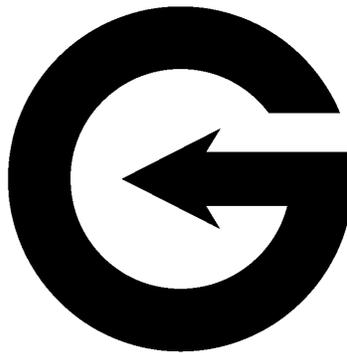


**OPERATION  
&  
SERVICE MANUAL**

***Model SMA7115  
Model SMA7115HP***

**Brush Type Amplifier System**



**GLENTEK**

***"Solutions for Motion Control"***

# TABLE OF CONTENTS

<b>INTRODUCTION .....</b>	<b>5</b>
<b>CHAPTER ONE: DESCRIPTION, FEATURES AND SPECIFICATIONS</b>	
1.1 Description.....	6
1.2 Features.....	6
1.2.1 Single Amplifier Module (SMA7115-1) .....	6
1.2.2 Stand Alone One Axis Amplifier (SMA7115-1A-1).....	6
1.2.3 Multi-Axis Power Supply (GP8600-70).....	7
1.3 Specifications.....	7
1.3.1 Single Amplifier Module (SMA7115-1) .....	7
1.3.1.1 Input and Output Power .....	8
1.3.1.2 Signal Inputs .....	8
1.3.1.3 Digital Inputs .....	8
1.3.1.4 System.....	8
1.3.1.5 Outputs.....	8
1.3.2 Stand Alone One Axis Amplifier (SMA7115-1A-1).....	8
1.3.3 Multi-Axis Power Supply (GP8600-70) .....	9
1.3.3.1 Input and Output Power .....	9
1.3.4 Mechanical .....	9
<b>CHAPTER TWO: THEORY OF OPERATION</b>	
2.1 Introduction .....	10
2.2 Driving DC Servo Motors .....	10
2.3 Servo Loops.....	10
2.4 Brushed Motors vs Brushless Motors.....	11
2.5 Operation of Output Switching Transistors .....	12
2.6 “ H ” Type Output Bridge Configuration .....	12
2.7 Pulse-Width-Modulation (PWM) .....	13
2.8 Current-Loop Operation .....	13
2.9 Velocity-Loop Operation.....	14
2.10 Protection Circuits.....	14
<b>CHAPTER THREE: MODEL NUMBERING</b>	
3.1 Introduction .....	15
3.2 Single Amplifier Module .....	15
3.3 Stand Alone One Axis Amplifier .....	16
3.4 Multi-axis Amplifier.....	16
<b>CHAPTER FOUR: INSTALLATION</b>	
4.1 Introduction .....	17
4.2 Mounting .....	17
4.3 Wiring .....	17
4.3.1 RFI/EMI and Wiring Technique.....	17
4.3.2 Wire Size and Type.....	17
4.3.3 Connector Size and Type.....	17
4.3.3.1 The Power Connector of the Single Amplifier Module .....	17
4.3.3.2 The Signal Connector.....	18
4.3.3.3 The Power & Motor Connectors of the Stand Alone Amplifier .....	18
4.3.4 Amplifier Module Connections.....	18
4.3.4.1 The Power Connections .....	18
4.3.4.2 The Signal Connections .....	19
4.3.5 Stand Alone One Axis Amplifier Connections .....	19
4.3.6 Multi-Axis Amplifier Connections .....	19

**CHAPTER FIVE: CONFIGURATION**

5.1	Introduction .....	20
5.2	Logic Input Configuration.....	20
5.2.1	15V/+5 Logic Level Configuration.....	20
5.2.2	Velocity Mode and Current Mode Configuration .....	20
5.2.3	Integrator Configuration .....	20
5.2.4	Stop Function .....	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 .....	23
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	Under Voltage Fault.....	25
7.2.3	High Speed Electronic Circuit Breaker (HS/ECB) Fault.....	25
7.2.4	Low Speed Electronic Circuit Breaker (LS/ECB) Fault.....	26
7.2.5	Over Temp Fault.....	26
7.2.6	Over Voltage Fault.....	26
7.2.7	Resetting A Fault .....	26
7.3	Amplifier Failure .....	26
7.4	Factory Repair.....	26
7.5	Warranty .....	27

**APPENDIX A: AMPLIFIER DRAWINGS**

SMA7115 & SMA7115HP Installation Schematic (7015-4042) .....	29
SMA7115 Installation Drawings (7015-4043).....	30
SMA7115-1A-1 Installation Drawing for the Stand Alone Amplifier (7015-4044) .....	32
SMA7115-2A-2 2 AXIS Amplifier Installation Drawing (7115-1033) .....	33
SMA7115-4A-4 4 AXIS Amplifier Installation Drawing (7115-1032) .....	34

**APPENDIX B: POWER SUPPLY**

GP8600-70 60A Power Supply Assembly Drawing (8600-2030).....	36
--	----

**APPENDIX C: EUROPEAN UNION EMC DIRECTIVES**

Electromagnetic Compatibility Guidelines for Machine Design.....	38
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 our TORQUE-SWITCH™ series, brush type servo amplifier, model SMA7115. 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 for ease of installation and service.

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

- As amplifier modules, SMA7115-1, where you supply the DC Buss voltage, cooling fan(s), fusing and shunt regulator. Please see section 1.2.1 for more detailed information.
- As a stand alone one axis amplifier, SMA7115-1A-1, which contains a DC power supply, cooling fan, soft start circuitry, fusing and a shunt regulator. Please see section 1.2.2 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.

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. LED's show what fault has occurred, and a separate output can be used to signal other equipment.

### 1.2 Features:

#### 1.2.1 Single Amplifier Module (SMA7115-1):

- Ergonomic design: Easy access to connections, adjustments, and test points.
- Wide operating buss voltage: 30-220VDC.
- Complete isolation: Complete isolation from input to output.
- Dual signal inputs: Two single-ended or one differential. Both single-ended inputs may be use simultaneously. All inputs have up to 15,000A/V gain (velocity mode), and inputs will accept up to  $\pm 13$ VDC.
- Dual mode operation: The amplifier may be field configured for velocity (RPM) control or current torque control.
- Current limit: Maximum peak motor current is adjustable.
- 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 termination, and a 0 to +5VDC or 0 to +15VDC 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: A 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 (HS/ECB): Instantly shuts down the amplifier in the event of a short across outputs and or ground fault condition. (i.e. amplifier exceeds 80A for 10microseconds)
- 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, 20A for high power) for 3 seconds.
- Over/under voltage and over temperature: These circuits constantly monitor amplifier power-supply voltages, and amplifier-heatsink temperature. They will shut down the amplifier in the event of any out-of-specification amplifier condition.
- Surface mount technology: Constructed with surface mount components.
- Current fold back: (Factory option) A factory option; Allows the motor current to “fold back” i.e. drop to a safe level after a pre-determined time.
- Multi-axis chassis: Up to four amplifier modules may be mounted on a single baseplate. Multi-axis baseplate includes a DC power supply, cooling fan(s) and wiring for each respective amplifier module.

### 1.2.2 Stand Alone One Axis Amplifier (SMA7115-1A-1):

The stand alone amplifier includes all of the features that the single amplifier module has, and also includes the following additional features.

- Line operated AC power operation, 110-130VAC: Fused single or three phase AC input with in-rush current protection at turn-on. No power isolation transformer is required.
- Fused regen clamp circuit (shunt regulator) with LED indicator and 50W internal load resistor bank bleeds off excess DC Buss voltage when decelerating a large load inertia. The regen clamp circuit is set to turn on at 215VDC.
- All faults can be monitored through isolated logic signals.
- Bridge rectifier(s) and filter capacitor.
- Cooling fans.

### 1.2.3 Multi-Axis Power Supply (GP8600-70):

- Power supply for 2 to 4 axis amplifier baseplates. 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. The regen clamp circuit is set to turn on at 215VDC.
- All faults can be monitored through isolated logic signals.
- Bridge rectifier(s) and filter capacitor.
- Cooling fans.

## 1.3 Specifications:

### 1.3.1 Single Amplifier Module (SMA7115-1):

The amplifier module requires 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:**

- Buss Voltage, B+: 30-220VDC.
- Output Current: Standard: 15A(continuous), 25A(peak).  
High Power: 20A(continuous), 40A(peak).

**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	±70	4,000	15,000	0-5
Tachometer input	±50	10,000	7,000	

**1.3.1.3 Digital Inputs:**

- ±Limit, Inhibit and Reset: +24V max. Terminated by 10K ohms.
- Fault (as input): +40V/-5v max. Terminated by 10K 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 selected.

**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 75mA max. through 10 ohms.
- Absolute motor current: Bipolar output. 1V=5A. 10mA max.
- LS/ECB, HS/ECB  
Overvolt, Overtemp: Open-collector outputs can sink 40mA max.

**1.3.2 Stand Alone One Axis Amplifier (SMA7115-1A-1):**

The stand alone one axis amplifier contains a single amplifier module, a DC power supply, a cooling fan, fusing and shunt regulator in a sheet metal enclosure. It has the same specifications as the single amplifier module, refer to 1.3.1, except the DC power supply and cooling fan are included. The shunt regulator within the DC power supply has a 50W internal load resistor bank which bleeds off excess DC Buss voltage when decelerating a large load inertia.

- Input Voltage: 110-130VAC (internally fused for 20A).
- Output Current: Standard: 15A (continuous), 25A (peak).  
High Power: 20A (continuous), 40A (peak).

NOTE: Customer must specify Single or Three Phase AC input when ordering (see chapter 3: model numbering), so that the proper power supply module can be installed.

### 1.3.3 Multi-Axis Power Supply (GP8600-70):

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

#### 1.3.3.1 Input and Output Power:

- Input Voltage: 95-135VAC, 50 or 60Hz.
- Fan Voltage: 110-130VAC, 50 or 60Hz, 0.12A.
- Output Voltage, (B+): 133-189 VDC.
- Output Current: 60A (continuous).

#### 1.3.4 Mechanical:

Model	L x W x H (inches)	Weight (lbs)
SMA7115-1(Single Amplifier Module)	7.12 x 1.36 x 4.79	1.28
SMA7115-1A-1 (Stand Alone Amplifier)	9.03 x 4.00 x 4.96	4.83
SMA7115-2A-2 (2-axis Amplifier System)	9.00 x 10.50 x 7.70	10.00
SMA7115-4A-4 (4-axis Amplifier System)	13.00 x 10.50 x 7.70	15.00

## 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:

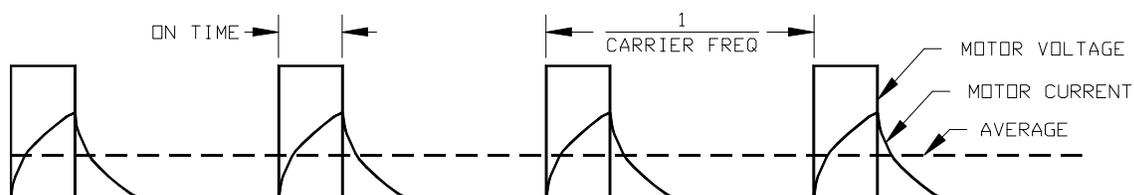
- The theory behind an amplifier driving DC servo motors.
- A comparison between brush type and brushless motors.
- Operation of output switching transistors.
- "H Type" output bridge configuration.
- Pulse-Width-Modulation (PWM).
- Current-Loop and Velocity-Loop operation.
- Protection circuits.

### 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:

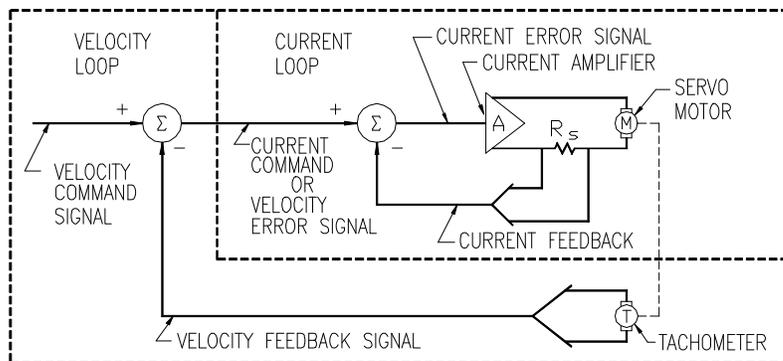
A basic velocity mode servo loop for a brush type motor is shown in figure 2.2a. An external controller commands a given velocity (RPM). The velocity loop summing amplifier compares this command with the actual motor velocity, supplied by a DC tachometer on the motor shaft, and produces an error voltage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

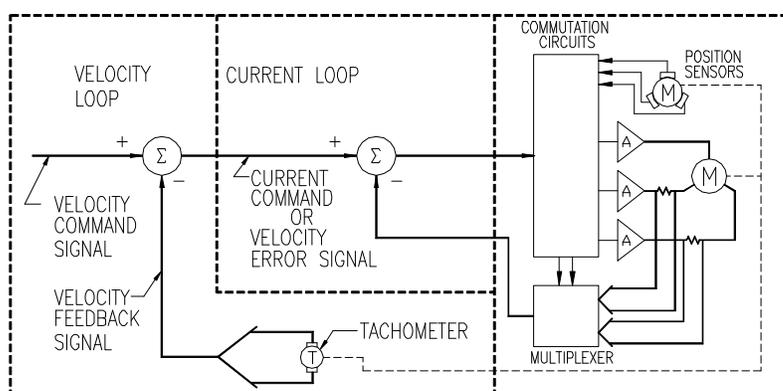
The velocity loop may be bypassed, and an external current command fed directly to the current loop. In this case,

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 servo 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 servo loop**  
**for a brushless motor**

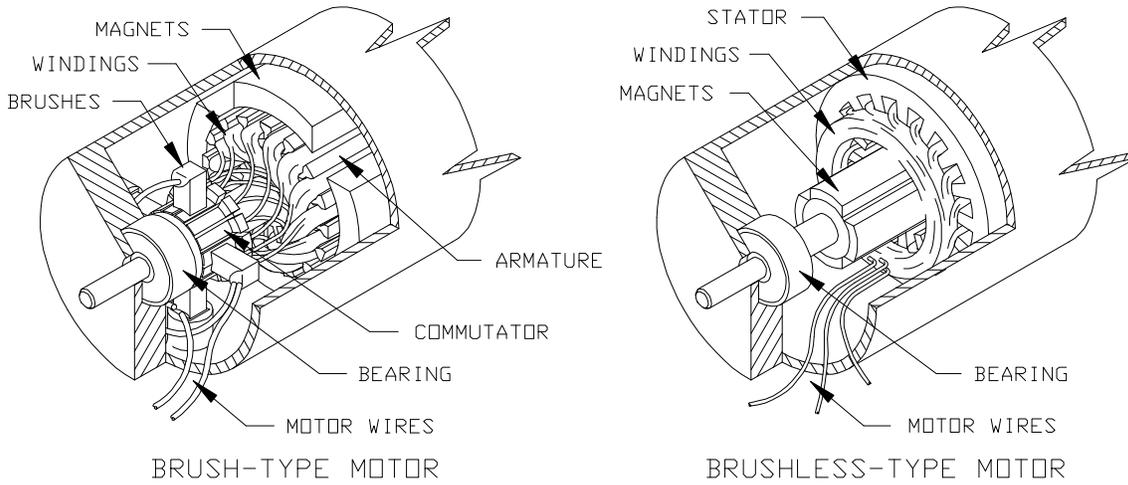
## 2.4 Brushed Motors vs. Brushless Motors:

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 2.3, 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**

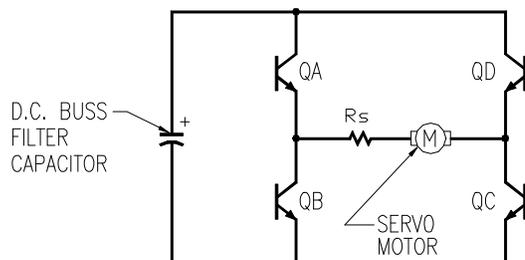
Brushless Motors/Amplifiers	Brushed Motors/Amplifiers
<p><b>Advantages</b></p> <p>No scheduled maintenance and no brush dust is generated.</p> <p>Higher RPM limits.</p> <p>Lower inertia/torque ratio.</p> <p>Dissipates heat more efficiently due to windings being located in stator.</p> <p>Safer for explosive atmospheres. Quieter and less electrical noise generated.</p>	<p><b>Disadvantages</b></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><b>Disadvantages</b></p> <p>Amplifiers are complicated and expensive.</p> <p>Higher torque ripple.</p> <p>No Industry standard packaging.</p>	<p><b>Advantages</b></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 2.4 for schematic representation of an output bridge with a motor connected).



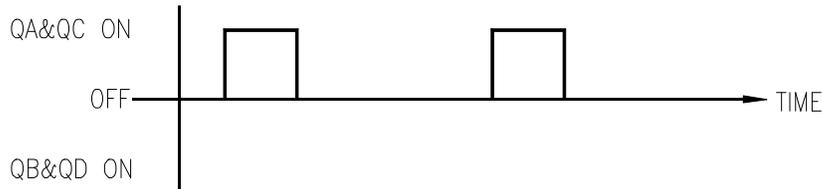
**Figure 2.4**  
**Schematic representation of an output bridge with a motor connected.**

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.

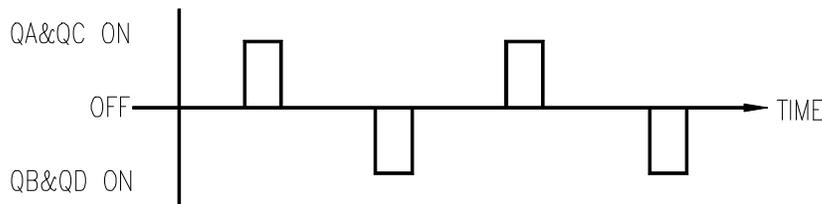
### 2.7 Pulse-Width-Modulation (PWM):

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 2.5. Note that since the pulse widths are equal, the net DC current in the motor is equal to zero.



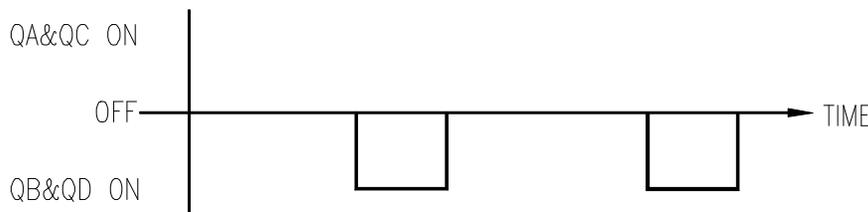
**Figure 2.6A**  
**Transistor switching**  
**waveform when current**  
**flows from A through C**

When a non-zero current is commanded to the current loop, the transistor switching waveform is as shown in figure 2.6A. 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 2.5**  
**Transistor switching**  
**waveform at zero**  
**current**

If the input to the current loop had been changed in polarity, the output transistor switching waveform would be as shown in figure 2.6B.



**Figure 2.6B**  
**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 2.2A 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 2.2A) 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 2.2A 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:**

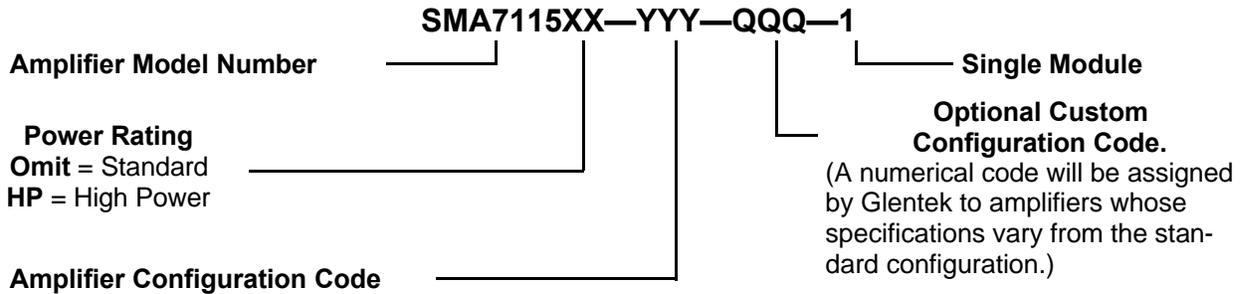
The High and Low Speed Electronic Circuit Breakers (HS/ECB and LS/ECB) protect the amplifier and motor from being damaged by high motor current (specified max. peak and rms current values). The Over Temperature and Over Voltage detection circuits will shut off the amplifier when the temperature of the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

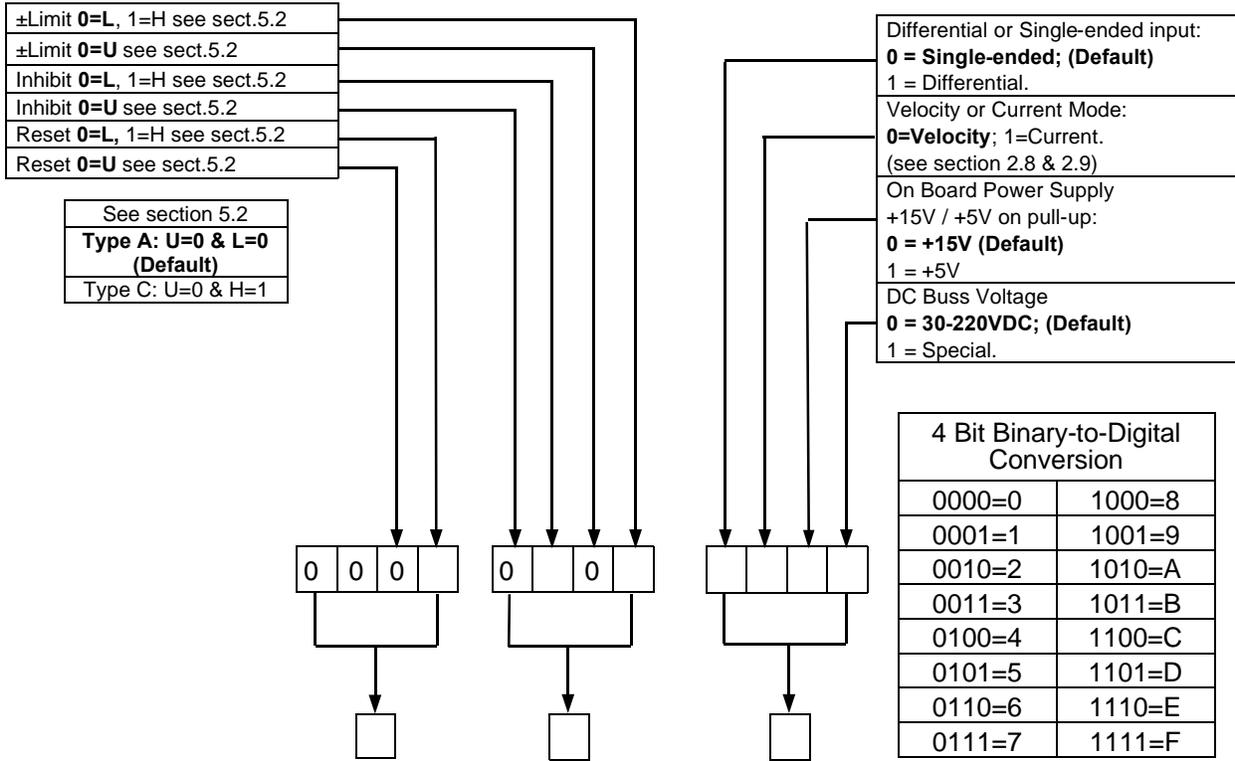
## 3.1 Introduction:

This chapter contains the model numbering system for the SMA7115 single amplifier module, stand alone one axis amplifier 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 quickly and as accurate as possible.

## 3.2 Single Amplifier Module:



## Amplifier Configuration Code



### 3.3 Stand Alone One Axis Amplifier:

SMA7115XX - YYY - QQQ - 1A - 1 - ZZ - RRR

Amplifier Model Number

Power Rating  
Omit = Standard  
HP = High Power

Amplifier Configuration Code

Optional Custom Configuration Code for the amplifier module

Stand alone amplifier designator

1 amplifier module mounted

Optional Custom Configuration Code for the Power Supply and Regen Circuit

Power Supply Configuration Code

00 = 110-130VAC, Single Phase  
01 = 110-130VAC, Three Phase  
02 = Special

### 3.4 Multi-Axis Amplifier:

SMA7\_15XX - 7\_15XX/ - A - - ZZ - RRR

Type of Amplifier Model

Power Rating  
Omit = Standard  
HP = High Power

Pre-amp & Custom Configuration Code (See sect. 3.2)

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.

Optional Custom Configuration Code for the Power Supply and Regen Circuit

Power Supply Configuration Code

00 = 110-130VAC  
01 = 208-240VAC  
02 = Special

The total number of amplifier modules mounted on the baseplate

Maximum number of amplifier modules the baseplate will hold.

2 = 2 axis baseplate  
4 = 4 axis baseplate

**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 the 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 each 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: 14AWG, shielded - Standard Version.  
12AWG, shielded - High Power Version.
- Motor Case Ground: Same as motor wires, or use metallic conduit.
- Main Power: 14AWG (single axis) or 12AWG (multi-axis), twisted.
- Fan Power: 16AWG, 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 right angle AUGAT terminal block mounted as its 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 all the mentioned connectors are listed as follows:

- AUGAT<sup>®</sup> RDI 6 Series Tri-Barrier Terminal Blocks(AUGAT P/N: 6PCR-04) - **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: 04 (4 screw positions).
  - Terminal lugs: Thomas & Betts (T&B P/N: A116 for 18awg wire, B19 for 14awg wire and C133 for 12/10awg wire).
- AUGAT<sup>®</sup> RDI 6 Series Tri-Barrier Terminal Blocks(AUGAT P/N: 6PCV-04):
  - Screw Size/Spacing: 6 (#6-32 on .375" centers).
  - Terminal Style: PC (Printed Circuit Pin).
  - Terminal Orientation: V (Vertical Angle).
  - Number of Screw Terminals: 04 (4 screw positions).
  - Terminal lugs: Thomas & Betts (T&B P/N: A116 for 18awg wire, B19 for 14awg wire and C133 for 12/10awg wire).
- PHOENIX CONTACT, *COMBICON Headers and Plugs* with 7.62mm pitch (HEADER PART# GMSTBA 2,5/4-G-7,62), (PLUG PART# GMVSTBR 2,5/4-ST-7,62):
  - header with side panels, plug-in direction parallel to PCB.
  - 4 positions.
  - color: green.

#### 4.3.3.2 The Signal Connector - J1:

The signal connector is supported by the molex<sup>®</sup> KK .100" (2,54mm) Centerline Connector System.

- Mating Header: molex<sup>®</sup> 7478 Series Right Angle Square Pin Friction Lock Header (molex P/N: 22-12-2164):
  - 16 pins.
  - .025" (0,64mm) right angle square brass pins.
  - 94V-0 nylon housing.
- Mating Connector: molex<sup>®</sup> 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<sup>®</sup> *Crimp Terminals* (molex P/N: 08-55-0102):
  - 15 microinch select gold plated.
  - brass.

#### 4.3.3.3 The Power and Motor Connectors of the Stand Alone Amplifier - TB1 & 2:

- PHOENIX CONTACT, *COMBICON Headers and Plugs* with 7.62mm pitch (Header P/N: GMSTBA 2,5/4-G-7,62, Plug P/N: GMVSTBW 2,5/4-ST-7,62), (Header P/N: GMSTBA 2,5/2-G-7,62, Plug P/N: GMVSTBR 2,5/4-ST-7,62):
  - header with side panels, plug-in direction parallel to PCB.
  - 2 and 4 positions.
  - color: green.

#### 4.3.4 Amplifier Module Connections:

##### 4.3.4.1 The Power Connections - TB1:

Signal Name	Terminal	Notes
BUS RETURN, B-	TB1-1	DC Buss -
BUSS, B+	TB1-2	DC Buss +
MOTOR -	TB1-3	Motor -
MOTOR +	TB1-4	Motor +

**4.3.4.2 The Signal Connections - J1:**

Signal Name	Terminal	Notes
DIFF SIG IN (+)	J1-1	Differential signal input.
DIFF SIG RET (-)	J1-2	Differential signal return.
SIG IN (+)	J1-3	Single-ended signal input.
COMMON	J1-4	Common for all signals and shields.
TACH IN	J1-5	Tachometer input. Not used in current-mode.
MTR CUR	J1-6	Scale factor: 1V=5A.
LIMIT +	J1-7	Inhibits the motor in the + direction.
LIMIT -	J1-8	Inhibits the motor in the - direction.
INHIBIT	J1-9	Inhibits the motor in both directions.
FAULT	J1-10	Goes low if there is a fault in the amplifier. May be externally forced low to stop motor rotation in both
COMMON	J1-11	Common for all signals and shields.
RESET	J1-12	Resets the fault latch. May also be used as an inhibit input.
LS/ECB	J1-13	Goes high if the Low Speed Electronic Circuit Breaker turns on.
HS/ECB	J1-14	Goes high if the High-Speed Electronic Circuit Breaker turns on.
OVERVOLT	J1-15	Goes high if the buss voltage rises above 250VDC.
OVERTEMP	J1-16	Goes high if the temperature of the amplifier rises above the specified temp.

**4.3.5 Stand Alone One Axis Power Connections:**

Signal Name	Terminal	Notes
GND	TB2-1	Ground.
AC (OMIT FOR SINGLE PHASE)	TB2-2	110-130VAC power input.
AC	TB2-3	110-130VAC power input.
AC	TB2-4	110-130VAC power input.

**4.3.6 Multi-Axis Chassis Power Connections:**

Main Voltage: Connect 95-135VAC line input, single or three phase at TB1 (see Power Supply Sub-assembly drawing 8600-7030).

Fan Voltage: Connect 110-130VAC, 50/60Hz for fans to TB1-5 and TB1-6.

## 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 changes to the jumpers (micro-shunts) 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 four logic inputs: Limit +, Limit -, Inhibit and Reset In. They may be configured for active-high or active-low signals, and all are pulled-up termination (type A or C). All 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 "C": Requires grounding of input to enable the amplifier (pull-up, active-high).

The following table shows how to configure the jumpers (micro-shunts) for the inputs selected. The standard configuration is shown in bold.

	Type A	Type C
LIMIT ±	<b>J8-A = Install Jumper</b>	J8-A = Omit Jumper
INHIBIT	<b>J8-B = Install Jumper</b>	J8-B = Omit Jumper
RESET IN	<b>J8-C = Install Jumper</b>	J8-C = Omit Jumper

#### 5.2.1 +15V/+5V Logic Level Configuration (Default: J9 = Omit Jumper):

- +15V: J9 = Omit Jumper.
- +5V: J9 = Install Jumper.

#### 5.2.2 Velocity Mode and Current Mode Configuration:

- Velocity Mode: J4 = Install Jumper, J5 = Omit Jumper.
- Current Mode: J4 = Omit Jumper, J5 = Install Jumper.

#### 5.2.3 Integrator Configuration (Default: J6 = Omit Jumper):

The integrator circuit is used to lower the integration proportional break point in the velocity PID loop. The lower break point may be required with motors having high inductance armatures. This jumper should remain omitted unless instructed to install by a Glentek engineer.

#### 5.2.4 Stop Function (Default: J8-D = Omit Jumper):

If the stop function is enabled (jumper installed), when the amplifier is inhibited at J1-9, the amplifier will actively decelerate the motor for 150 ms, then all current output from the amplifier will cease until the inhibit is de-activated. This function only works when the amplifier is in velocity mode (see above). If the stop function is disabled (jumper omitted), when the amplifier is inhibited, all amplifier current output immediately ceases.

## Chapter Six: Start Up and Calibration

### 6.1 Introduction:

This chapter contains the procedure required for initial start up and amplifier calibration. The SMA7115 amplifier 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. 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.
3. Disconnect the signal and/or auxiliary inputs.
4. Be sure the Loop-Gain pot(s) are fully CCW.
5. Apply main power. Check for the correct AC voltage at power supply TB1. The DC Bus (amplifier supply-voltage) will be 1.4 times this value.
6. Work on only one amplifier 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 required 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: RV7-RV11 are single turn pots and RV1-RV6 are 20-turn pots.)

Note: RV8-RV11 are factory set and should not be adjusted. Adjusting these pots voids warranty.

Pots	Name of Pot	Notes
RV1	Differential Gain, <b>DIFF GAIN</b>	Sets the input voltage to velocity ratio for differential signal input.
RV2	Signal Gain, <b>SIG GAIN</b>	Sets the input voltage to velocity ratio for single-ended signal input.
RV3	Balance, <b>BAL</b>	Used to null any offsets in system.
RV4	Tach. Gain, <b>TACH</b>	Sets the DC tachometer gain.
RV5	Compensation, <b>COMP</b>	Used in conjunction with tach. gain to set the system bandwidth.
RV6	Current Limit, <b>CUR LIMIT</b>	Sets the maximum peak motor current. Shipped set CW (max. current).
RV7	<b>LOOP GAIN</b>	Used to shut off uncalibrated amplifiers. When the loop gain is full CCW, no current is delivered to the motor.

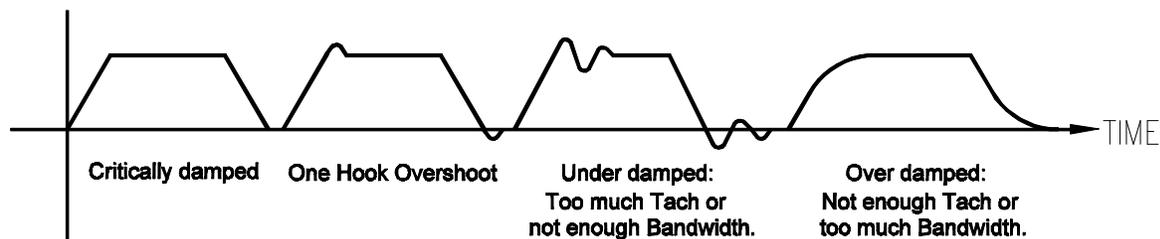
**PROCEDURE:**

1. Apply the main power and fan power.
2. Slowly turn the Loop Gain pot (RV7) CW. The motor should be stopped or turning slowly. If the motor starts running away, remove the power, reverse the tach leads, and retest.
3. Set the Balance pot (RV3) for zero motor rotation.
4. Connect an oscilloscope to J1-6 (MTR I) and a battery box to J1-3 (J1-4 is common for both). The voltage on J1-6 is a function of motor current: 1V=5A. While applying a step input voltage, adjust the Current Limit pot (RV6) for the 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 (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 (RV4) fully CW (up to 20 turns).

5. Connect an oscilloscope to J1-5 (TACH IN) and J1-4, common. Set the battery box for a DC signal output to obtain approximately 400RPM. The RPM may be set by measuring the tach voltage at J1-5, 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 (RV5) 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 (CCW) the Tach Gain pot (RV4) 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 J1-3 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 the battery box for a known DC voltage. Adjust the Signal Gain pot (RV2) or (RV1 for differential input) to obtain the desired motor velocity.
11. If the motor is rotating in the wrong direction for a given input polarity, remove 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: RV7-RV11 are single turn pots and RV1-RV6 are 20-turn pots.)

Note: RV8—RV11 are factory set and should not be adjusted. Adjusting these pots voids warranty.

Pots	Name of Pot	Notes
RV1	Differential Gain, <b>DIFF GAIN</b>	Sets the input voltage to current ratio for differential signal input.
RV2	Signal Gain, <b>SIG GAIN</b>	Sets the input voltage to current ratio for single-ended signal input.
RV3	Balance, <b>BAL</b>	Used to null any offsets in system.
RV6	Current Limit, <b>CUR LIMIT</b>	Sets the maximum peak motor current. Shipped set at full CW (Max. current).
RV7	<b>LOOP GAIN</b>	Used to shut off uncalibrated amplifiers. When the loop gain is full CCW, no current is delivered to the motor.

### PROCEDURE:

1. Apply the main power and fan power.
2. Slowly turn the Loop Gain pot (RV7) CW. The motor should be stopped or turning slowly. Set the Balance pot (RV3) for zero motor rotation.
3. Connect an oscilloscope to J1-6 (MTR CUR) and a battery box to J1-3 (J1-4 is common for both). The voltage on J1-6 is a function of motor current:  $1V=5A$ . While applying a step input voltage, adjust the Current Limit pot (RV6) 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 (RV2) for single-ended input or Differential Gain pot (RV1) for differential input.
4. 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 the battery box for a known DC voltage. Apply  $\pm$  input signal pulses and adjust the Signal Gain pot (RV2) or (RV1 for differential input) 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 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 3 in the calibration procedure.

Pot/Dip-Switches	AMP1	AMP2	AMP3	AMP4
Differential Gain pot wiper J2-1 to common (ohms):				
Signal Gain pot wiper J2-2 to common (ohms):				
Tach Gain pot wiper J2-3 to common (ohms):				
IR Compensation pot wiper J2-4 to common (ohms):				
Compensation pot wiper J2-5 to common (ohms):				
Current Limit pot wiper J2-6 to common (ohms):				
Foldback Current Limit pot wiper J2-7 to common (ohms):				

Date data taken:    /    /

Serial number S/N: \_\_\_\_\_

Model number:    SMA7115\_\_\_\_\_

Note: Tach voltage is measured at J1-5. Common for all measurements is at J1-11.

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 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	RED LED FLASHES	GREEN LED	FAULT OUTPUT
NORMAL OPERATION	OFF	ON	PULL-UP
CURRENT FOLBACK	ON	ON	PULL-UP
OVER TEMP (LATCHED)	ONCE	OFF	LOW
+/- LIMITS	TWICE	ON	PULL-UP
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
AMPLIFIER INHIBIT	OFF	OFF	LOW

#### 7.2.2 Under Voltage Fault:

When the +15VDC power supply 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:
- Main AC line voltage is too low.
- Bad rectifier bridge.
- Bad DC buss filter capacitor.

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

When the peak output of the amplifier exceeds 80A for 10 microseconds, 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:

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

#### **7.2.4 Low Speed Electronic Circuit Breaker (LS/ECB) Fault:**

When the RMS output of the amplifier exceeds 15A for standard or 20A for high power 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:

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

#### **7.2.5 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 OVER TEMP LED is latched on, 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.

#### **7.2.6 Over Voltage Fault:**

When the DC Buss voltage reaches 250VDC, the Run LED will turn off, the Overvoltage 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:

- Main AC line voltage is too high.
- 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.

#### **7.2.7 Resetting A Fault:**

The fault latch may be reset by pushing the Reset button, activating the Reset input J1-12 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 A will enable a skilled technician to troubleshoot an amplifier to even lower levels. The modular construction of the amplifier allows for fast and easy repair.

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

- Fuses In the power supply.
- 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 24-48hr. repair service in the unlikely event that your system is down and you do not have a replacement amplifier module.

### **7.5 Warranty:**

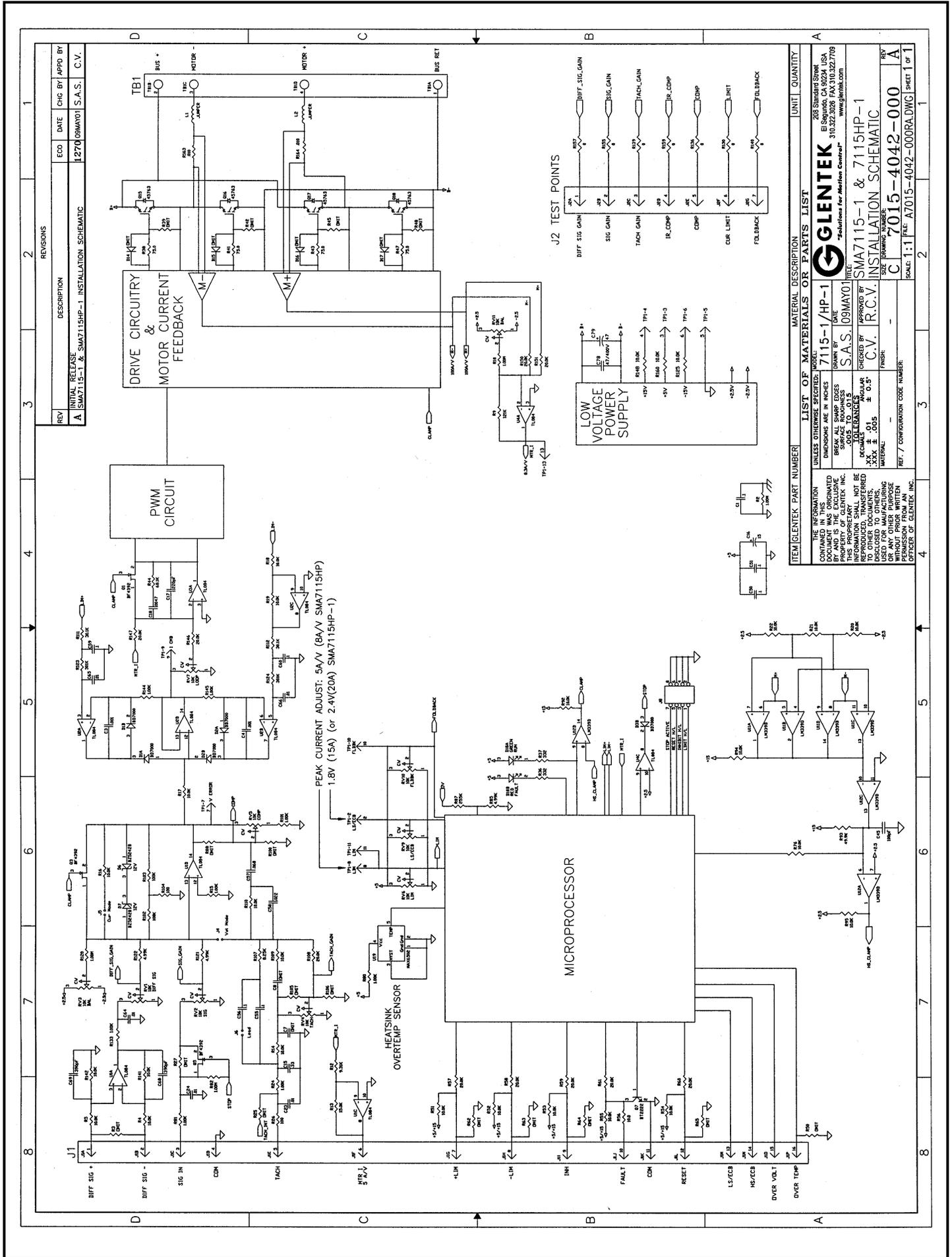
Any product, or part thereof, manufactured by Glentek, Inc., described in this manual, which, under normal operating conditions in the plant of the original purchaser thereof, proves defective in material or workmanship within one year from the date of shipment by us, as determined by an inspection by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

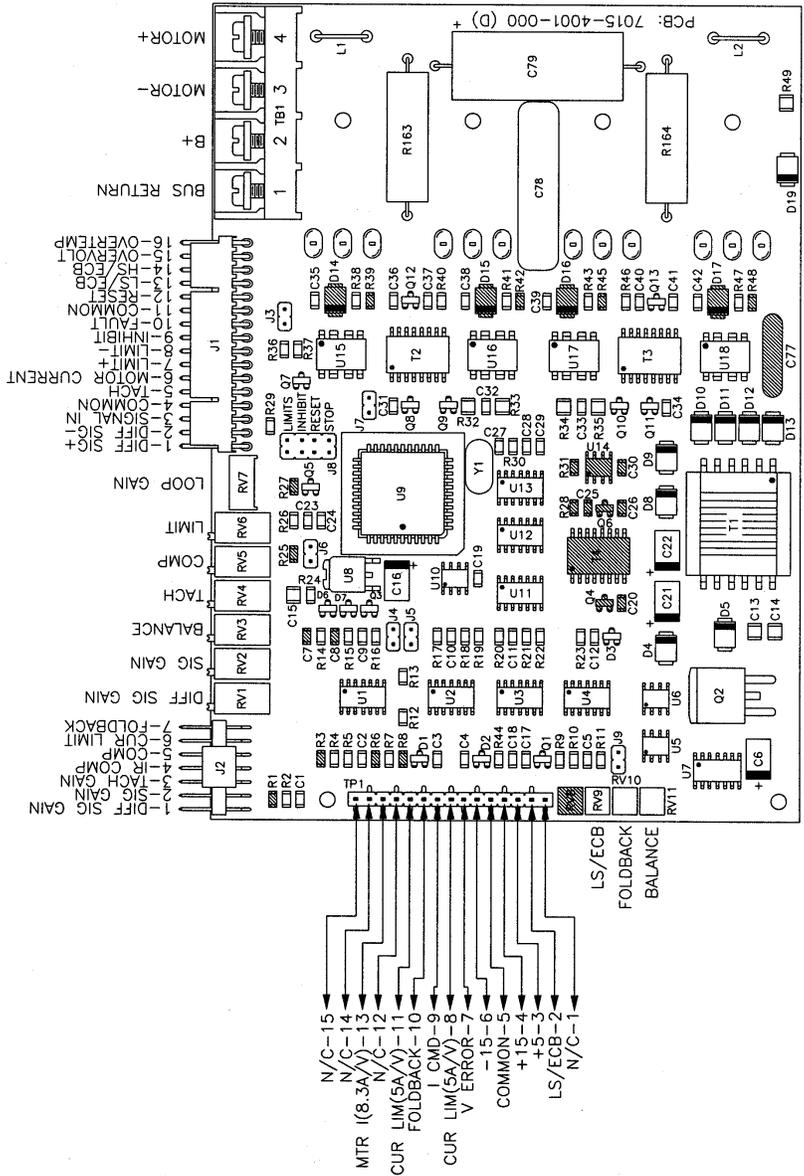


REV	INITIAL RELEASE	DESCRIPTION	ECO	DATE	CHG BY	APPD BY
A	SMA7115-1 & SMA7115HP-1	INSTALLATION SCHEMATIC		1270 (09MAY01)	S.A.S.	C.V.

ITEM	QLENTEK PART NUMBER	MATERIAL DESCRIPTION	UNIT	QUANTITY
LIST OF MATERIALS OR PARTS LIST				
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES. BREAK ALL SHARP EDGES TO .005. TOLERANCES: .XX ± .01, .XXX ± .005. MATERIAL: REF. 7 CONFIGURATION CODE NUMBER.				
THE INFORMATION CONTAINED HEREIN IS UNCLASSIFIED EXCEPT WHERE SHOWN OTHERWISE AND IS THE EXCLUSIVE PROPERTY OF QLENTEK INC. THIS INFORMATION SHALL NOT BE DISCLOSED TO OTHERS WITHOUT PRIOR WRITTEN PERMISSION OF AN OFFICER OF QLENTEK INC.				
MODEL: 7115-1/HP-1				
DRAWN BY: S.A.S. (09MAY01)				
DATE: 09MAY01				
CHECKED BY: C.V.				
APPROVED BY: S.A.S.				
TITLE: SMA7115-1 & 7115HP-1 INSTALLATION SCHEMATIC				
SCALE: 1:1				
REF: A7015-4042-000RA.DWG				
SHEET 1 OF 1				



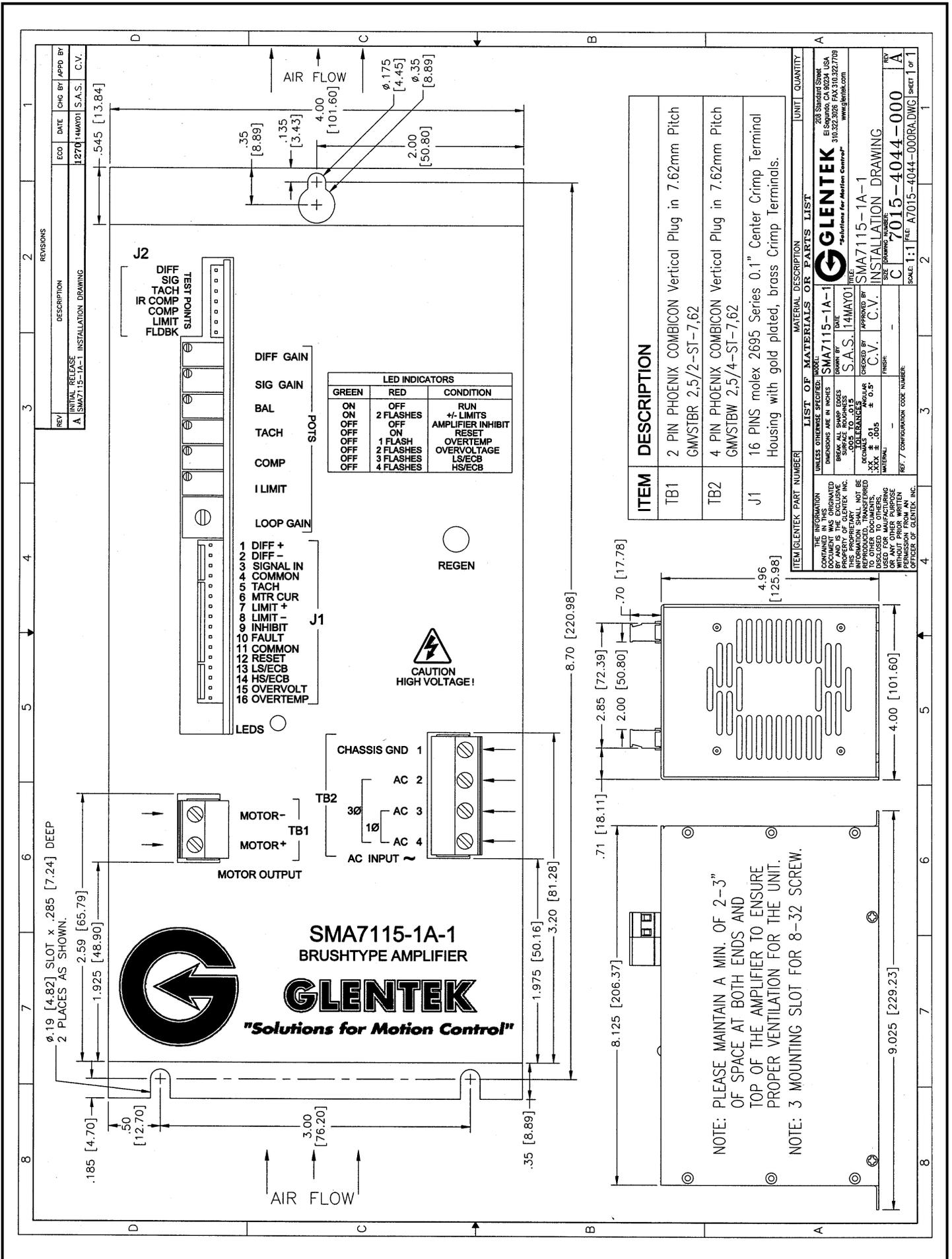
REV	INITIAL RELEASE	DESCRIPTION	DATE	CHK BY	APPD BY
A	SMA7115-1	INSTALLATION DRAWING	11MAY01	S.A.S.	C.V.



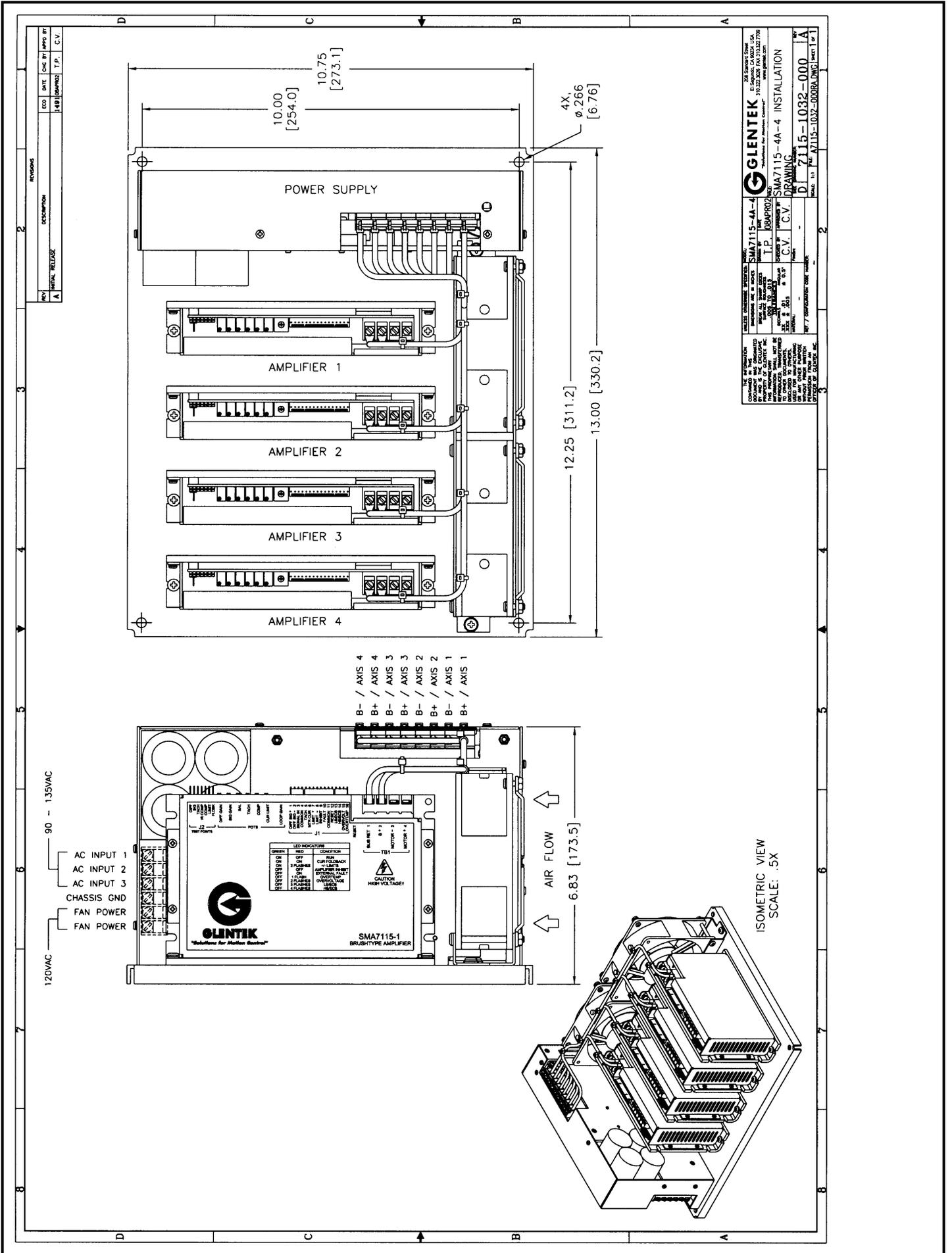
TOP VIEW

ITEM	GLENTEK PART NUMBER	MATERIAL DESCRIPTION	UNIT	QUANTITY
<p>UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. BREAK ALL SHARP EDGES. SIZE DECIMALS TO FOLLOW. TOLERANCES: DIMENSIONS ±0.05, ANGLES ±0.5, FINISH: -</p>				
<p>THE INFORMATION CONTAINED IN THIS DRAWING IS THE PROPERTY OF GLENTEK INC. INFORMATION SHALL NOT BE DISCLOSED TO OTHERS, IN ANY MANNER, WITHOUT PRIOR WRITTEN PERMISSION OF GLENTEK INC.</p>				
<p>LIST OF MATERIALS OR PARTS LIST</p>				
<p>MODEL: SMA7115-1</p>		<p>208 Standard Street El Segundo, CA 90234 USA 310.322.3026 FAX 310.322.7709 www.glenetek.com</p>		
<p>DATE: 11MAY01</p>		<p>DRAWN BY: S.A.S.</p>		
<p>CREATED BY: C.V.</p>		<p>APPROVED BY: S.M.A.7.1.15-1</p>		
<p>TITLE: INSTALLATION DRAWING</p>		<p>SIZE: A</p>		
<p>SCALE: 1:1</p>		<p>REV: A</p>		
<p>REF: 7015-4043-000</p>		<p>FILE: A7015-4043-000RApp2</p>		
<p>SHEET 2 OF 2</p>		<p>SHEET 2 OF 2</p>		

- NOTES:
1. HATCHED COMPONENTS ARE OMITTED.
  2. DO NOT ADJUST RV9, RV10 & RV11 WITHOUT CONSULTING GLENTEK FACTORY.







## Appendix C

### POWER SUPPLY



## **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.

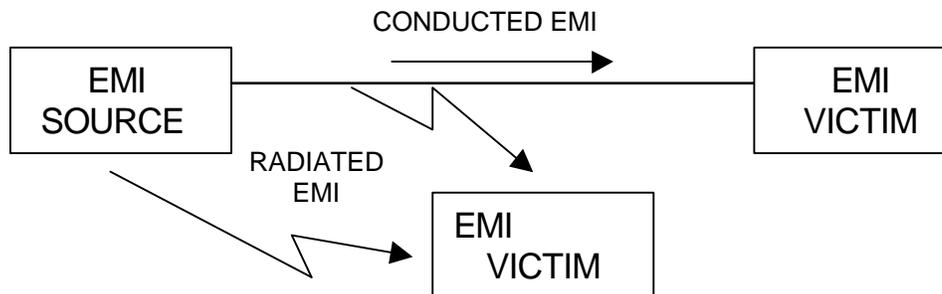


Figure 1- EMI Source-Victim Model

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 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.

- 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.

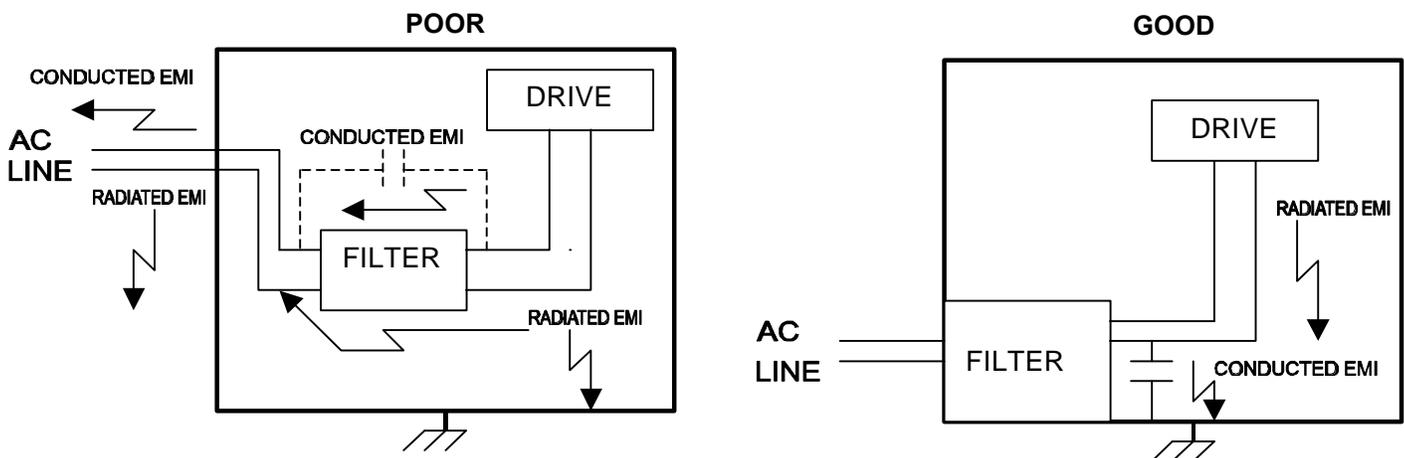


Figure 2- AC Line Filter Installation

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.

	<p><b>WARNING</b></p> <p><b>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.</b></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 SMA7115**

**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	Class A
	And Medical (ISM) RF Equipment	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):	SMA7115, SMA7115HP. The above amplifier modules packaged in the following configurations: -1, -1A-1, -2A-1, -2A-2, -4A-4, -6A-5, -6A-6, -3U-1 and all power supply configurations: 00, 01, 02.

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

## **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#: 7015-4040-000  
REVISION: (A)  
DATE: 14 May 2002

208 Standard Street, El Segundo, California 90245, USA.  
Telephone: (310)322-3026; Fax: (310)322-7709  
www.glentek.com e-mail sales@glentek.com

