OPERATOR'S MANUAL
FOR THE
8020-QS/6020-QS
SERVO AMPLIFIER

PN: EDA101

Patent No. 4,554,512

AEROTECH®

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DISCLAIMER:

The information contained in this manual is subject to change due to improvement in design.

Though this document has been checked for inaccuracies, Aerotech does not assume responsibility for any errors contained herein.

Table of Contents

CHAPTER 1: INTRODUCTION

This manual provides information on the installation, set up and operation of the 8020-QS/6020-QS servo amplifier.

Included in this manual is information on the set-up and adjustment of the 8020-QS/6020-QS servo amplifier, as well as information on wiring this amplifier into a system.

One-line diagrams describing the operational characteristics of the servo amplifier are also included. More detailed information, such as Theory of Operation, is included in supplemental literature, which is readily obtained upon request (see chapter 5, Service and Repair).

A description of the general operational characteristics of the amplifier is given in chapter 2, General Description. This chapter contains indentification and electrical specifications.

A detailed description of the installation and set-up of the amplifier is given in chapter 3, Installation and Start-up.

Information on field troubleshooting and general repair is presented in chapter 4, Troubleshooting and chapter 5, Service and Repair, respectively.

CHAPTER 2: DESCRIPTIONS & SPECIFICATIONS

The 8020-QS is a 80 VDC (and the 6020-QS is a 60 VDC), 20 amp peak, 10 amp continuous servo amplifier, exhibiting a very high gain transconductance. It is intended primarily to drive a permanent magnet (PM) DC motor. Typically, a servo amplifier is used with a motor and a tachometer in a velocity loop configuration (refer to figure 2- 1). Here a velocity input command, a voltage between ±10V, is summed with the tachometer output (negative-feedback-phased) to produce a net voltage input to the servo amplifier; the module provides an output current to the motor, which is proportional to the net input. For user convenience, separate input terminals and individual scale (gain) controls are provided for both command and tachometer voltages. Summation takes place within the module itself.

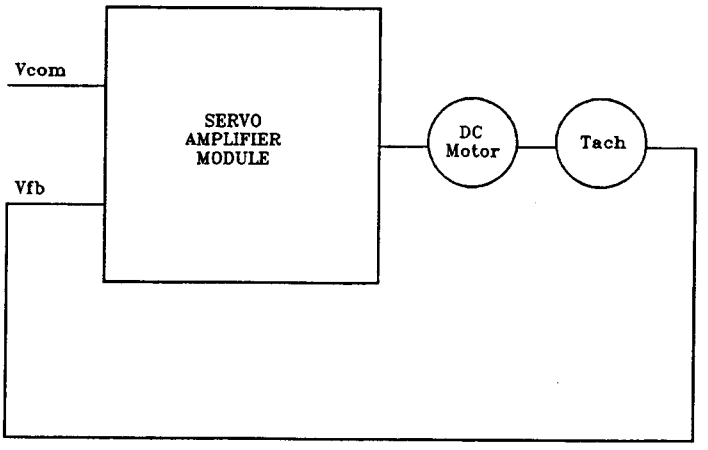


Figure 2-1: Velocity Loop Configuration

The amplifier obtains its high transconductance (ie., voltage in gives current out) through a pre-amplifier/ post-amplifier arrangement, wherein the pre-amplifier supplies a voltage gain of 2000 V/V and the post-amplifier supplies a transconductance of 3.3 amps per volt (A/V). The pre-amplifier is an operational-amplifier based gain block which provides customer adjustable compensation. The post-amplifier is a pulse-width-modulated voltage amplifier contained within a current feedback loop configuration, internal to the amplifier. No customer adjustment of the post-amplifier is required. For the 8020-QS/6020-QS amplifier, the overall transconductance is approximately 6600 A/V. To further explain the arrangement shown in figure 2-1, any difference in magnitude between the scaled input command and the scaled negative-feedback tachometer output results in a proportional current into the motor. This current accelerates or decelerates the motor until the motor speed matches the (scaled) input command. Since the module has a current output proportional to speed error (rather than a voltage output), developed motor torque, and therefore acceleration, are likewise proportional to speed error (independent of back emf, resistance and inductance within the motor). This gives a higher degree of accuracy to the user.

To protect the motor, maximum current to the motor is controlled through self-contained, isolated current feedback clamp circuits. A current trip (shutdown) circuit is activated if the motor current instantaneously exceeds a safe operating level. These current feedback clamp circuits are as follows:

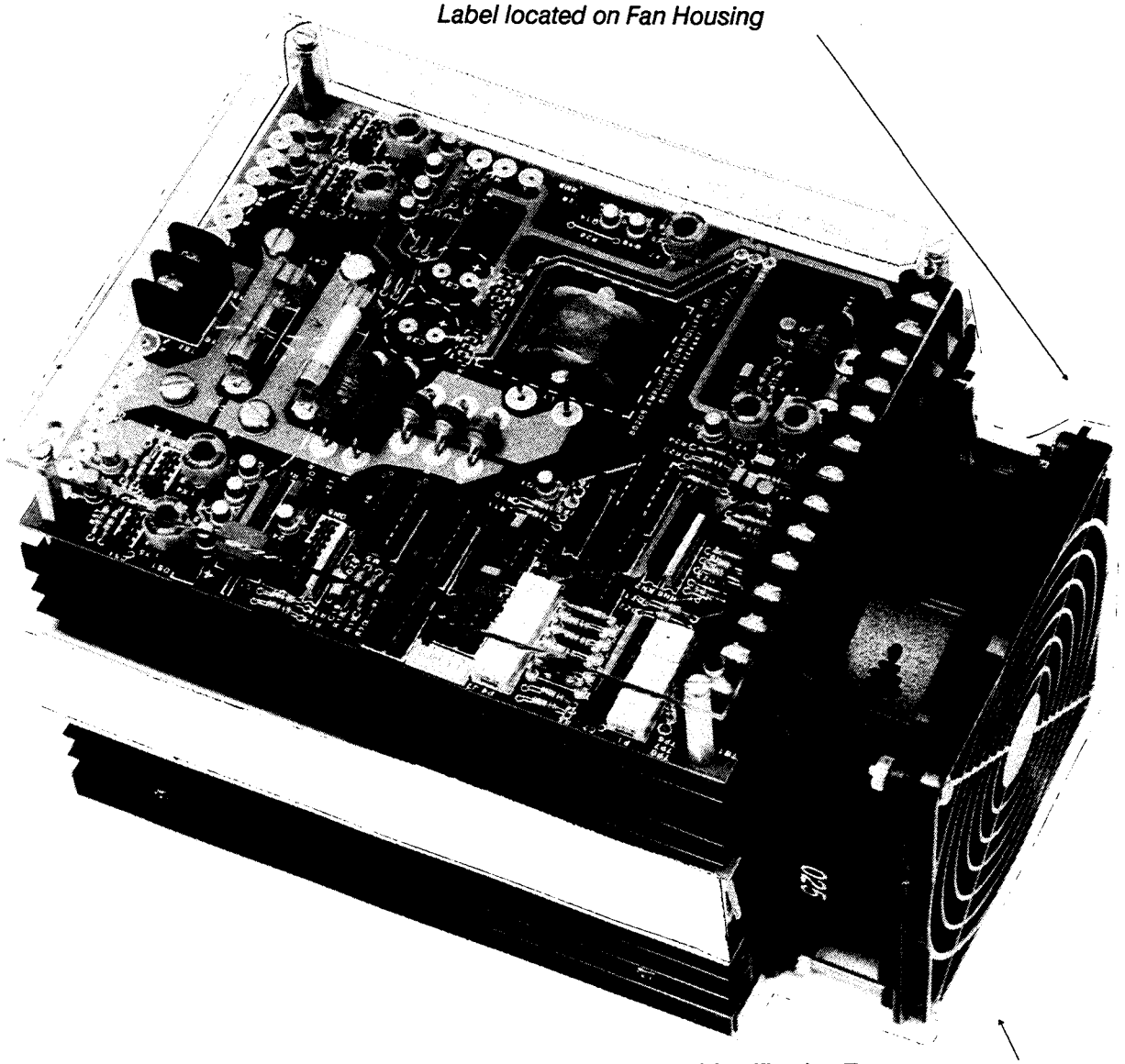
- The Current Limit Circuit clamps the command signal (the output of the pre-amplifier) at a certain level, either positive or negative. This clamping level is adjustable through the Current Limit Pot.

- Limit Switch Input Connections (discussed later) allow the user to limit current output directionally (ie., separate control of clamps on + or - output current flow).

IMPORTANT: NOTE INPUT VOLTAGE RATING (see table 2-1)

Volts	AC-DC	Amps	Hertz
115	AC	7A	60
220 or 240	AC	4A	50/60

Label located on Fan Housing



Identification Tag on Fan Housing

Figure 2-2: Module Identification Locations

SECTION 2-1 MODULE IDENTIFICATION

Figure 2-2 shows the label location for identification of the servo amplifier. This label is located on the side of the fan.

SECTION 2-2 ELECTRICAL SPECIFICATIONS

Electrical specifications for the amplifier are shown in table 2-1. These specifications are divided into two headings: *Power* and *Control.*

Table 2-1: Electrical Specifications for Servo Amplifier

ELECTRICAL SPECIFICATIONS FOR SERVO AMPLIFIER MODULE (Table 2-1)

POWER	
	8020-QS/6020-QS
Power output current	
Amps (max)	20
Continuous output current	
Amps (max)	10
AC input voltages (VAC)	
Maximum	135 or 270
Minimum	85 or 185
Nominal	115 or 220/240
Output power (see note 1)	
Watts (max)	
Peak	1400 (8020-QS), 1050 (6020-QS)
Continuous	700 (8020-QS), 525 (6020-QS)
Load inductance (see note 1)	
mH (min)	2

Switching frequency kHz, ±10% (Nominal)	20
Operating temperature °C	0 to 50
Storage temperature °C	-30 to 85

CONTROL

Current Loop (Power Amplifier)

Current feedback (current monitor) gain Amps/volt	3.33
Current command gain Amps/volt	3.33
Current limit adjustment range Amps	0 to 20
Short circuit current trip level (manual reset) Amps	25
Power amplifier bandwidth kHz (nominal)	1.0
±12 VDC external connection current draw mA, DC	30
±12 VDC power supply shut-down and inhibit (also, power stage inhibit)	Activated if the input line voltage at terminals TB2, 15 and 16 drops below 85 VAC

Table 2-1: Continued

Rate Loop (Pre-Amplifier)

Voltage gain	
Open Loop, dB	100
Tach feedback signal (see note 2)	
Volts (nominal)	10 to 20
Speed command signal (see note 2)	
Volts (nominal)	10
Tach feedback signal	
Input impedance (input 3)	
Kohms (min)	9.5
Speed command Signal	
Input impedance (input 1)	
Kohms (min)	6.5
Speed command input signal	
Offset null adjustment	
±mV (max)	15
Pre-amplifier output drift	
mV/C° (nominal)	10
Pre-amplifier bandwidth (see note 3)	
Hz (nominal)	100

NOTES:

(1) Data relative to nominal loaded DC bus voltage of 70 VDC (8020-QS) or 52 VDC (6020-QS).

(2) Tach and speed signal levels can be accepted up to ±60 volts with changes in pre-amplifier compensation (see figure 2-5).

(3) Measurements taken with Aerotech Model 1135 motors.

Table 2-1: Continued

SECTION 2-3 DESCRIPTION OF COMPONENTS

Location of fuses, potentiometers, test points and other components for the 8020-QS/6020-QS servo amplifier that are of concern to the user, are identified in figure 2-3. Figure 2-4 illustrates a diagram of the power circuitry contained in the servo module.

General descriptions of the components illustrated in figures 2-3 and 2-4 are provided in table 2-2 and figure 2-5.

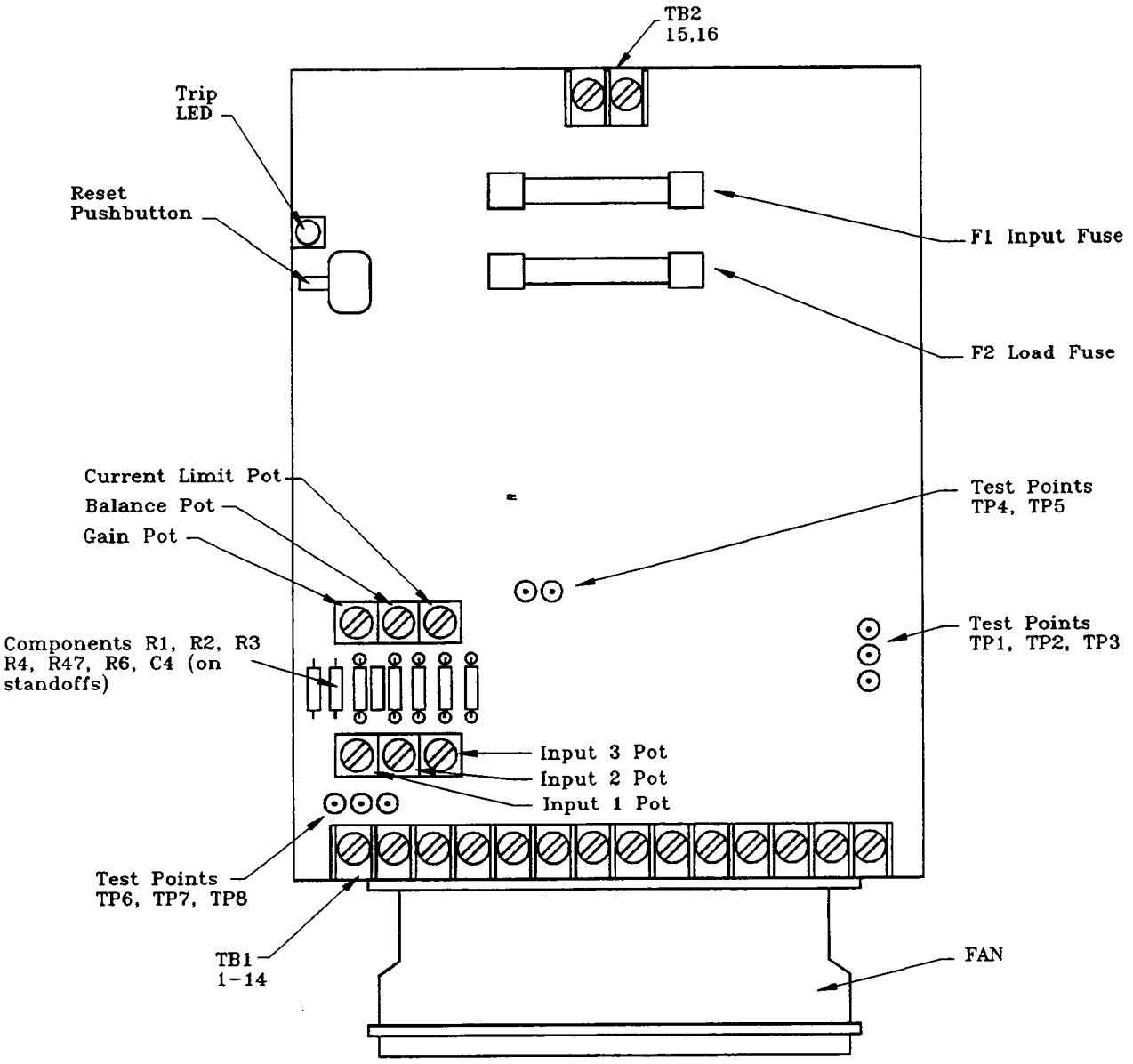


Figure 2-3: Top View of 8020-QS/6020-QS Servo Amplifier

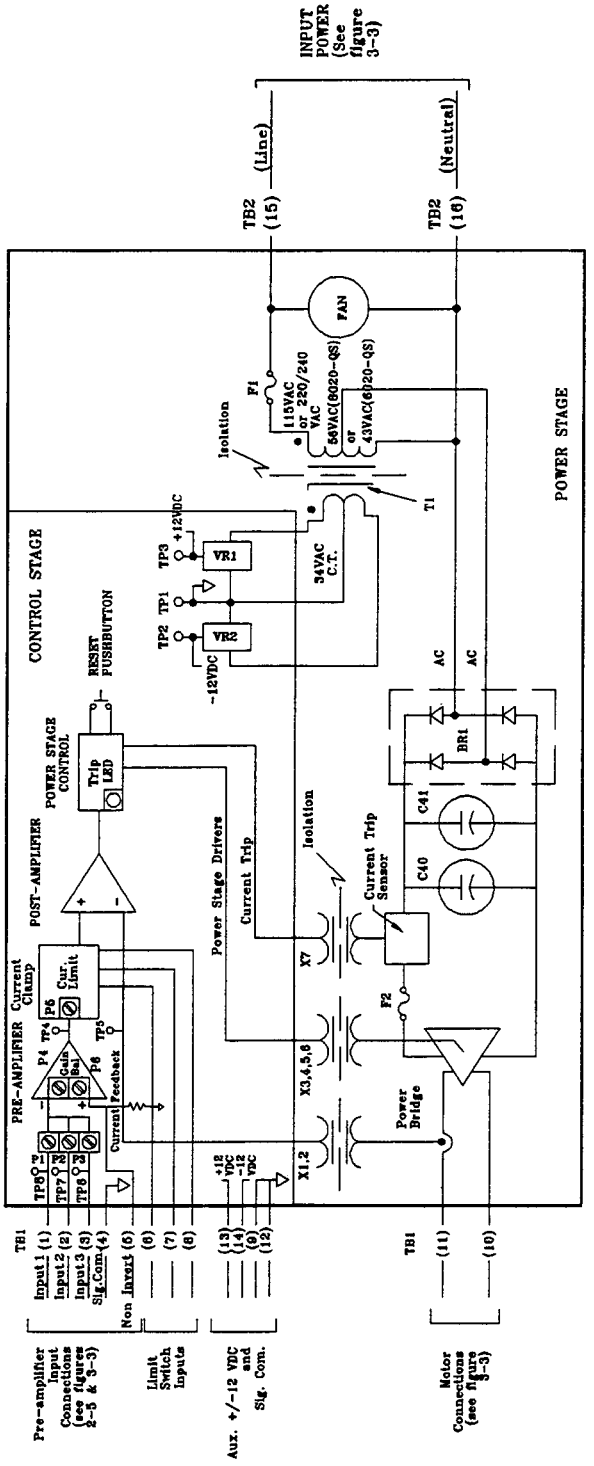


Figure 2-4: Functional Diagram of 8020-QS/6020-QS Servo Amplifier

Component Description for Servo Amplifier Module (Table 2-2)

(Items Shown in Figures 2-3 and 2-4)

Reset Button	Provides a means of manually resetting a short circuit current trip condition. A successful reset is verified by observing the trip LED change from an energized to de- energized state.
Trip LED	Trip LED indicator serves as an indication of a short circuit current trip. The current trip level is set at approximately 25 amps. A current trip condition is a latched function requiring a manual pushbutton reset.
Signal Common Testpoint (TP1)	Signal common for control stage circuitry and testpoints mentioned below.
-12VDC Supply Testpoint (TP2)	Negative power supply testpoint for the control stage.
+12VDC Supply Testpoint (TP3)	Positive power supply testpoint for the control stage.
Current Feedback Testpoint (TP5)	Provides a means of monitoring the current feedback signal sent back from the power stage. The gain of this signal is 3.33 amp/volt.
Current Command Testpoint (TP4)	Provides a means of monitoring the current command signal from the preamplifier. The gain of this signal is 3.33 amp/volt.
Tach Feedback Testpoint (or Input 3 Testpoint, TP6)	Provides a means of monitoring the motor's tach feedback signal. This signal is fed to the input of input 3 (or tach) feedback pot.

Table 2-2: Component Description for Servo Amplifier Module

Input (Speed) Command Testpoint (or Input 1 Testpoint, TP8)	Provides a means of monitoring the speed command signal. This signal is fed to input 1 pot (or speed command).
Current Limit Pot (P5)	This pot provides a means of adjusting the clamp levels of the current command signal produced by the output of the pre-amplifier. The plus as well as the minus current clamp levels are adjusted concurrently with this potentiometer. Turning this pot CCW increases the current clamping levels.
Gain Pot (P4)	This pot provides the means of adjusting the AC gain of the pre-amplifier. Turning this pot CCW increases gain (see also figure 2-5).
Balance Pot (P6)	The balance pot provides the means of cancelling small DC offsets that may be present on the input 1 or (speed) command signal (and the pre-amplifier circuit as well) when the rate (or speed) loop is closed on the pre-amplifier (see also figure 2-5) via the tach connection.
Input 1 Pot (or Speed Command Pot) (P1)	This pot provides the means of adjusting the DC gain of the input command signal seen on the input command testpoint, at the input of the pre-amplifier. Turning this pot CW increases gain.
Input 3 Pot (or Tach Feedback Pot) (P3)	The function of this pot is to provide a means of adjusting the DC gain of the tach feedback signal seen on the tach feedback testpoint, at the input of the pre-amplifier. Turning this pot CW increases gain.

Table 2-2: Continued

Motor Load Fuse (F2)	This fuse provides motor overload protection and is sized in the factory to the maximum continuous output current of the amplifier (i.e., 10 amps). If motors are used whose continuous current ratings are lower than that of the amplifier driving them, fuse F2 must be resized accordingly.
Input Fuse (F1)	This fuse provides short circuit protection for the power stage circuitry ahead of the auto transformer T1. Typically, the fuse is sized at 7 amps (slow blow) for 115 VAC operation, and 4 amps (slow blow) for 220/240 VAC operation.
(Items Shown in Figure 2-3 only)	
Pre-amplifier Compensation (R1, R2, R3, R47, R6, C4)	Components are mounted on standoffs, allowing the user to "tailor" specific gain parameters of the pre-amplifier circuit. These components do not usually need to be altered by the user under normal circumstances. Usually, the operator need only adjust the potentiometers (just mentioned above) to effect specific gain parameters of the system. A circuit diagram of the pre-amplifier is shown in figure 2-5.
(Items Shown in Figure 2-4 only)	
Auto Transformer (T1)	This transformer supplies 56 VAC or 43 VAC to bridge rectifier, BR1, producing a nominal 80 VDC or 60 VDC on the bridge capacitors C40 and C41. This 80 VDC or 60 VDC supply in turn feeds the switching

Table 2-2: Continued

	power bridge circuit and ultimately the voltage to the DC motor connects to TB2-10 and TB2-11. An isolated 34 volt C.T. winding is also coupled to T1 to supply voltage to the ±12 VDC regulators VR1 and VR2 in the control stage.
Magnetic Drivers (X1, X2, X3, X4, X5, X6 and X7)	These drivers are toroidal isolation transformers providing functions such as isolated current feedback (X1 and X2), isolated power bridge driver control (X3,4,5,6) and isolated short circuit-current trip feedback (X7).
Pre-amplifier input connections (TB1-1,2,3,4)	Speed command input and tach feedback connections are made at these terminals (see figure 2-5 for input gain specifications). The nominal input voltage ranges for input 1, input 2 and input 3 connections are factory set for approximately ±15 volts. By re-scaling resistors R1, R2 and R3, this range can be raised to a maximum of ±60 volts.
Aux. ±12VDC Supply Connections for External Use (TB1-13,14,9,12)	The ±12VDC control supply is brought out on these terminals for external use. IMPORTANT: The maximum external current draw for both the +12 VDC and -12VDC is 30mA.
Limit Switch Input Connections (TB1-6,7,8)	These connections are designed to interface directly to mechanical switch contact closures only. IMPORTANT: These connections are *NOT* to interface with logic signals such as open collector, TTL or CMOS signals.

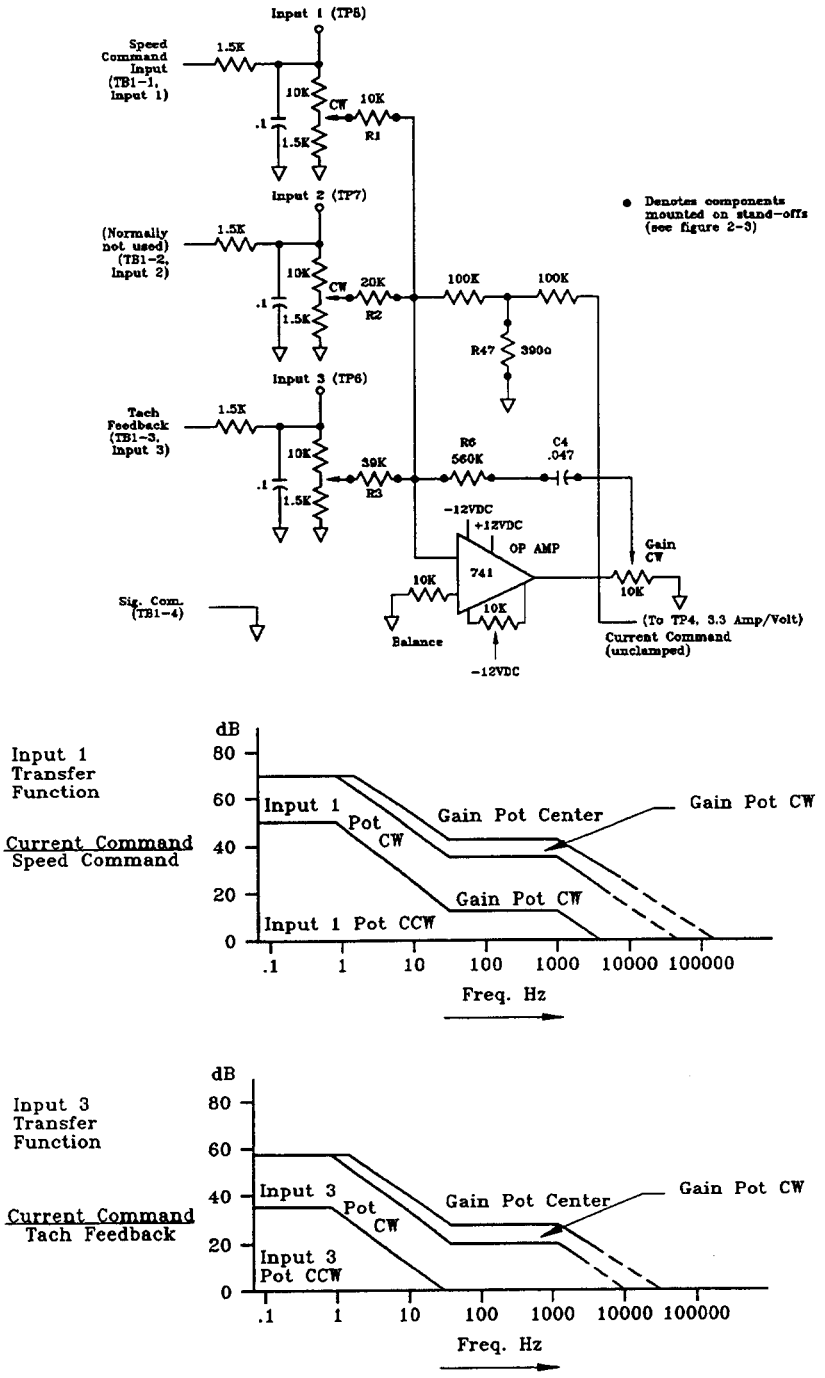
Table 2-2: Continued

The Current Limiting Functions are as Follows:

	Closing terminal TB1-7 on to TB1-8 limits current (or power) flowing from motor connections TB1-10(+) to TB1-11(-). Current flow is limited to no more than 1.8 amps in this direction. The opposite direction is uneffected.
	Closing terminal TB1-6 onto TB1-7 limits current (or power) flowing from motor connections TB1-11(+) to TB1-10(-). Current flow is limited to no more than 1.8 amps in this direction. The opposite direction is uneffected.
	Closing terminal TB1-7 onto TB1-8 and TB1-6 onto TB1-7 together, limits current flow to the motor in both directions (±1.8 amps, max.).
	Closing terminal TB1-6 onto TB1-8 also limits current flow to motor in both directions. However, the clamp level is even lower, allowing no more than ±.3 amp to flow at terminal TB1-11 and TB1-10.
Input Power Connection (TB2-15,16)	The input power of 115VAC, 60Hz or 220/240 VAC, 50/60 Hz to the servo amplifier, is applied at these connections (see figure 2-4).

Table 2-2: Continued

The circuit and graphs on the next page show the configuration and gain characteristics of the pre-amplifier circuit shown in the control stage section of figure 2-4. Note that some of the passive components making up the circuit are mounted on standoffs for ease of replacement in the field.



(Input 2 transfer function not shown)

Figure 2-5: Electrical Outline of Pre-amplifier Circuit with Open Loop Gain Characteristics

CHAPTER 3: INSTALLATION AND START-UP

CAUTION: High Voltages Exist on PC Board Area Associated with the Power Stage.

Before attempting to install or remove the servo amplifier, make sure the following steps are taken:

- Input power (TB2-15, 16) is disconnected.
- Allow at least two minutes to elapse (from the time power is turned off) BEFORE REMOVING THE DUST COVER FROM THE TOP OF THE AMPLIFIER.

(See figure 3-1 for additional information)

WARNING: Damage to the servo amplifier due to improper handling during installation or removal voids warranty.

Mounting dimensions for the 8020-QS/6020-QS servo amplifier are shown in figure 3-2. Mounting is accomplished with four 1/4 - 20 bolts installed from the back of the servo amplifier.

Input power connections to the 8020-QS/6020-QS servo amplifier are made at terminals 15 and 16 of TB2 as shown in figure 3-3.

Motor power connections and tach connections are also shown in figure 3-3. Color codes for the motor and tach wiring are also shown for Aerotech SERIES 1000 motors. The technique for properly connecting the polarity of the motor power connections and motor tach connections to the 8020-QS/6020-QS servo amplifier is described in this section.

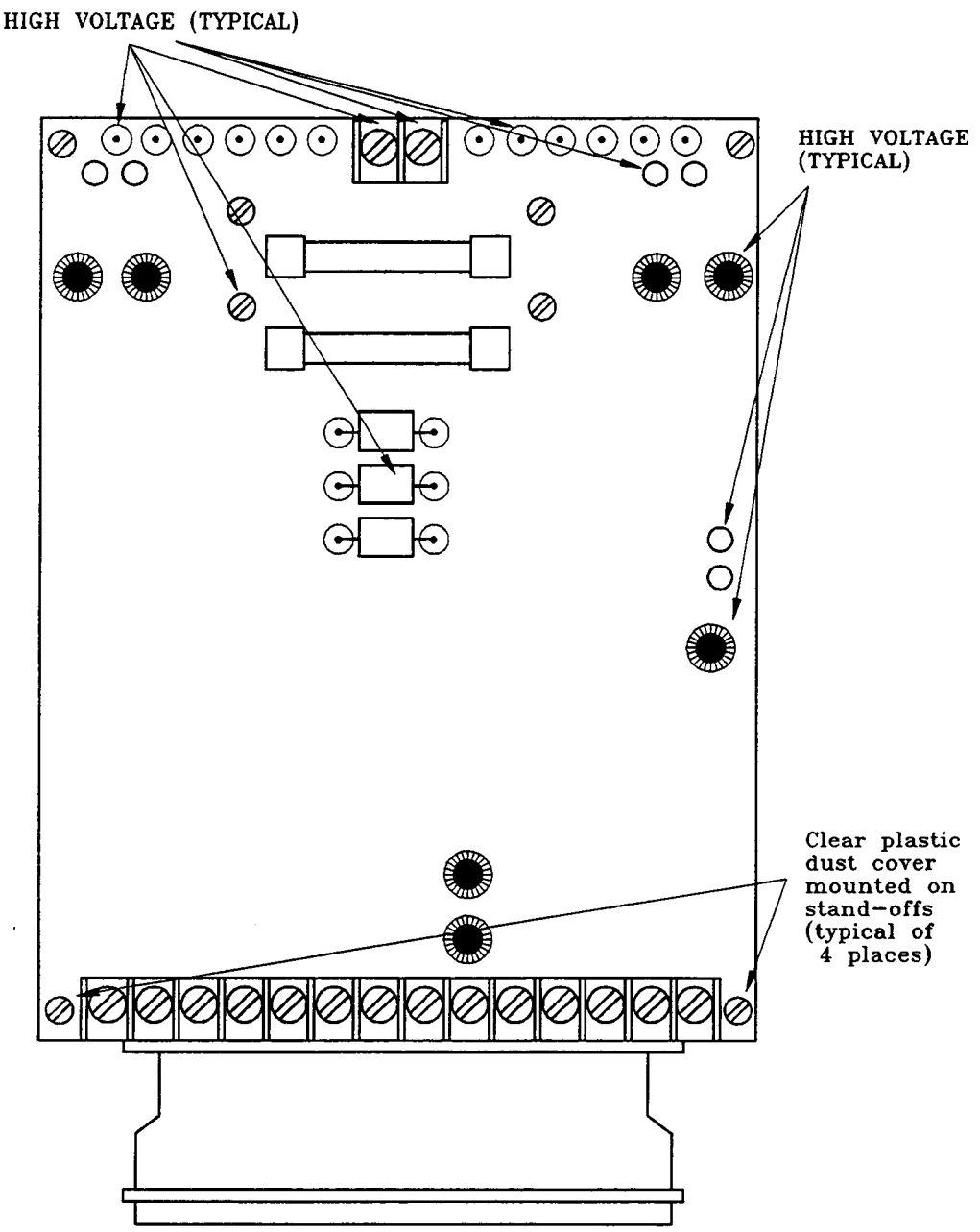


Figure 3-1: Locations of High Voltages on the 8020-QS/6020-QS Servo Amplifier

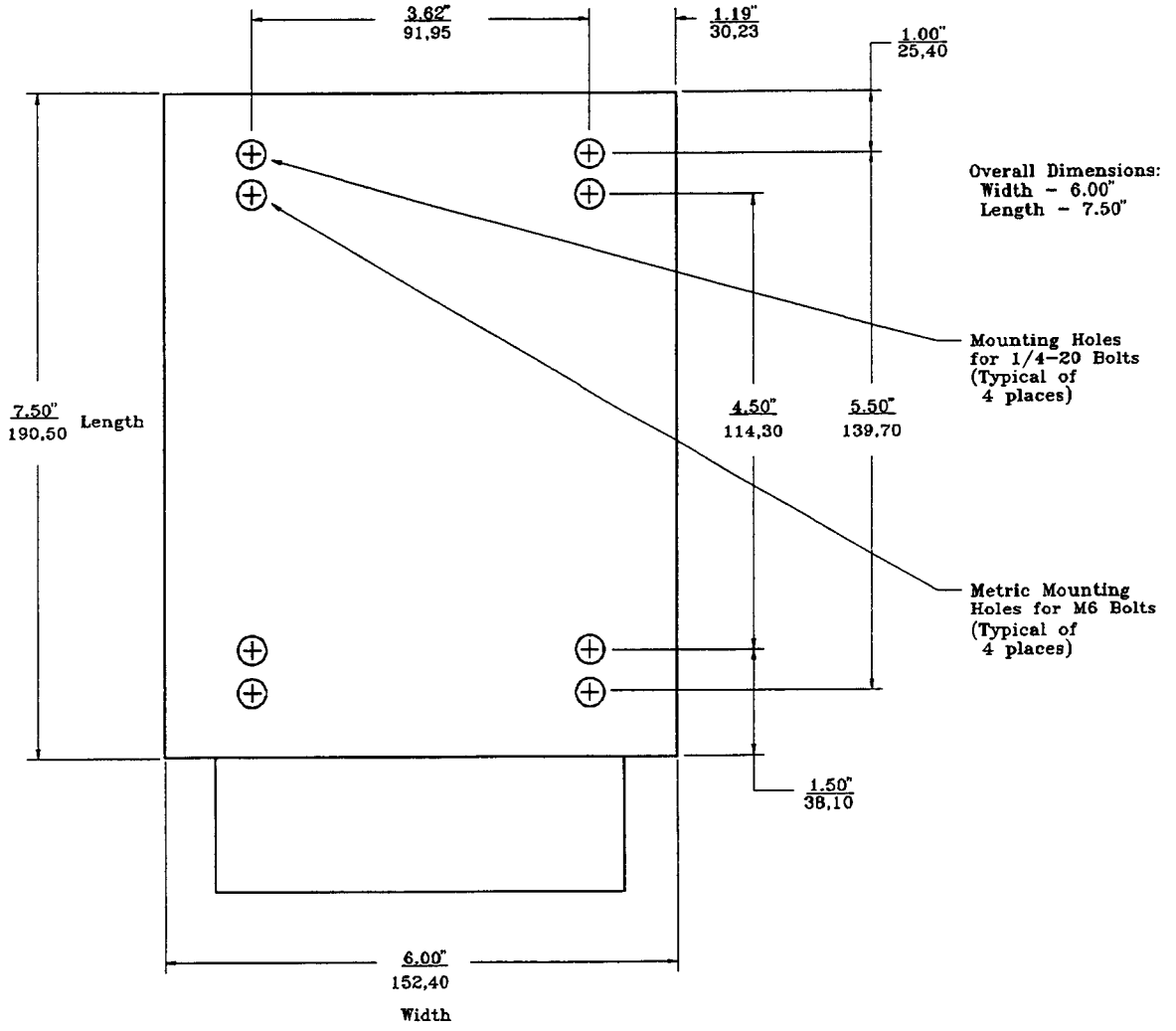


Figure 3-2: Back View of 8020-QS/6020-QS Servo Amplifier Showing Mounting Hole Locations

To close the position loop using any of Aerotech standard position controllers, follow this procedure:

1. Spin motor shaft CW (looking into flange). Note the polarities of the motor power leads and tach leads.

2. A minus (-) signal on Input 1 (TB1-1) with respect to signal common (TB1-4) will cause the motor to spin CW (looking into flange) if:

   - The " + " lead (red) of the motor is connected to TB1 terminal 10, with the "-" lead (black) connected to TB1 terminal 11.

   - The " + " lead (blue) of the tach is connected to TB1 terminal 3 with the "-" lead (white) connected to TB1 terminal 4.

After the 8020-QS/6020-QS servo amplifier has been installed and wired into the system, adjustments may be made on the amplifier.

Note in figure 2-3 the locations of the six control pots and eight testpoints on the servo amplifier. Set the pots to the following positions:

- Current limit pot to be adjusted to midway position.
- Gain (Gain) pot to be turned completely CW.
- Input 1 (speed command) pot to be turned completely CW.
- Input 3 (tach feedback) pot to be turned completely CW.
- Balance (Bal.) pot to be adjusted to midway position.

(It is assumed that the input 2 pot is not being used. Therefore, no adjustment is necessary.)

NOTE: **Make certain that motor shaft is mechanically decoupled from drive system, therefore avoiding possible damage to the mechanical system.**

If the servo amplifier is being used in a position loop, temporarily disconnect input 1 (speed command) signal. This will allow the servo amplifier to work only in the rate loop.

Apply the 115 VAC or 220/240 VAC input power to the amplifier. If the motor races, disconnect power and reverse the tach connections to the given motor at the terminal board of the base plate. (If this problem is encountered, it is assumed that a motor other than an Aerotech SERIES 1000 motor is being used.)

With power again applied, adjust the balance pot until the motor comes to a complete stop.

Disconnect power, reconnect input 1 signal and recouple the motor shaft to the drive system. Be sure that the signal on input 1 is at zero volts (i.e., make sure the position loop controller is in "home" position).

Now reapply power. If the position controller indicates that the system is out of "zero" (or "home") position, readjust the balance pot.

NOTE: The balance pot is capable of cancelling only small offsets (± 15 mV) in the pre-amplifier and/or on the input 1 connection. If adjusting the balance pot fails to bring the system to zero position, then the speed command signal on input 1 is exhibiting too much offset voltage.

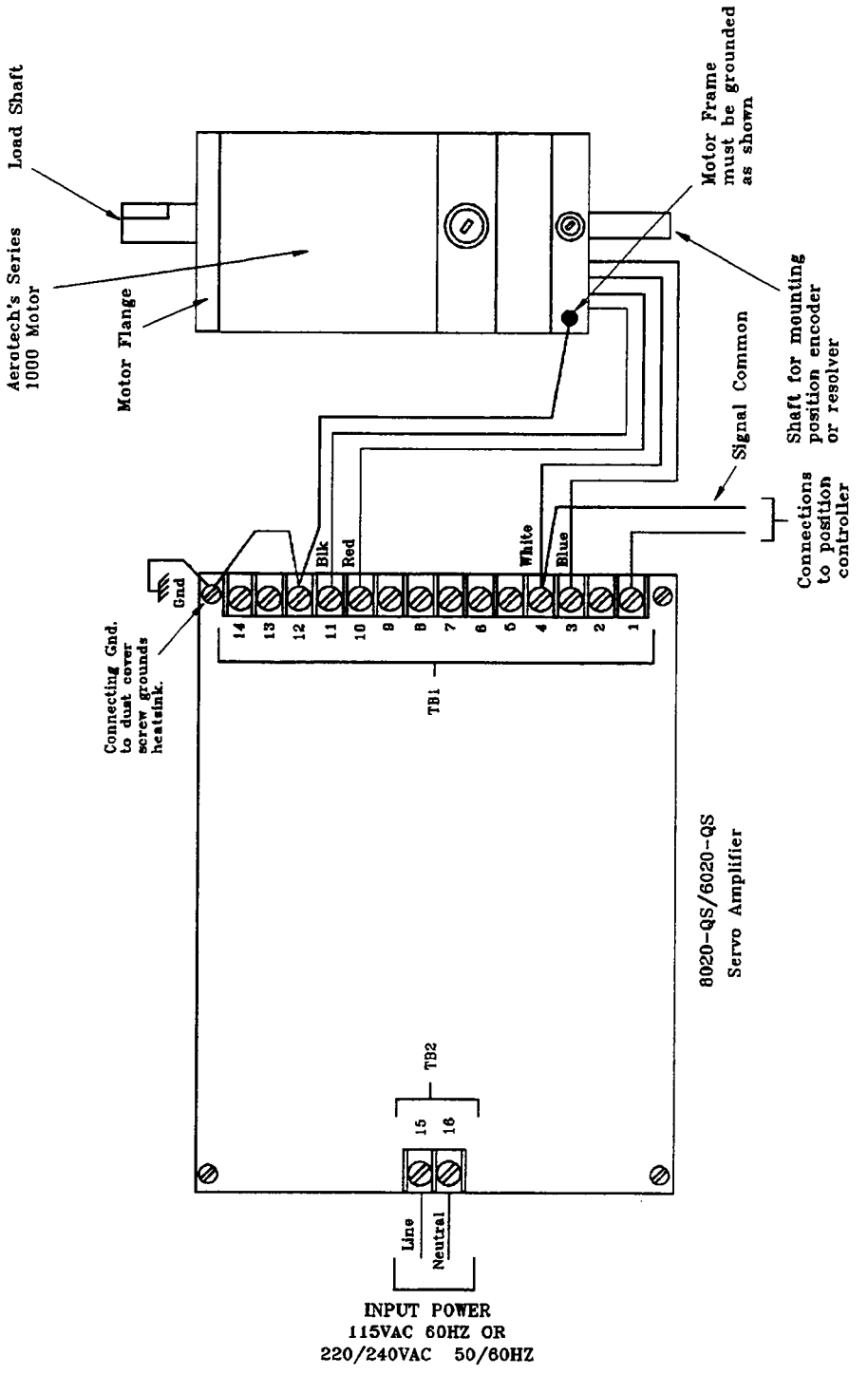


Figure 3-3: Input Power, Motor and Control Interconnection Diagram for the 8020-QS/6020-QS

Position commands can now be applied to the system. Program the position controller so that the motor accelerates and decelerates to some position, stops, and then returns to "home" position. Make the cycle time in which this event occurs approximately 2 seconds. With an oscilloscope, monitor the input 3 (tach testpoint, TP6) with respect to signal common, TP1 (refer to figure 2-3).

SECTION 3-1 ADJUSTING INPUT AND TACH POTS

(FOR POSITION LOOP STABILITY)

Motor overshoot, when present in a closed position loop system, can be very detrimental to position loop accuracy. Care must be taken in the fine tuning adjustments of the tach, input, and gain pots to prevent the problem from occurring.

Portion "A" of figure 3-4 shows a typical deceleration interval for a motor (in this case, Aerotech's 1135-01-01 motor used with the 8020-QS servo amplifier) being commanded to decelerate to zero speed by a position controller. Note that the motor's speed (seen as tach voltage on TP6) ramps smoothly to zero speed, without ever crossing zero. Portion "A" shows optimum motor response during deceleration.

Portion "B" of figure 3-4 shows a deceleration interval where the tach gain is set too low (or the speed command gain is set too high). Note that the tach voltage crosses zero. In this case, the motor "over-shoots" its designated "home" position, but eventually settles into position.

A good rule of thumb for adjusting motor deceleration response is to initially set the input 1 and input 3 pots full CW. Then slowly turn the input 3 pot (tach feedback DC gain) CCW until minimum motor deceleration time is achieved without over-shooting.

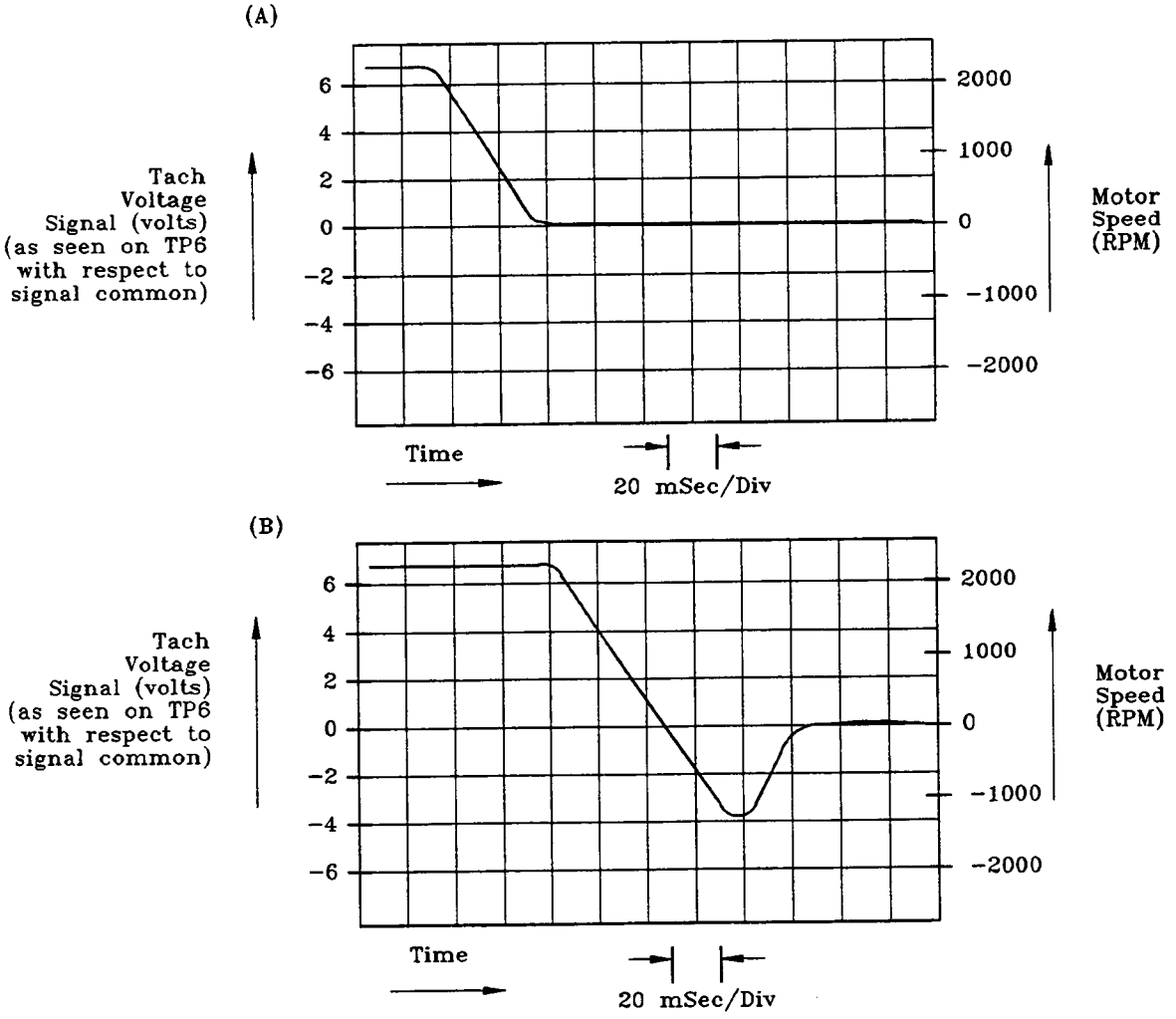


Figure 3-4: Adjusting Input 1 and Input 3 Pots for Position Loop Stability

SECTION 3-2 MINIMIZING RIPPLE CURRENT

The magnitude of ripple current present on the current feedback testpoint TP5 of the servo amplifier when the motor is running at a constant speed, is basically the product of two characteristics of that motor. They are:

- The motor's armature inductance, which contributes to the servo amplifier switching ripple current on the current feedback signal (TP5).

- The tach feedback ripple voltage (produced by the commutator of the tach), which is amplified by the pre-amplifier circuit, contributes to ripple on the current command signal (TP4).

It is the ripple from the tach signal on the current command signal that usually contributes to most of the excess I^2R heating in the motor.

Portion "A" of figure 3-5 shows an optimum level peak to peak ripple current for the 1135-01-01 motor running unloaded, at constant speed. (This RMS ripple should be no more than 10% - 20% of the continuous current rating of the motor.)

Portion "B" of figure 3-5 shows an excessive level of ripple current, due to excessive gain in the pre-amplifier, for the motors running under the same conditions as in portion "A".

With these adjustments complete, the 8020-QS/6020-QS servo amplifier is ready for full operation within the system.

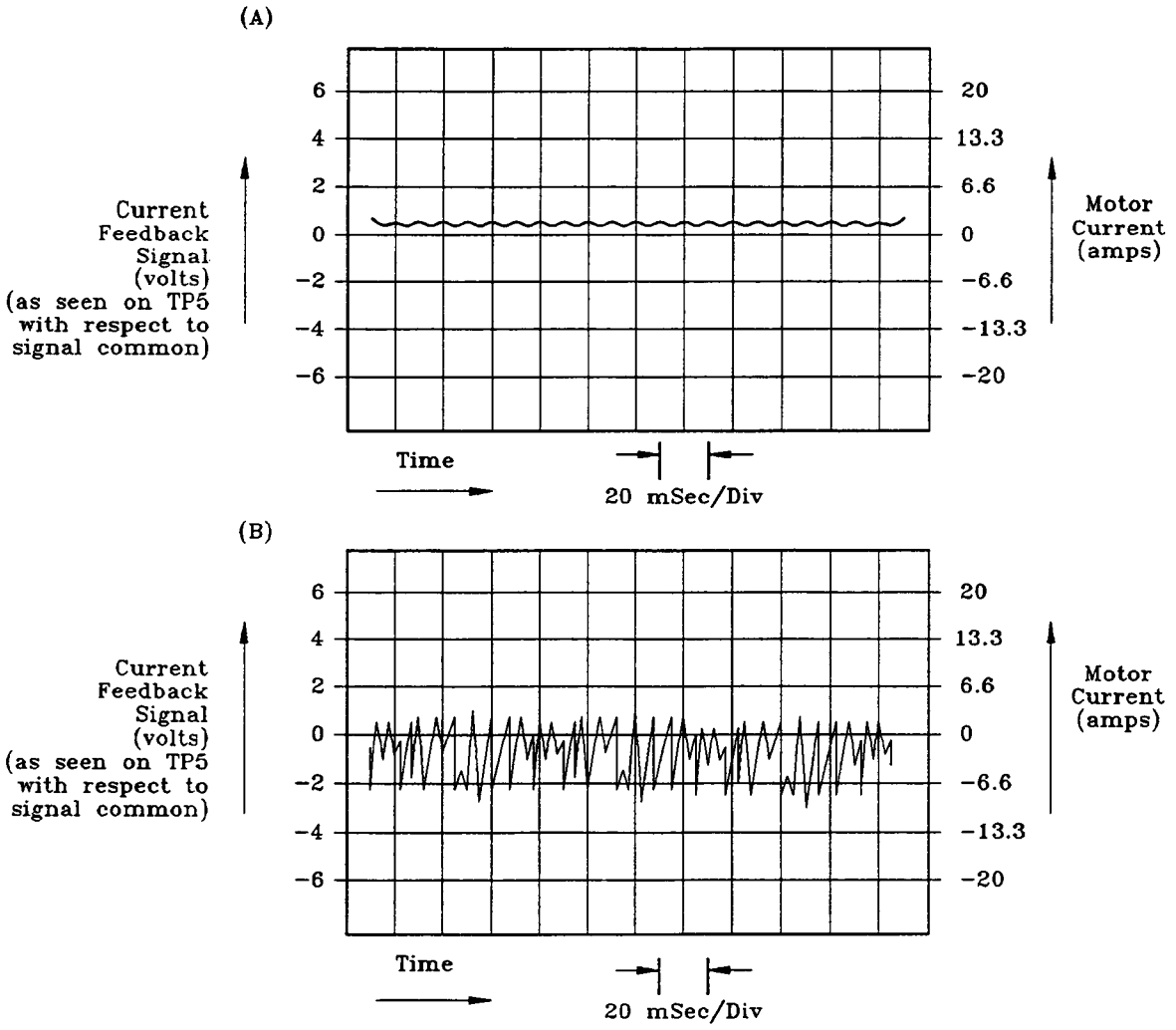


Figure 3-5: Adjusting the Gain Pot to Minimize Ripple Current in Motor

CHAPTER 4: TROUBLESHOOTING

Unless otherwise noted, refer to figure 2-3, 2-4 and 3-3. Refer to chapter 5 for service information if necessary.

WARNING: Before any action is taken or unless otherwise specified, TURN OFF POWER.

Symptom	Possible Cause	Solution
No power to motor when 115 VAC or 220/240 VAC is applied to TB2 terminals 15 and 16.	Input fuse F1 is open.	Replace fuse and reapply power (use 3AG, 7ASB (115V) or 4ASB (220/240V). If fuse opens again, return unit to Aerotech.
	Motor fuse (F2) is open.	Remove fuse and check for continuity.
	Limit switch connections on TB1, terminals 6, 7 and 8 are activated.	Temporarily remove connection to restore power.
	±12VDC control voltage not present.	Check TP3 (+12VDC) and TP2 (-12VDC) with respect to signal common (TP1). If input power is applied and these voltages are not present, return unit to Aerotech.
Motor is racing.	Tach polarities are reversed on TB2 terminals 3 and 4.	Reverse tach connections on TB2, 3 and 4.

Symptom	Possible Cause	Solution
	No tach connection.	Check tach testpoint (TP6) with respect to signal common (TP1). With motor racing, tach voltage signal should be present at this testpoint. If no signal is present, motor tachometer may be defective.
Current trip LED remains energized (unable to reset through reset push-button). Current trip shutdown circuit activated.	Short circuit exists on motor terminals.	Disconnect motor leads on the base plate. Reapply power and depress reset button. If LED stays energized, the servo module is defective. Return to Aerotech for repair.
Motor is sluggish or overshoots in response to speed command input.	Current limit pot set to clamp at too low a value.	Turn current limit pot CCW to increase the curret clamp level.
Motor will not lock in "home" position (position loop control).	Excessive DC offset on input signal to servo module.	Adjust balance pot to bring system into "home" position. If system does not respond to this solution, then excessive offset exists on the speed command signal of the position controller.
Motor overshoots when coming to rest (position loop control).	Gain not set properly.	See section 3-1 for information on gain control adjustment in a position loop.
Motor runs very hot.	Gain set too high in servo module, causing excessive ripple current in motor.	See section 3-2 for information on gain adjustments.

CHAPTER 5: SERVICE AND REPAIR

General repair of equipment consists entirely of solutions listed in chapter 4, *Troubleshooting*, or the removal and replacement of a servo amplifier, should the need arise.

WARNING: If under warranty, repairs of defective electrical components of the servo amplifier should not be attempted, since to do so would void the entire warranty.

If necessary, any on-site service should be performed by an experienced electronic technician, preferably trained by Aerotech, Inc. It is recommended that the user NOT attempt repair of the servo amplifier (except for those items associated with changing fuses) whether these units are under warranty or not.

SECTION 5-1 PARTS LIST

Description	Part Number	Manufacturer
Fuse F1	313007 (7 amp slow blow) or 313004 (4 amp slow blow)	Littlefuse
Fuse F2	* 313010 (10 amp slow blow)	Littlefuse
8020-QS Servo Amplifier	EFA 447	Aerotech

6020-QS Servo Amplifier	EFA460	Aerotech

* This fuse is shipped with the 8020-QS/6020-QS servo amplifier for 10 amps continuous output operation, if the accompanying motor is not specified.

If the amplifier is shipped with a standard Aerotech motor, the following fuse ratings for F2 apply:

Aerotech Motor	Littlefuse	Current rating
1410-03-01	313008	8 amp
1210-01-01	3136.25	6.25 amp
1135-01-01	313005	5 amp
1075-01-01	313005	5 amp

SECTION 5-2 SHIPMENT

The procedure for shipping equipment back to Aerotech for repair is shown below. This procedure pertains to warranty as well as non-warranty repairs of equipment.

1. Before shipping any equipment back to Aerotech, the person making the return must call ahead for a "*Return Authorization Number*". *(Have your serial number on hand when calling.)*

2. The equipment being returned must be encased in a proper cushioning material and enclosed in a cardboard box.

Call for a "Return Authorization Number" if it is necessary to ship any part to the factory.

Warning: Damage due to improper packaging voids warranty!

Aerotech Sales and Service offices are listed on the following pages. For service and information, contact the office servicing your area.

AEROTECH, INC. SALES OFFICES

World Headquarters
AEROTECH, INC.

101 Zeta Drive
Pittsburgh, PA 15238

Phone (412) 963-7470
FAX (412) 963-7459
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FAX (419) 874-4280
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FAX (312) 428-5471
IL, MO, KS, WI, MN, ND, SD, IA, NE

AEROTECH, CENTRAL-EAST
856 Cottonwood Drive
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FAX (412) 373-4163
WV, western PA, western NY, eastern OH

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#3101
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Phone (214) 987-4556
FAX (214) 987-4706
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Mountain View, CA 94041
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FAX (415) 967-4998
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La Palma, CA 90623
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FAX (213) 860-4639
AZ, southern CA

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521 Kingwood Road
King of Prussia, PA 19406

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FAX (215) 265-3566
MD, DC, DE, NJ, northern VA, eastern PA

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Raleigh, NC 27615
Phone (919) 848-1965
FAX (919) 848-3393
NC, TN, southern VA, AL, FL, GA, SC, MS

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19A Hampshire Road
Glen Waverley
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Phone (613) 560 2366
FAX (613) 560 8402
TLX AA 35670

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Warranty and Field Service Policy

Aerotech, Inc. warrants its products to be free from defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech's liability is limited to replacing, repairing or issuing credit, at its option, for any products which are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, whether or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech's products are specifically designed and/or manufactured for buyer's use or purpose. Aerotech's liability on any claim for loss or damage arising out of the sale, resale or use of any of its products shall in no event exceed the selling price of the unit.

Laser Product Warranty

Aerotech, Inc. warrants its laser products to the original purchaser for a minimum period of one year from date of shipment. This warranty covers defects in workmanship and material and is voided for all laser power supplies, plasma tubes and laser systems subject to electrical or physical abuse, tampering (such as opening the housing or removal of the serial tag) or improper operation as determined by Aerotech. This warranty is also voided for failure to comply with Aerotech's return procedures.

Return Products Procedure

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within (30) days of shipment of incorrect materials. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. Any returned product(s) must be accompanied by a return authorization number. The return authorization number may be obtained by calling an Aerotech service center. Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than (30) days after the issuance of a return authorization number will be subject to review.

Returned Product Warranty Determination

After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warrantied defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an air freight return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

Returned Product Non-Warranty Determination

After Aerotech's examination, the buyer shall be notified of the repair cost. At such time the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number or approval within (30) days of notification will result in the product(s) being returned as is, at the buyer's expense. Repair work is warranted for (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

Rush Service

At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech's approval.

On-Site Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty- related, then the following policy applies.

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special service rates apply.

If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following "On-Site Non-Warranty Repair" section apply.

On-Site Non-Warranty Repair

If an Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies.

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.

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