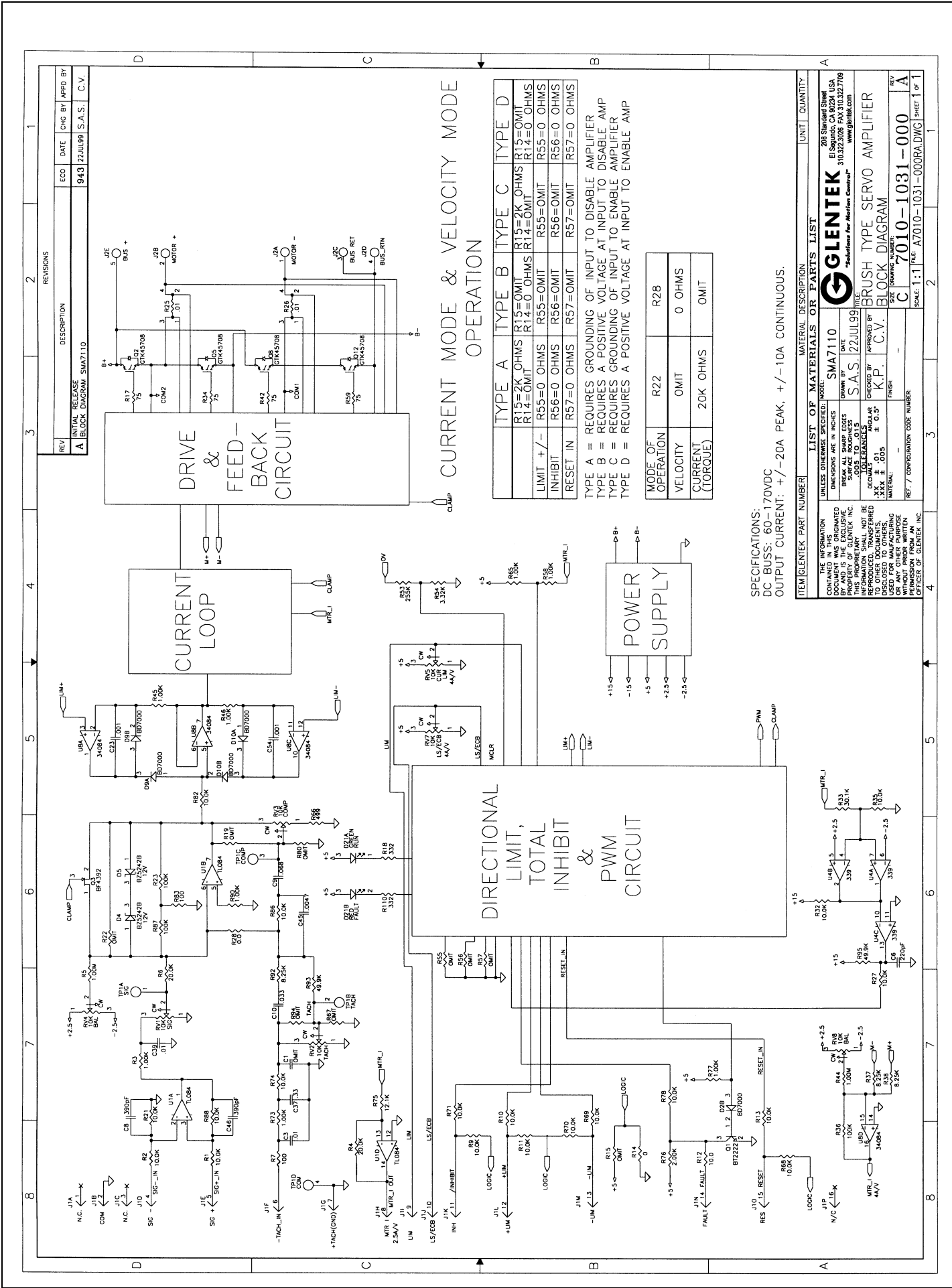
REVISIONS			
REV	DESCRIPTION	DATE	CHK BY/APP'D BY
A	INITIAL RELEASE - INSULATION ASSEMBLY DRAWING	9/43/1999	S.A.S. / C.V.

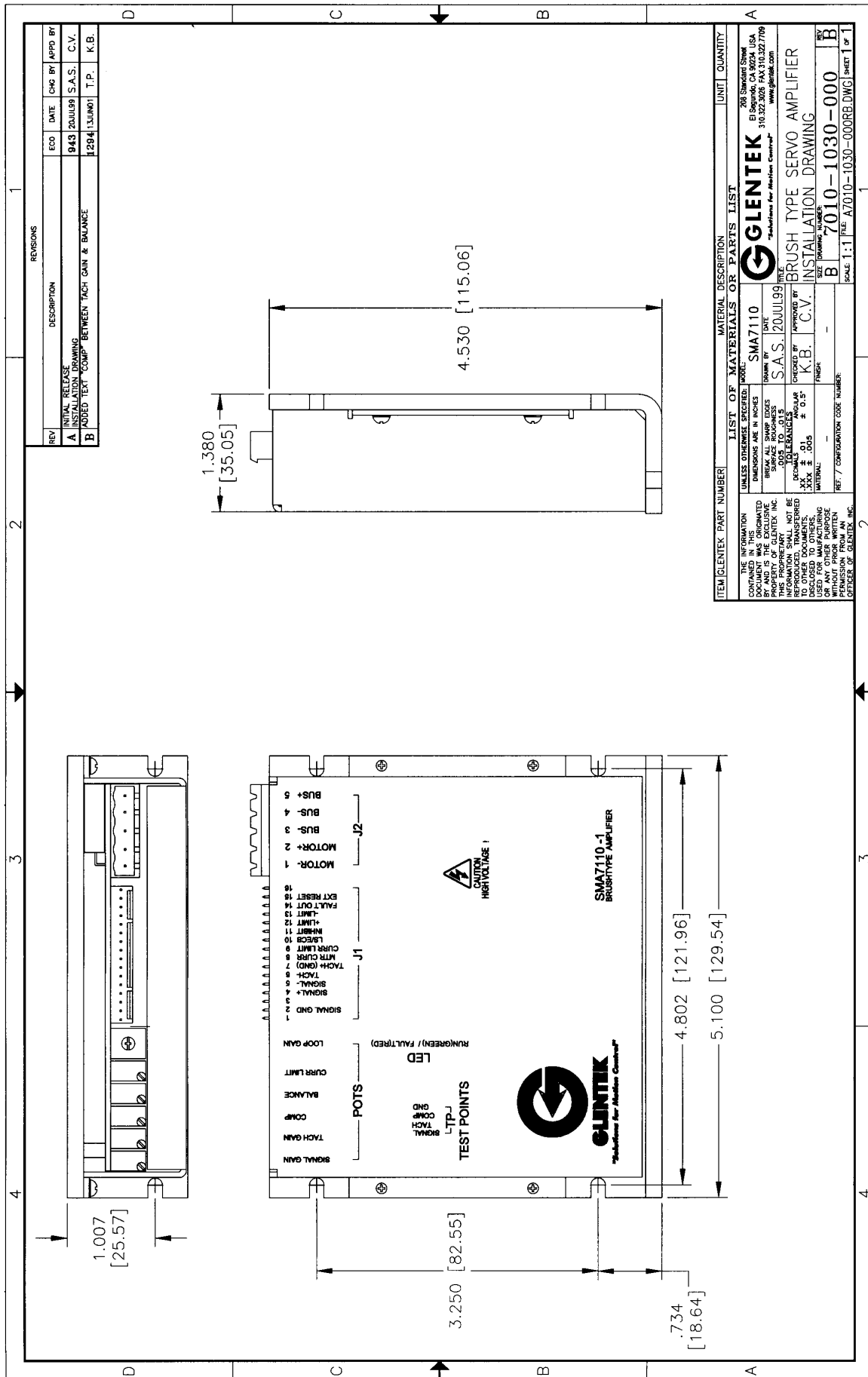


- TP1
 1 SIGNAL
 2 TACH
 3 COMP
 4 GROUND

LS/ECB
 CURRENT LOOP BALANCE

ITEM/GLENTEK PART NUMBER	MATERIAL DESCRIPTION	UNIT	QUANTITY
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES			
BRUSH TYPE SERVO AMPLIFIER			
SMA7110			
DATE: 20JUL99			
APPROVED BY: K.B.			
CHECKED BY: APPROVED BY			
DRAWN: K.B.			
FILE: A7010-1032-000A			
SCALE: 1:1			
<p>GLENTEK 208 Standard Street El Segundo, California 90245 (310) 322-3026 FAX (310) 322-2709 www.glenetek.com</p> <p>BRUSH TYPE SERVO AMPLIFIER INSTALLATION ASSEMBLY DRAWING</p>			

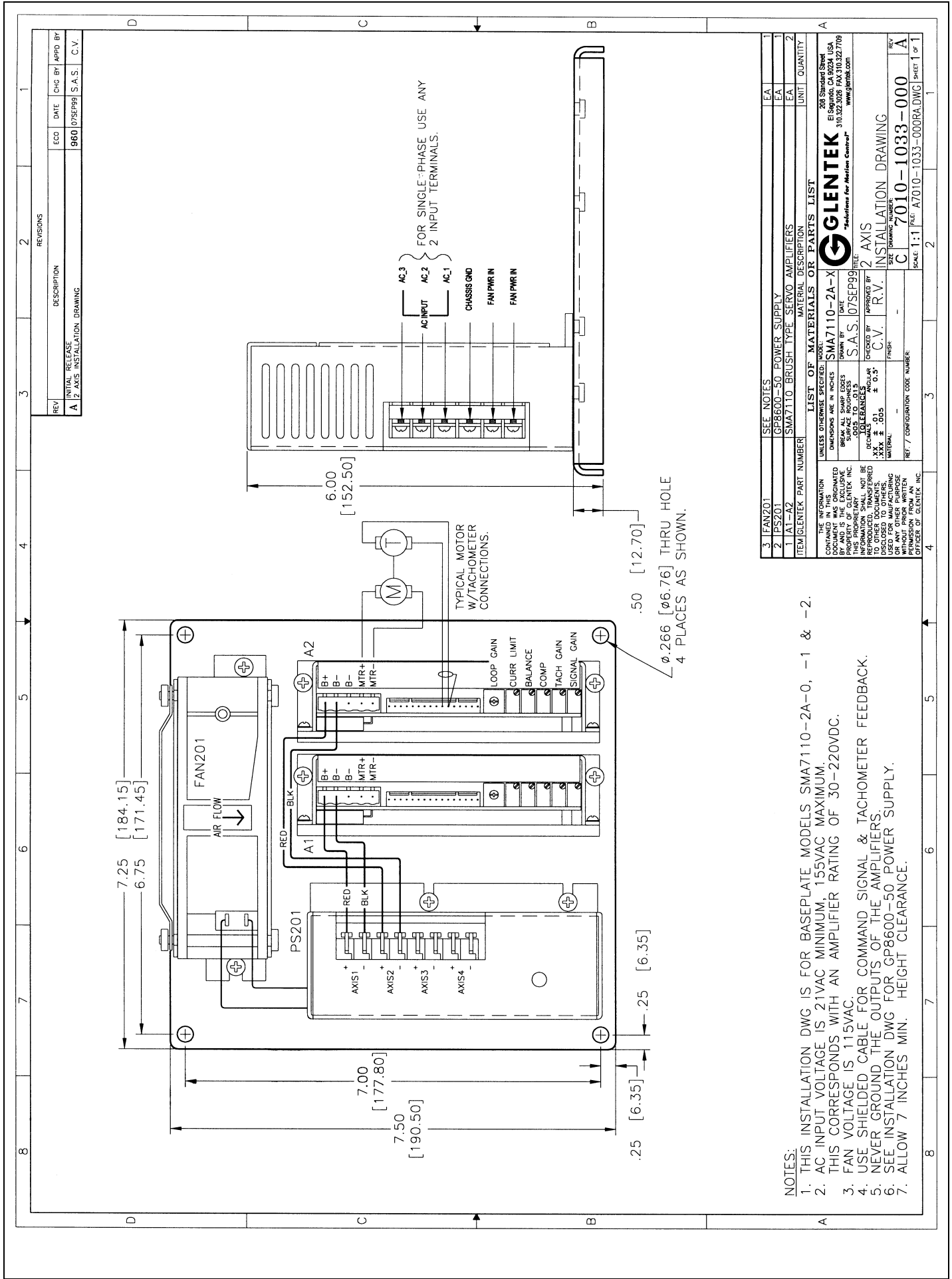




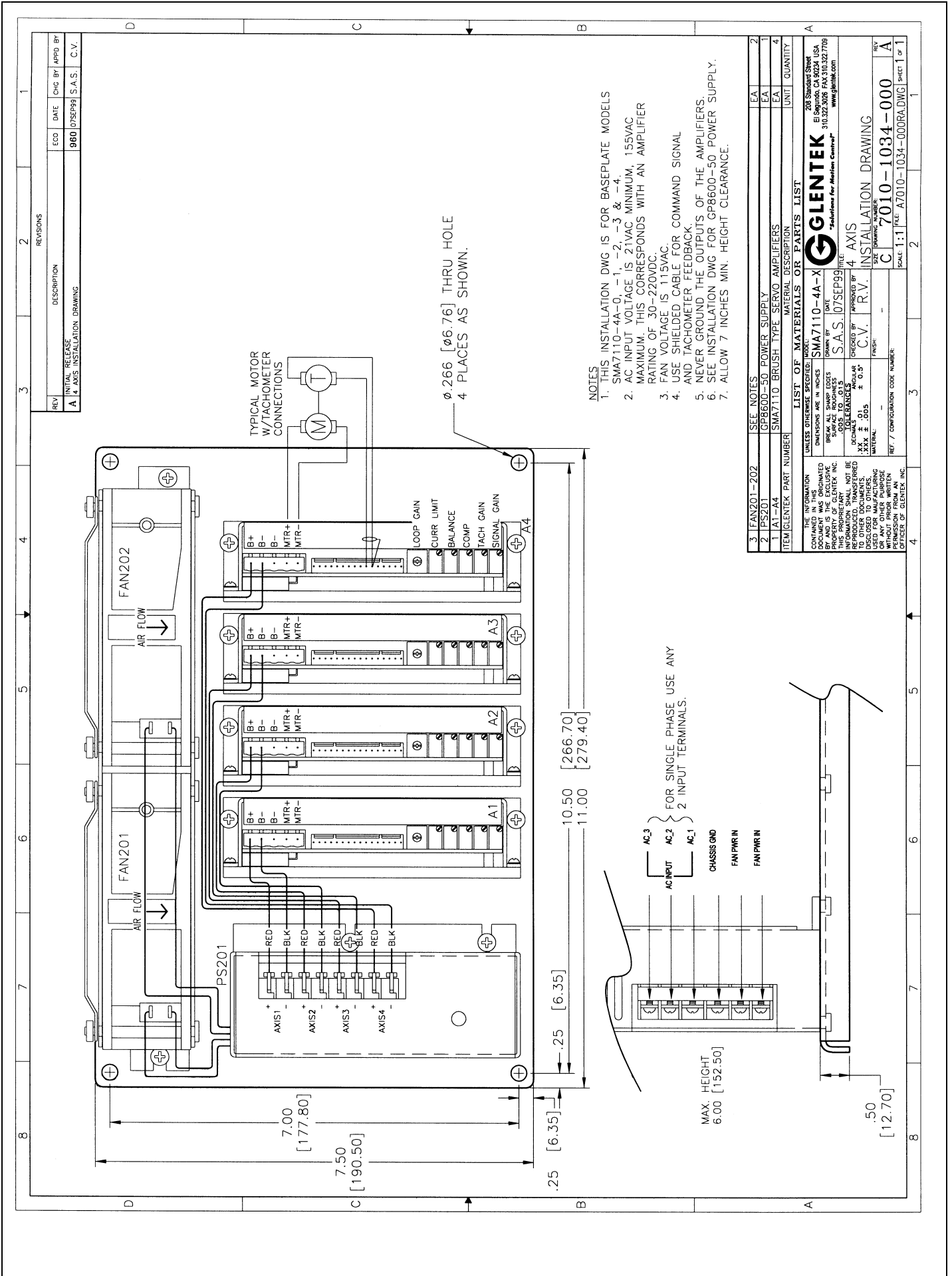
REVISIONS

REV	DESCRIPTION	ECO	DATE	CHK BY	APP'D BY
A	INITIAL RELEASE FROM TOOLING DRAWING	943	20JUL99	S.A.S.	C.V.
B	ADDED TEXT COMP BETWEEN TACH GAIN & BALANCE	1284	13JUN01	T.P.	K.B.

ITEM	GLENTEK PART NUMBER	MATERIAL DESCRIPTION	UNIT	QUANTITY
<p>UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES DECIMALS: .005 TO .015 FRACTIONS: 1/16, 1/8, 3/16, 1/4, 3/8, 1/2, 5/8, 3/4, 7/8 TOLERANCES: ±0.005 SURFACE FINISH: XXX ± 0.05 MATERIAL: - REF / CONFIGURATION CODE NUMBER: -</p>				
<p>THE INFORMATION CONTAINED HEREIN IS THE PROPERTY OF GLENTEK, INC. AND IS UNCLASSIFIED. IT IS REPRODUCED, TRANSMITTED, OR OTHERWISE DISCLOSED TO OTHER DOCUMENTS, OR FOR ANY OTHER PURPOSE WITHOUT THE PERMISSION FROM AN OFFICER OF GLENTEK, INC.</p>				
<p>GLENTEK 208 Standard Street, El Segundo, California 90245 U.S.A. (310) 322-3026 FAX 310.322.3799 www.glenetek.com "Innovations for Motion Control"</p>				
<p>MODEL: SMA7110 DATE: 20JUL99 TITLE: BRUSH TYPE SERVO AMPLIFIER DRAWN BY: S.A.S. CHECKED BY: K.B. C.V. APPROVED BY: K.B. C.V. SIZE: B DRAWING NUMBER: 7010-1030-000 SCALE: 1:1 FILE: A7010-1030-000RB.DWG SHEET 1 OF 2</p>				



- NOTES:**
1. THIS INSTALLATION DWG IS FOR BASEPLATE MODELS SMA7110-2A-0, -1 & -2.
 2. AC INPUT VOLTAGE IS 21VAC MINIMUM, 155VAC MAXIMUM. THIS CORRESPONDS WITH AN AMPLIFIER RATING OF 30-220VDC.
 3. FAN VOLTAGE IS 115VAC.
 4. USE SHIELDED CABLE FOR COMMAND SIGNAL & TACHOMETER FEEDBACK.
 5. NEVER GROUND THE OUTPUTS OF THE AMPLIFIERS.
 6. SEE INSTALLATION DWG FOR GP8600-50 POWER SUPPLY.
 7. ALLOW 7 INCHES MIN. HEIGHT CLEARANCE.



REV	INITIAL RELEASE	DESCRIPTION	ECO	DATE	CHG BY	APP'D BY
A	14	AXIS INSTALLATION DRAWING	960	07SEP99	S.A.S.	C.V.

ITEM	GLENTEK PART NUMBER	MATERIAL DESCRIPTION	UNIT	QUANTITY
3	FAN201-202	SEE NOTES	EA	2
2	PS201	GP8600-50 POWER SUPPLY	EA	1
1	A1-A4	SMA7110 BRUSH TYPE SERVO AMPLIFIERS	EA	4

LIST OF MATERIALS OR PARTS LIST	
UNLESS OTHERWISE SPECIFIED, MODEL: SMA7110-4A-X	208 Standard Street
CONTAINED IN THIS DRAWING	El Segundo, CA 90244 USA
PROPERTY OF GLENTEK INC.	310.322.3026 FAX 310.322.7709
ALL DIMENSIONS ARE IN INCHES	www.glenetek.com
BREAK ALL SHARP EDGES	
SURFACE FINISHES	
INFORMATION SHALL NOT BE	
DISCLOSED TO OTHERS.	
IF YOU HAVE ANY QUESTIONS	
OR NEED ANY OTHER PURPOSE	
REF. 7 CONFIGURATION CODE NUMBER:	

REV	DATE	DESCRIPTION
C	0710-1034-000	INSTALLATION DRAWING

SCALE: 1:1 FILE: A7010-1034-000RA.DWG SHEET 1 OF 1

- NOTES
- THIS INSTALLATION DWG IS FOR BASEPLATE MODELS SMA7110-4A-0-1, -2, -3 & -4.
 - AC INPUT VOLTAGE IS 21VAC MINIMUM, 155VAC MAXIMUM. THIS CORRESPONDS WITH AN AMPLIFIER RATING OF 30-220VDC.
 - FAN VOLTAGE IS 115VAC.
 - USE SHIELDED CABLE FOR COMMAND SIGNAL AND TACHOMETER FEEDBACK.
 - NEVER GROUND THE OUTPUTS OF THE AMPLIFIERS.
 - SEE INSTALLATION DWG FOR GP8600-50 POWER SUPPLY.
 - ALLOW 7 INCHES MIN. HEIGHT CLEARANCE.

FOR SINGLE PHASE USE ANY
AC INPUT

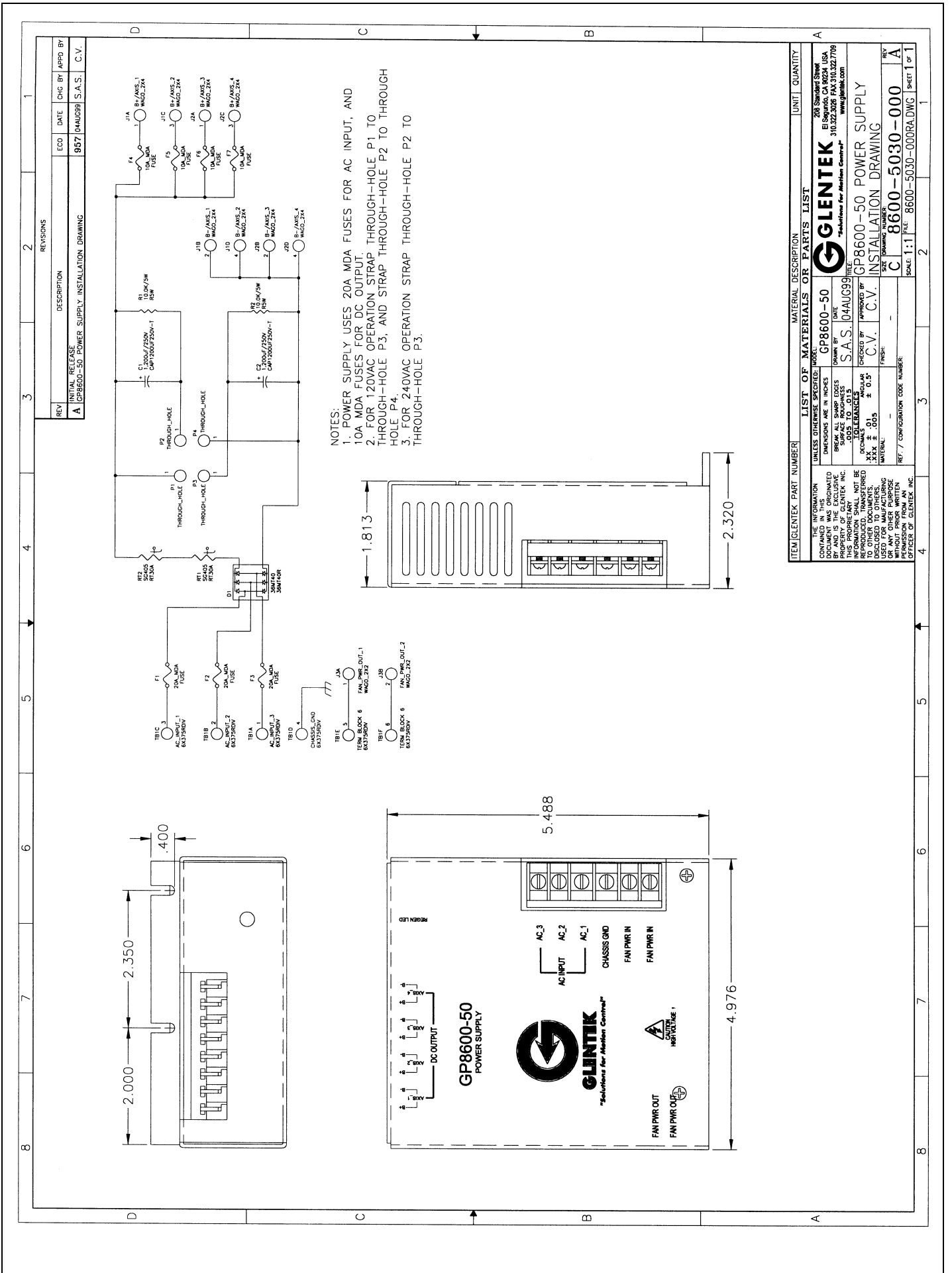
AC3
AC2
AC1

CHASSIS GND
FAN PWR IN
FAN PWR IN

MAX. HEIGHT
6.00 [152.50]

.50
[12.70]

Appendix B
Power Supply



NOTES:
 1. POWER SUPPLY USES 20A MDA FUSES FOR AC INPUT, AND 10A MDA FUSES FOR DC OUTPUT.
 2. FOR 120VAC OPERATION STRAP THROUGH-HOLE P1 TO THROUGH-HOLE P3, AND STRAP THROUGH-HOLE P2 TO THROUGH-HOLE P4.
 3. FOR 240VAC OPERATION STRAP THROUGH-HOLE P2 TO THROUGH-HOLE P3.

ITEM	GLENTK PART NUMBER	MATERIAL DESCRIPTION	UNIT	QUANTITY
<p>UNLESS OTHERWISE SPECIFIED: MODEL: GP8600-50 DIMENSIONS ARE IN INCHES BREAK ALL SHARP EDGES SURFACE FINISHES TOLERANCES DECIMALS ± 0.5 FRACTIONS ± .005 MATERIAL REF. / CONFIGURATION CODE NUMBER</p>				
<p>THE INFORMATION CONTAINED IN THIS DRAWING IS THE PROPERTY OF GLENTK INC. AND IS THE EXCLUSIVE PROPERTY OF GLENTK INC. INFORMATION SHALL NOT BE REPRODUCED, TRANSMITTED, COPIED, OR IN ANY MANNER USED FOR MANUFACTURING OR REPAIRING WITHOUT PRIOR WRITTEN PERMISSION OF GLENTK INC.</p>				
<p>GLENTK 208 Standard Street El Segundo, CA 90234 USA 310.322.3026 FAX 310.322.7769 www.glenitek.com</p>				
<p>DATE: 04AUG99 DRAWN BY: S.A.S. CHECKED BY: C.V. APPROVED BY: C.V. SIZE: 11x17 SCALE: 1:1 FILE: 8600-5030-000RA.DWG</p>				
<p>GP8600-50 POWER SUPPLY INSTALLATION DRAWING</p>				<p>REV. 1 SHEET 1 OF 1</p>

Appendix C
European Union EMC Directive

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.

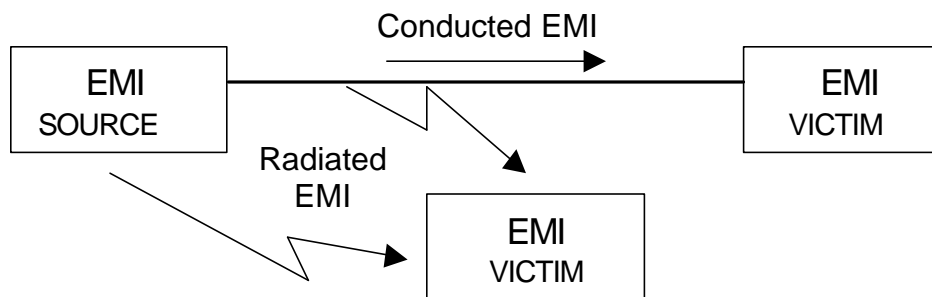
The majority of installations do not exhibit noise problems. However, these filtering and shielding guidelines are provided as counter measures. The grounding guidelines provided below are simply good grounding practices. They should be followed in all installations.

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 IEC801-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 EMI attenuation and to ensure safety. All of the following guidelines should be met for effective filter use.

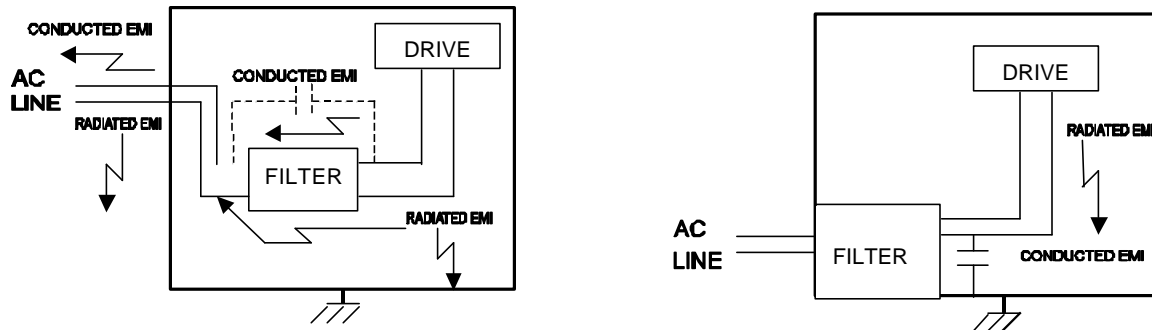
The filter should be mounted to a grounded conductive surface.

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.

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
	<p>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.</p>

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° 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 *not* 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 SMA7110**



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):	SMA7110. The above amplifier modules packaged in the following configurations: -1, -1A-1, -2A-1, -2A-2, -4A-3, -4A-4 and all power supply configurations: 00, 01.

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

NOTES

NOTES

NOTES

Omega Series Digital PWM Brushless Servo Amplifiers

- PWM (Pulse-Width-Modulated) Brushless 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 #: 7010-1040
Revision: (C)
Date: 22 September 2005

208 Standard Street, El Segundo, California 90245, USA.
Telephone: (310) 322-3026 **Fax:** (310) 322-7709
www.glentek.com

