OPERATOR'S MANUAL
FOR THE
100QVS SERVO AMPLIFIER
100.25-QV

MAY, 1987

This Product Protected

Under Patent No. 4,554,512

AEROTECH, INC., 101 Zeta Drive, Pittsburgh, PA 15238
(412) 963-7470 TWX 710-795-3125

NOTICE

AEROTECH'S DESIGNATION OF THE "100QVS" SERVO CONTROLLER DESCRIBED IN THIS MANUAL HAS BEEN CHANGED TO "100.25-QV". WHEN ORDERING OR WHEN REQUESTING TECHNICAL INFORMATION, PLEASE REFER TO THE "100.25-QV" SERVO CONTROLLER.

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LIST OF ILLUSTRATIONS

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.

CHAPTER 1: INTRODUCTION

This manual provides information on the installation, set up and operation of the 1000VS servo amplifier.

Included in this manual is information on the set-up and adjustment of the 1000VS servo amplifier, as well as information on wiring this amplifier into a system.

One line diagrams are also included on the operational characteristics of the servo amplifier. 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 section 5, Service and Repair, respectively.

SECTION 2-1 GENERAL DESCRIPTION

The 1000VS is a 0 to 100VDC, 25 amp peak, 12.5 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 amplifier 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 amplifier itself.

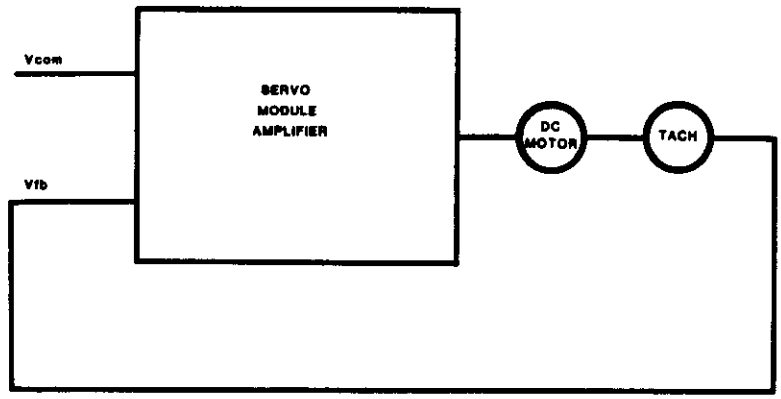


FIGURE 2-1: VELOCITY LOOP CONFIGURATION

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 5 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 1000VS amplifier, the overall transconductance is approximately 10,000 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:

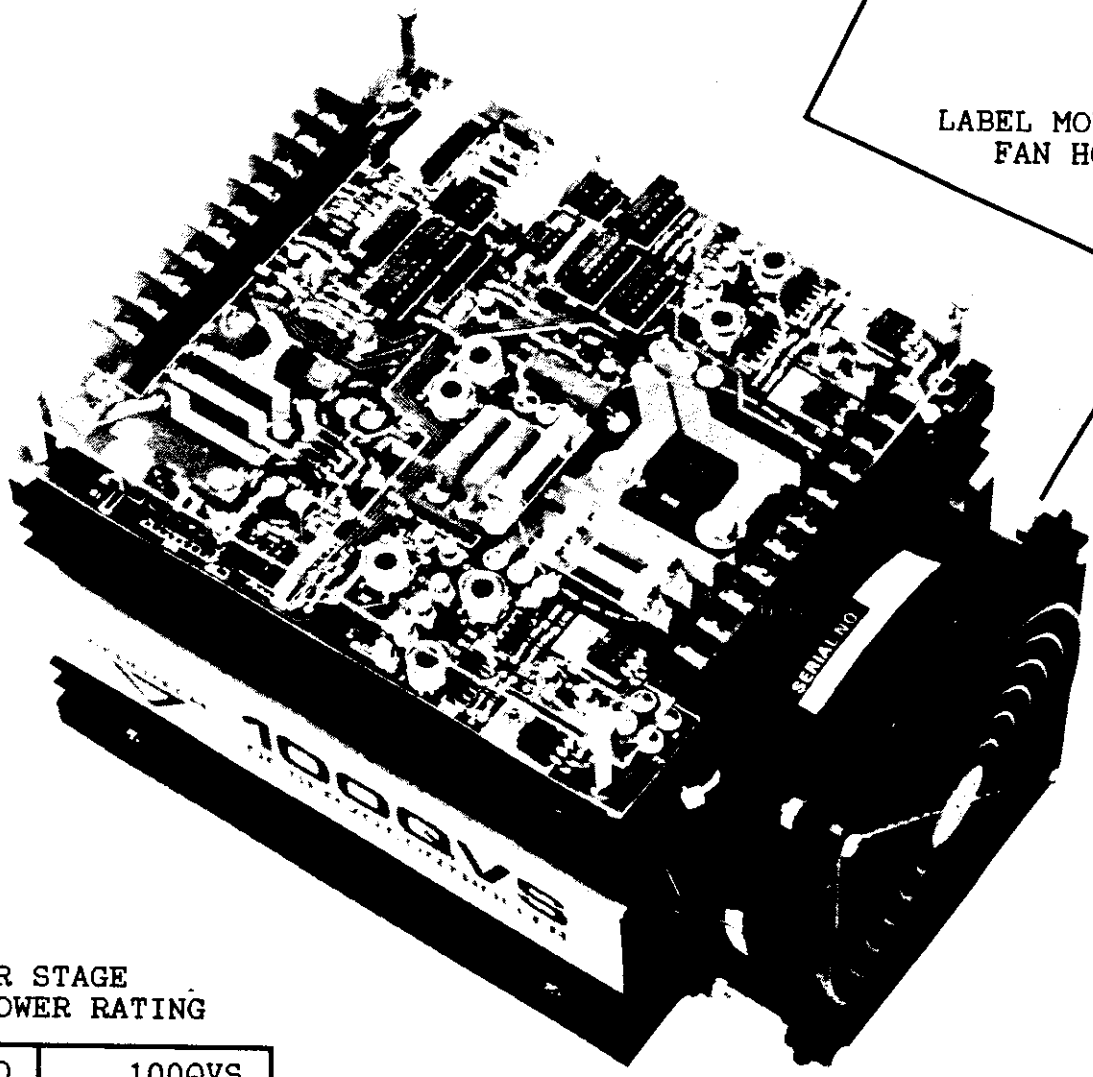
A. The Current Limit Circuit clamps the command signal, the output of the pre-amplifier, at a certain level, either positive or negative. This clamping level is adjustable through the Current Limit Pot.

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

INPUT CONTROL POWER
RATING (TB1-9,10)

VOLTS	AC-DC	AMPS	HERTZ
115	AC	3A	50/60

LABEL MOUNTED ON
FAN HOUSING



POWER STAGE
INPUT POWER RATING

MODEL NO.	100QVS
630D1313	

0 TO 70VAC, FULL WAVE, 12 AMPS (TB2-18,19)

0 TO 140VAC, FULL WAVE C.T., 6 AMPS (TB2-18,19,13)

FIGURE 2-2: MODULE IDENTIFICATION LOCATIONS

SECTION 2-2 MODULE IDENTIFICATION

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

SECTION 2-3 ELECTRICAL SPECIFICATIONS

Electrical specifications for the amplifier is shown in figure 2-3. These specifications are broken up into two headings: POWER and CONTROL.

ELECTRICAL SPECIFICATIONS FOR SERVO AMPLIFIER MODULE

POWER

POWER OUTPUT CURRENT (MAX., AMPS)	25
CONTINUOUS OUTPUT CURRENT (MAX., AMPS)	12.5
POWER STAGE AC INPUT VOLTAGES (VAC)	
(MAXIMUM)	80 (Full Wave), 160 (Full Wave, C.T.)
(NOMINAL)	0 to 70 (Full Wave) 0 to 140 (Full Wave, C.T.)
OUTPUT POWER * (MAX., WATTS)	
PEAK	2250
CONTINUOUS	1125
LOAD INDUCTANCE * (MIN., mH)	2
SWITCHING FREQUENCY (NOMINAL, KHz)(±10%)	18
OPERATING TEMPERATURE (C DEGREES)	0 TO 50
STORAGE TEMPERATURE (C DEGREES)	-30 TO 85

FIGURE 2-3: ELECTRICAL SPECIFICATIONS

CONTROL

CURRENT LOOP (POWER AMPLIFIER)

CURRENT FEEDBACK (CURRENT MONITOR, TP4) GAIN (AMP/VOLT)	5
CURRENT COMMAND GAIN (TP5) (AMP/VOLT)	5
CURRENT LIMIT ADJUSTMENT RANGE (AMPS)	0 TO 25
SHORT CIRCUIT CURRENT TRIP LEVEL (MANUAL RESET) (AMPS)	38
POWER AMPLIFIER BANDWIDTH (NOMINAL, KHz)	1.0
±12 VDC EXTERNAL CONNECTION CURRENT DRAW (mA DC)	30
±12 VDC POWER SUPPLY SHUTDOWN AND INHIBIT (ALSO, POWER STAGE INHIBIT)	ACTIVATED IF THE INPUT CONTROL VOLTAGE AT TERMINALS TB1, 9 & 10 DROPS BELOW 85 VAC
CONTROL INPUT VOLTAGE (VAC)	
(MAXIMUM)	135
(MINIMUM)	85 (shutdown occurs)
(NOMINAL)	115

RATE LOOP (PRE-AMPLIFIER)

VOLTAGE GAIN (OPEN LOOP, dB)	100
TACH FEEDBACK SIGNAL ** (NOM., VOLTS)	10 to 20
SPEED COMMAND SIGNAL ** (NOM., VOLTS)	10
TACH FEEDBACK SIGNAL INPUT IMPEDANCE (INPUT 3) (MIN., Kohms)	9.5

FIGURE 2-3: CONTINUED

SPEED COMMAND SIGNAL INPUT IMPEDANCE (INPUT 1) (MIN., Kohms)	6.5
SPEED COMMAND INPUT SIGNAL, OFFSET NULL ADJUSTMENT (MAX., + AND - mV)	15
PRE-AMPLIFIER OUTPUT DRIFT (NOMINAL, mV/C DEGREES)	10
PRE-AMPLIFIER BANDWIDTH *** (NOMINAL, Hz)	100

* Data relative to nominal loaded DC bus voltage of 100 VDC.

** Tach and speed signal levels can be accepted up to ±60 volts with changes in pre-amplifier compensation (see figure 2-7).

*** Measurements taken with Aerotech Model 1410 motors.

FIGURE 2-3: CONTINUED

SECTION 2-4 DESCRIPTION OF COMPONENTS

Location of fuses, potentiometers, test points and other components for the 100QVS servo amplifier that are of concern to the user, are identified in figure 2-4. Figure 2-5 illustrates a diagram of the power circuitry contained in the servo module.

General descriptions of the components illustrated in figures 2-4 and 2-5 are provided in figures 2-6 and 2-7.

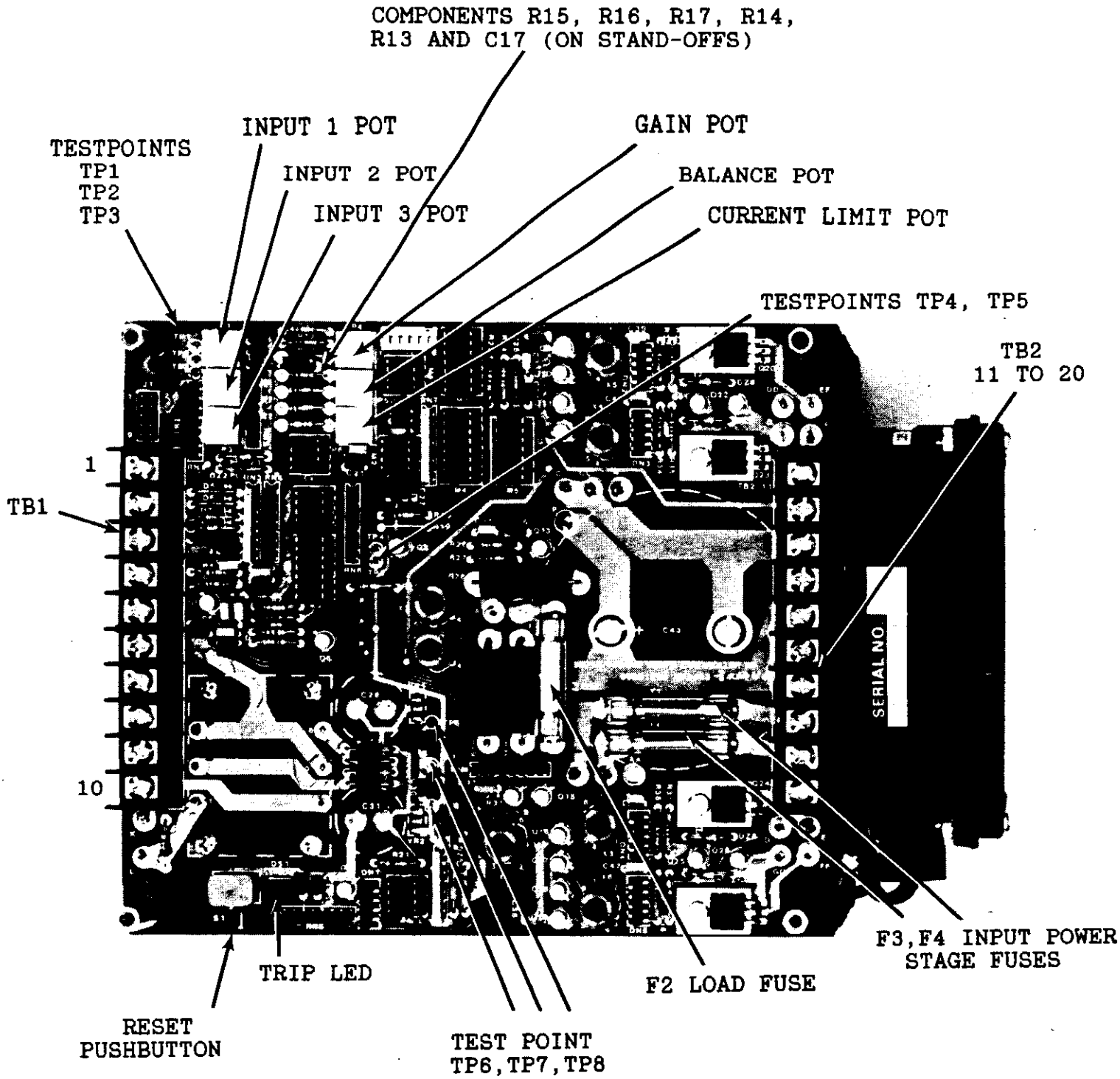
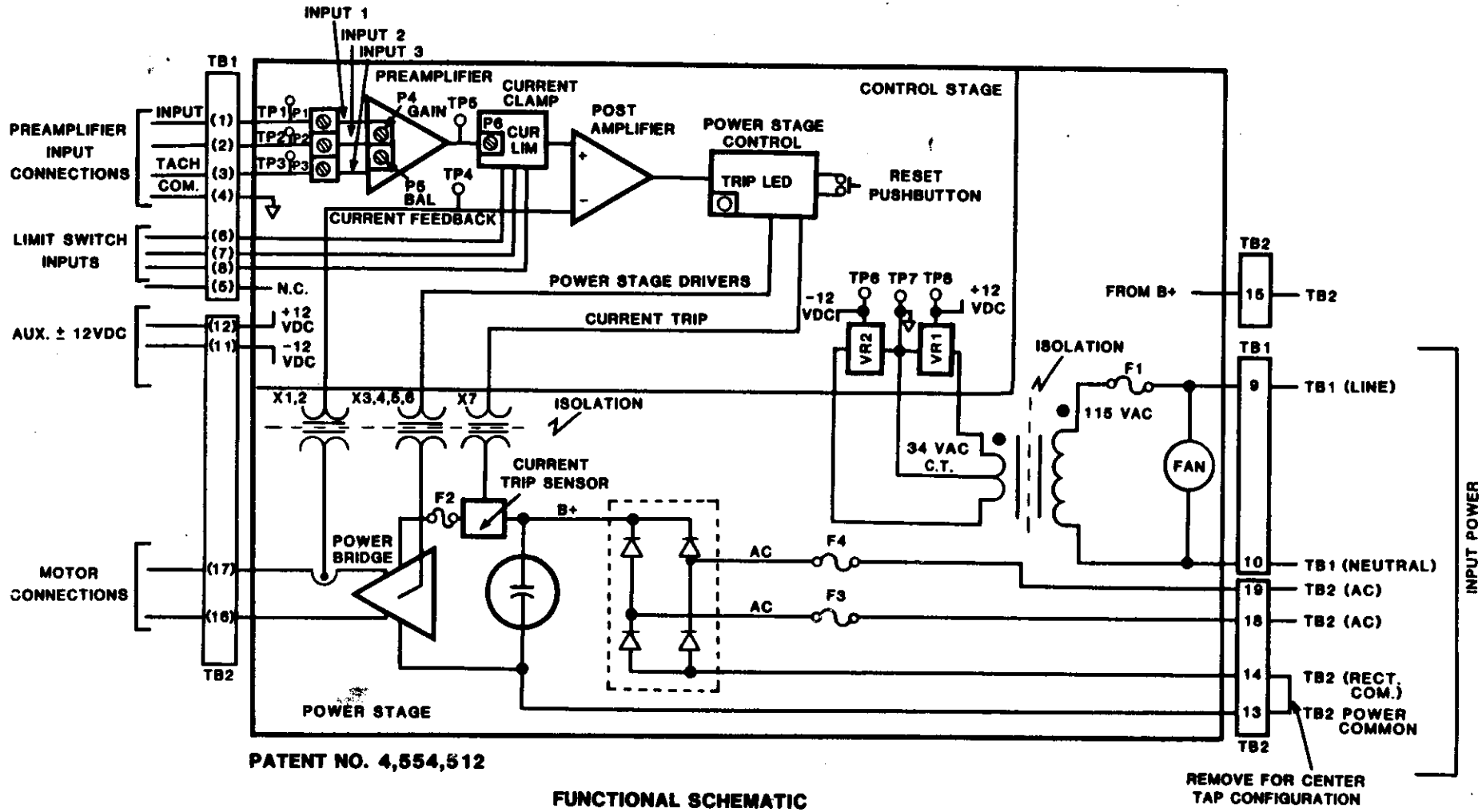


FIGURE 2-4: TOP VIEW OF 100QVS SERVO AMPLIFIER



PATENT NO. 4,554,512

FUNCTIONAL SCHEMATIC

FIGURE 2-5: FUNCTIONAL DIAGRAM OF 100QVS SERVO AMPLIFIER

COMPONENT DESCRIPTION

(Items show in figures 2-4 and 2-5)

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 38 amps. A current trip condition is a latched function requiring a manual pushbutton reset.
SIGNAL COMMON TESTPOINT (TP7)	Signal common for control stage circuitry and testpoints mentioned below.
-12VDC SUPPLY TESPPOINT (TP6)	Negative power supply testpoint for the control stage.
+12VDC SUPPLY TESTPOINT (TP8)	Positive power supply testpoint for the control stage.
CURRENT FEEDBACK TESTPOINT (TP4)	Provides a means of monitoring the current feedback signal sent back from the power stage. The gain of this signal is 5 amp/volt.
CURRENT COMMAND TESTPOINT (TP5)	Provides a means of monitoring the current command signal from the preamplifier. The gain of this signal is 5 amp/volt.
TACH FEEDBACK TESTPOINT (OR INPUT 3 TESTPOINT, TP3)	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.

FIGURE 2-6: COMPONENT DESCRIPTION FOR SERVO AMPLIFIER

INPUT (SPEED) COMMAND TEST-POINT (OR INPUT 1 TEST-POINT, TP1)	Provides a means of monitoring the speed command signal. This signal is fed to input 1 pot (or speed command).
CURRENT LIMIT POT (P6)	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 2-7).
BALANCE POT (P5)	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 2-7) 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) (P2)	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.
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., 12 amps, slow-blow).

FIGURE 2-6: CONTINUED

	If motors are used whose continuous current ratings are lower than that of the amplifier driving them, fuse F2 must be resized accordingly.
CONTROL STAGE INPUT FUSE(F1)	This fuse provides short circuit protection for the circuitry ahead of the ±12VDC control transformer.
POWER STAGE INPUT FUSE (F3, F4)	This fuse provides short circuit protection for the power stage circuitry ahead of the current trip circuitry of the power stage. F3 and F4 are sized typically for 20 amps (slow blow).

(ITEMS SHOWN IN FIGURE 2-4 ONLY)

PRE-AMPLIFIER COMPENSATION (R15,R16,R17 R14,C17,R13)	Components 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 affect specific gain parameters of the system. A circuit diagram of the pre-amplifier is shown in figure 2-7.

(ITEMS SHOWN IN FIGURE 2-5 ONLY)

MAGNETIC DRIVERS (X1,X2,X3, X4,X5,X6, 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 2-7 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

FIGURE 2-6: CONTINUED

resistors R15, R16 and R17, this range can be raised to a maximum of ±60 volts.

AUX. ±12VDC SUPPLY CONNECTIONS FOR EXTERNAL USE (TB2-12,11)

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.

THE CURRENT LIMITING FUNCTIONS ARE AS FOLLOWS:

Closing terminal TB1-7 on to TB1-8 limits current (or power) flowing from motor connections TB2-17(+) to TB2-16(-). 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 TB2-16(+) to TB2-17(-).

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 (±.3 amps, max.).

Closing terminal TB1-6 onto TB1-8 also limits current flow to motor in both directions, allowing no more than ±.3 amp to flow at terminal TB2-17 and TB2-16.

INPUT CONTROL POWER CONNECTION (TB1-9, 10)	The input power of 115VAC, 60Hz to the servo amplifier, is applied at these connections.

FIGURE 2-6: CONTINUED

The circuit and graphs on the next page show the configuration and gain characteristics of the pre-amplifier circuit shown pictorially in the control stage section of figure 2-5. Note that some of the passive components making up the circuit, are mounted on standoffs for ease of replacement in the field.

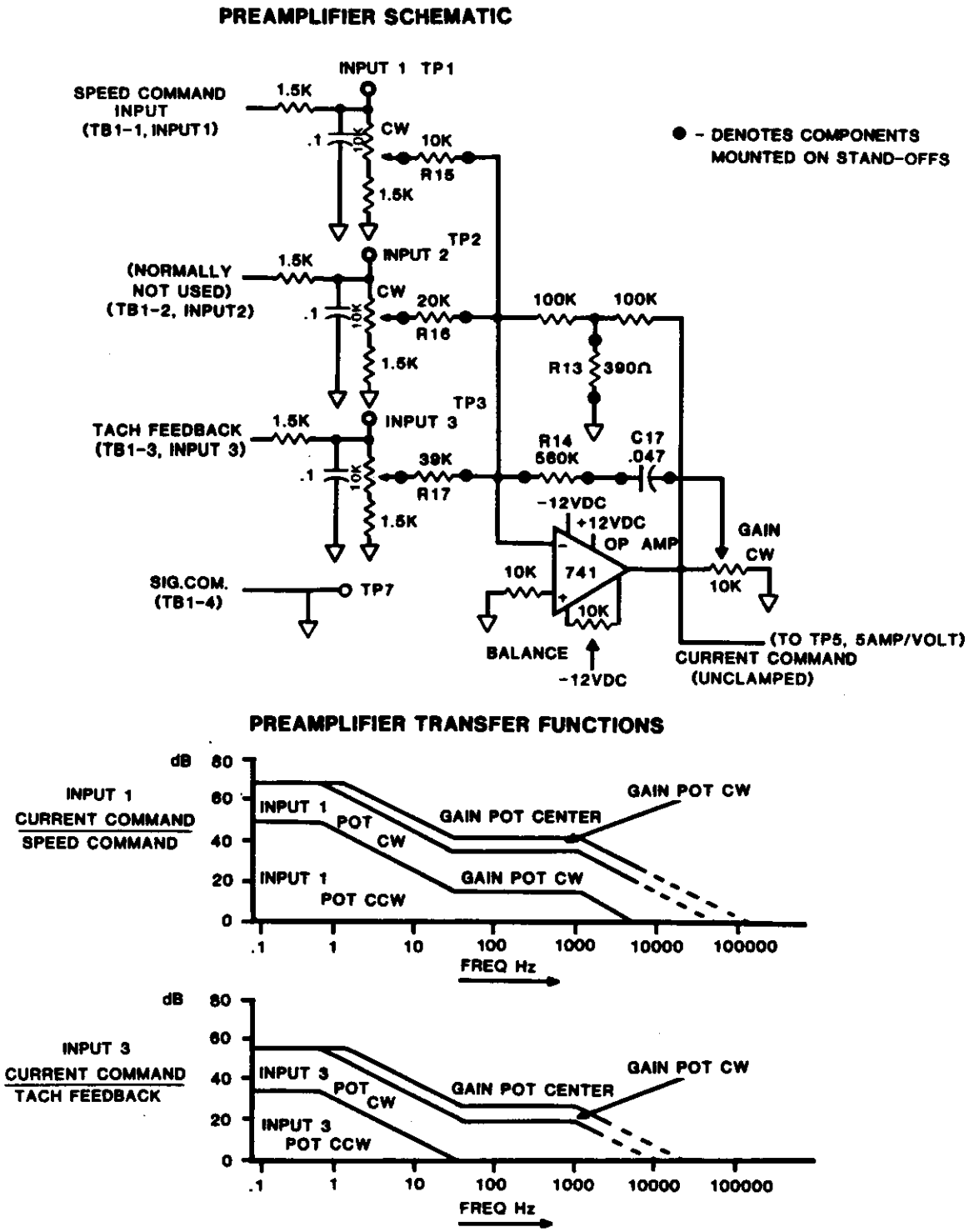


FIGURE 2-7: ELECTRICAL OUTLINE OF PRE-AMPLIFIER CIRCUIT WITH OPEN LOOP GAIN CHARACTERISTICS

CHAPTER 3

SECTION 3-1 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:

1. Input control power (TB1-9,10) and power stage input power (TB2-13,14,18,19) are disconnected.

2. 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 nullifies warranty.**

Mounting dimensions for the 1000VS 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, motor power 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 1000VS servo amplifier is described on page 3-4.

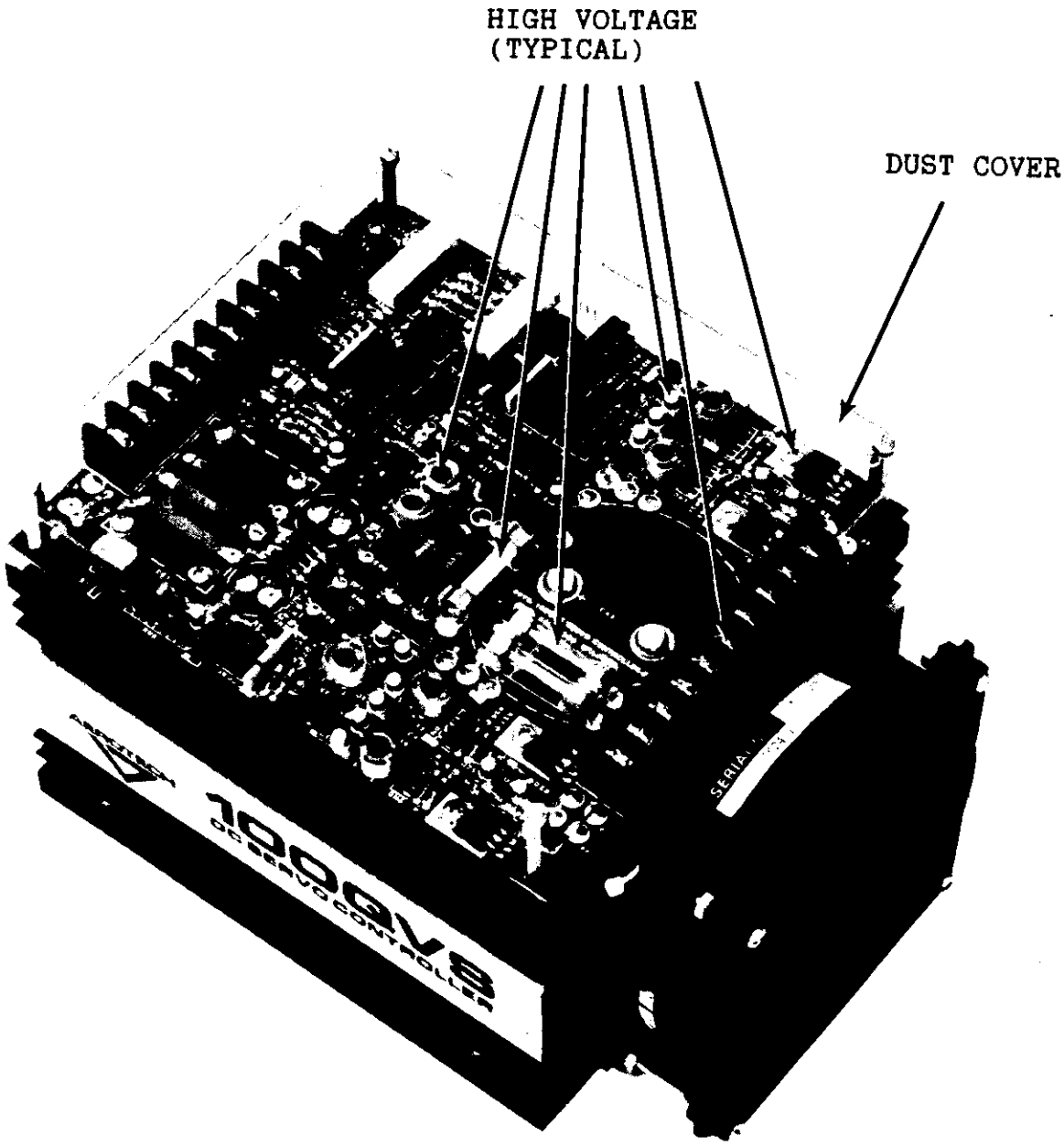


FIGURE 3-1: LOCATIONS OF HIGH VOLTAGES ON THE 100QVS SERVO AMPLIFIER

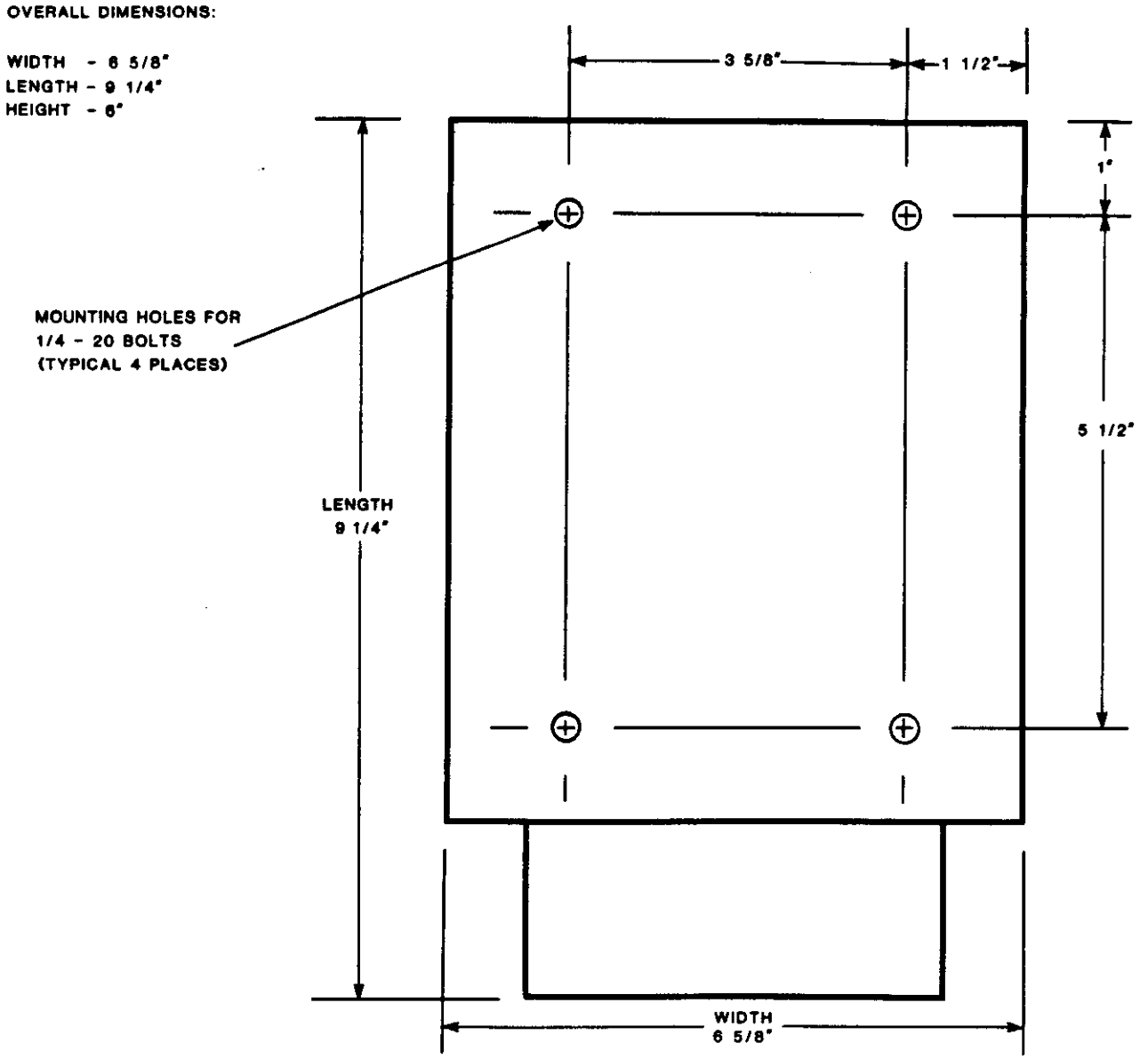


FIGURE 3-2: BACK VIEW OF 100QVS SERVO AMPLIFIER SHOWING MOUNTING HOLE LOCATIONS

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:

   a. The "+" lead (red) of the motor is connected to TB2 terminal 17, with the "-" lead (black) connected to TB2 terminal 16.

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

After the 100QVS servo amplifier has been installed and wired into the system, adjustments may now be made on the amplifier.

Note in figure 2-4 the locations of the six control pots and eight testpoints on the servo amplifier. Set the pots to the following positions:

1. Current limit pot to be adjusted to midway position.

2. Gain (Gain) pot to be turned completely CW.

3. Input 1 (speed command) pot to be turned completely CW.

4. Input 3 (tach feedback) pot to be turned completely CW.

5. 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 control and power stage 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 ($\pm$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.

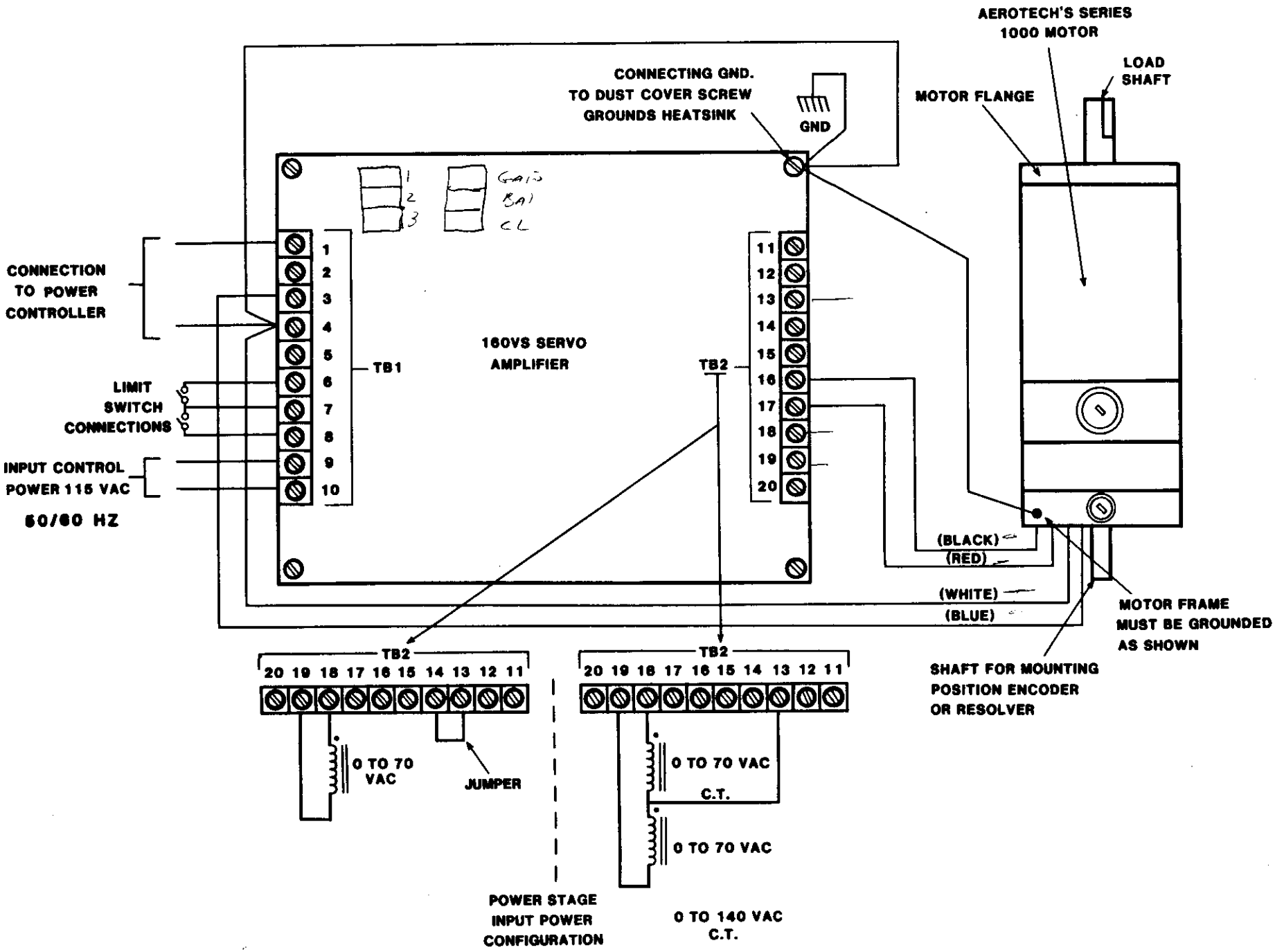


FIGURE 3-3: INPUT POWER, MOTOR AND CONTROL INTERCONNECTION DIAGRAM FOR THE 100QVS SERVO AMPLIFIER

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, TP3) with respect to signal common, TP7 (refer to figure 2-4).

SECTION 3-2 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.

Photograph A of figure 3-4 shows a typical deceleration interval for a motor (in this case, Aerotech's 1410-02-01 motor used with the 1000VS servo amplifier) being commanded to decelerate to zero speed by a position controller. Note that the motor's speed (seen as tach voltage on TP3) ramps smoothly to zero speed, without ever crossing zero. This photograph shows optimum motor response during deceleration.

Photograph 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.

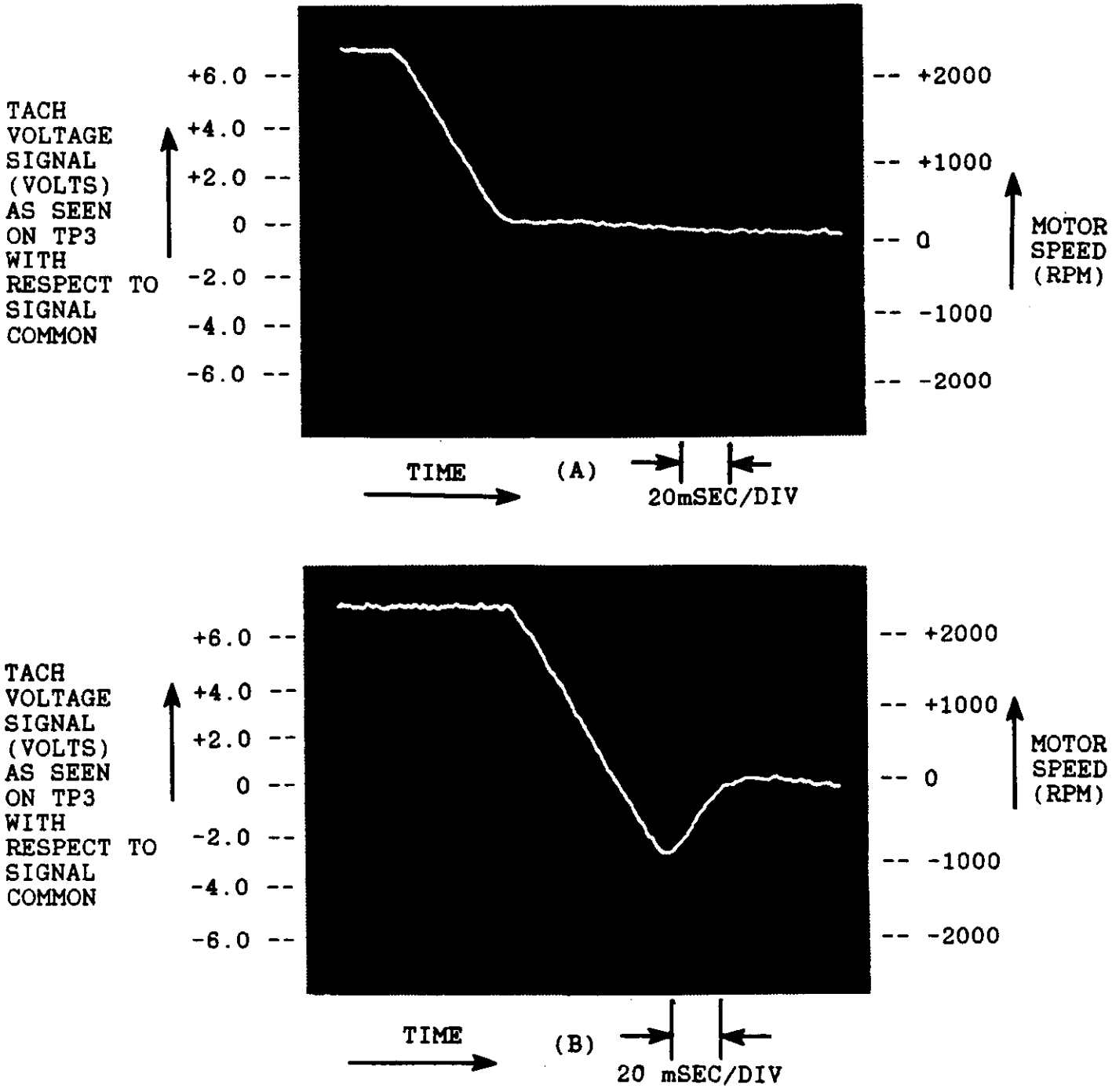


FIGURE 3-4: ADJUSTING INPUT 1 AND INPUT 3 POTS FOR POSITION LOOP STABILITY

SECTION 3-3 MINIMIZING RIPPLE CURRENT

The magnitude of ripple current present on the current feedback testpoint TP4 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:

1. The motor's armature inductance, which contributes to the servo amplifier switching ripple current on the current feedback signal (TP4).

2. 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 (TP5).

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.

Photograph A of figure 3-5 shows an optimum level peak to peak ripple current for the 1410-02-01 motor running unloaded, at constant speed. (This RMS ripple should be no more than 10% - 20% of the continuous current rating of the motor.)

Photograph 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 photograph A.

With these adjustments complete, the 1000VS servo amplifier is ready for full operation within the system.

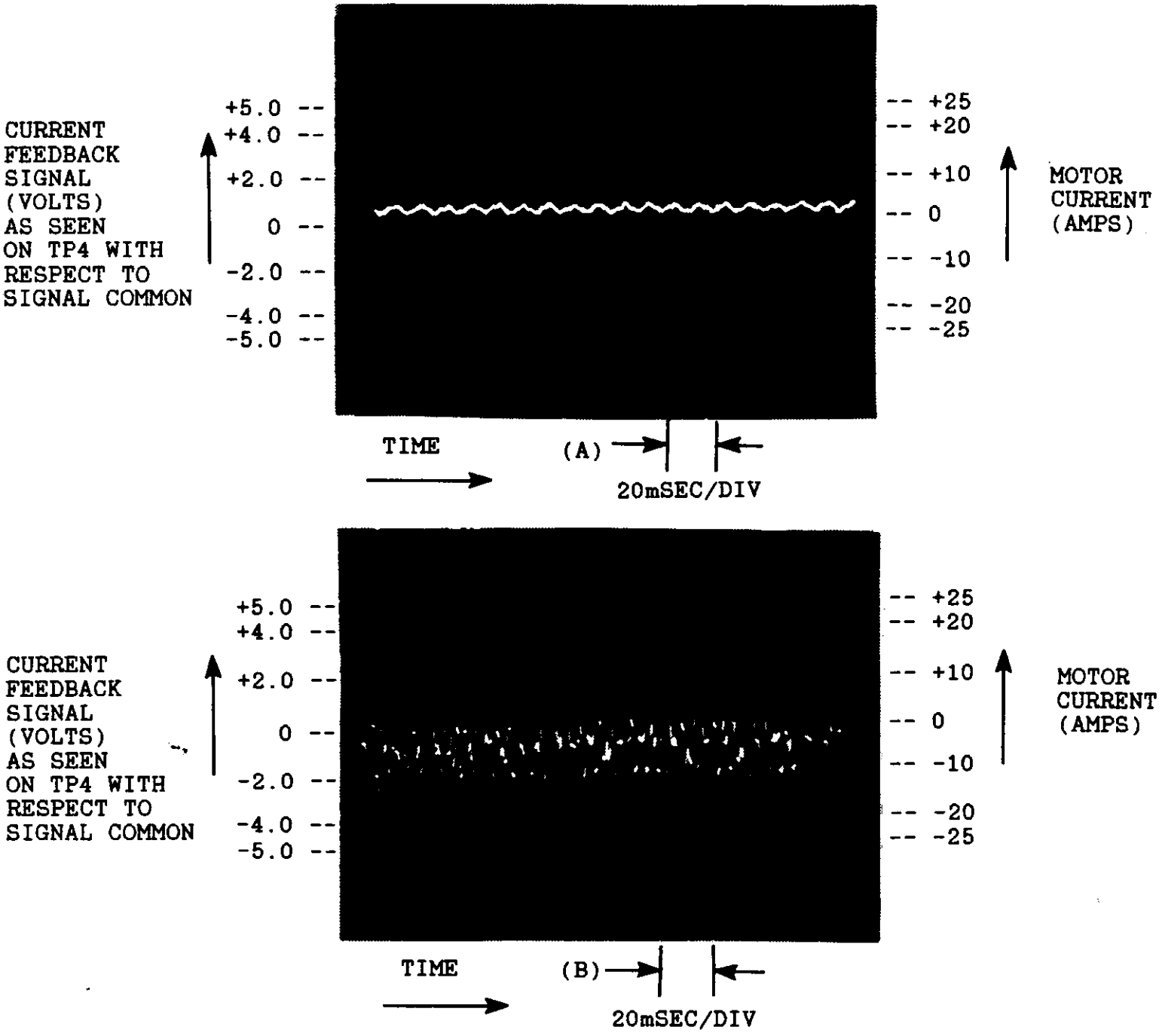


FIGURE 3-5: ADJUSTING THE GAIN POT TO MINIMIZE RIPPLE CURRENT IN THE MOTOR

CHAPTER 4

SECTION 4-1 TROUBLESHOOTING

Unless otherwise noted, refer to figure 2-4, 2-5 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 input power is applied to TB1 terminals 9 and 10, and TB2 terminals 13, 14, 18 and 19.	Input fuse F3 and F4 are open.	Replace fuses and re-apply power (use 3AG, 30 amp slow-blow fuse). If fuse opens again, return unit to Aerotech.
	Motor fuse (F2) is open.	Remove fuse and check for continuity (use 3AG, 12 amp slow-blow).
	Limit switch connections on TB1, terminals 6, 7 and 8 are activated.	Temporarily remove connection to restore power.
	±12 VDC control voltage not present.	Check TP8 (+12VDC) and TP6 (-12VDC) with respect to signal common (TP7). If input control power (TB1-9,10) is applied and these voltages are not present, return unit to Aerotech.
Motor is racing	Tach polarities are reversed on TB1 terminals 3 and 4.	Reverse tach connections on TB1, 3 and 4.

SYMPTOM	POSSIBLE CAUSE	SOLUTION
	No tach connection	Check tach testpoint (TP3) with respect to signal common (TP7). With motor racing, tach voltage signal should be present at this testpoint. If no signal is present, motor tachometer may be defective.
Trip LED remains energized (unable to reset through reset pushbutton). Current trip shut-down circuit activated.	Short circuit exists on motor terminals.	Disconnect motor leads on TB2-16, 17. Reapply power and de-press reset button. If LED stays energized, the servo amplifier is defective. Return to Aerotech for repair.
Motor is sluggish or over-shoots 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 current clamp level.
Motor will not lock in "home" position (position loop control).	Excessive DC off-set on input signal to servo module.	Adjust balance pot to bring system into "home" position. If system does not res-pond to this solution, then excessive offset exists on the speed command signal of the position controller.

SYMPTOM	POSSIBLE CAUSE	SOLUTION
Motor overshoots when coming to rest (position loop control).	Gain not set properly.	See section 3-2 for information on gain control adjustment in a position loop.
Motor runs very hot.	Gain set too high in servo amplifier, causing excessive ripple current in motor.	See section 3-3 for information on gain adjustments.

CHAPTER 5

SECTION 5-1 SERVICE AND REPAIR

General repair of equipment consists entirely of solutions listed in section 4-1 on Troubleshooting, or the removal and replacement of a servo amplifier should the need arise.

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 5-2 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 should call ahead for a "Return Authorization Number".

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

3. Equipment should be sent to:

   Aerotech, Inc.
   101 Zeta Drive
   Pittsburgh, PA 15238
   Phone: (412) 963-7470
   c/o Customer Service

WARNING: DAMAGE DUE TO IMPROPER PACKAGING VOIDS WARRANTY.

SECTION 5-3 PARTS LIST

DESCRIPTION	PART NUMBER	MANUFACTURER
Fuse F1	313003 (3 amp slow blow)	Littlefuse
Fuse F2	* MDA 12 (12 amp slow blow)	Bussmann
Fuse F3,F4	313020 (20 amp slow blow)	Littlefuse
100QVS Servo Amplifier	EFA 453	Aerotech

* This fuse is shipped with the 100QVS servo amplifier for 12 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
1960-01-01	MDA12	12 amp
1410-03-01	MDA10	10 amp
1210-01-01	MDA6.25	6.25 amp
1135-01-01	MDA5	5 amp
1075-01-01	MDA5	5 amp

Warranty and Field Service Policy

Aerotech, Inc. warrants its products to be free from defects caused by faulty materials or poor workmanship for a period of one year from date of shipment from Aerotech. Seller'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 one-year period. Seller 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 seller in specifications or drawings previously or subsequently provided seller, and whether or not seller's products are specifically designed and/or manufactured by seller 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.

Returning Goods Procedure
Claims for incorrect or defective materials must be filed within thirty (30) days from delivery at buyer's place of business. No units or systems may be returned, in or out of warranty, without first obtaining approval from the seller, and no claim will be allowed nor credit given for units or systems returned without such approval.

Returned Goods Warranty Determination
If possible, after approval from Aerotech, the defective unit or system is to be returned to the factory with statement of problem and transportation prepaid (no c.o.d. or collect freight shipments will be accepted). After Aerotech's in-plant examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination of such unit or system, warrantied defects exist, then the unit or system will be repaired at no charge and shipped, prepaid, back to the buyer. If an out-of-warranty situation exists, the buyer shall be notified of the repair cost immediately. At such time, the buyer must issue a purchase order to cover the cost of the repair or authorize the unit or system to be shipped back as is, at the buyer's expense.

On-Site Warranty Repair
If the system or unit cannot be made functional by telephone assistance or by sending and having customer install replacement parts, and cannot be returned to the Aerotech factory for repair, and if it is determined that 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 bona-fide purchase order to Aerotech covering all transportation and subsistence costs. For warranty repairs, customer will not be charged for cost of labor and material.

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 system or unit cannot be made functional by no-charge telephone assistance or purchased replacement parts cannot be returned to the Aerotech factory 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 bona-fide purchase order to Aerotech covering all transportation and subsistence costs and the prevailing cost per hour including travel time necessary to complete the repair.

AEROTECH,INC., 101 Zeta Drive, Pittsburgh, Pennsylvania 15238 • (412) 963-7470
TWX 710-795-3125 • FAX 412-963-7459

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