Compumotor

VAC
(Velocity and Acceleration Controller)
User Guide

Compumotor Division
Parker Hannifin Corporation
p/n 88-012134-01B

Parker

User Guide Change Summary

The following is a summary of the primary changes to this user guide since the last version was released. This user guide, version 88-012134-01**B**, supersedes version 88-012134-01**A**.

When a user guide is updated, the new or changed text is differentiated with a change bar in the right margin (this paragraph is an example). If an entire chapter is changed, the change bar is located to the right of the chapter title.

Technical changes to each chapter are synopsized below.

Chapter 1
(Introduction)

VAC Features Section:
- ❑ *Requires ±15VDC regulated power at 250mA* was deleted (power specifications are provided in Table 3-1 in Chapter 3)

VAC System Configurations Section:
- ❑ Deleted any reference to closed-loop velocity control and closed-loop velocity following (these options are not available)

Chapter 2
(Getting Started)

⑤ *Jumper Jog Input* Section:
- ❑ Corrected Figure 2-7—changed connector label from **P2** to **P3**

Chapter 3
(Installation)

Vfb Inputs Section:
- ❑ Replaced reference to tachometers with LVDTs (Linear Variable Differential Transformers)

Typical Input Source Connections Section:
- ❑ Deleted all references to closed-loop velocity control and closed-loop velocity following (these options are not available)
- ❑ Added Figure 3-5 to illustrate connections for bi-directional velocity control

Chapter 4
(Tuning & Modifications)

No changes

Chapter 5
(Troubleshooting)

No changes

Appendices

Appendix E: Index has been redone

Table of Contents

List of Figures

List of Tables

How To Use This User Guide

This user guide is designed to help you install, develop, and maintain your system. Each chapter begins with a list of specific objectives that should be met after you have read the chapter. This section is intended to help you find and use the information in this user guide.

Assumptions

This user guide assumes that you have the skills or fundamental understanding of the following information:

- ❑ Basic electronics concepts (voltage, switches, current, etc.)
- ❑ Basic motion control concepts (torque, velocity, distance, force, etc.)

With this basic level of understanding, you will be able to effectively use this user guide to install, develop, and maintain your system.

Contents of This User Guide

This user guide contains the following information.

Chapter 1: Introduction

This chapter describes the product and its specific features. Included in this chapter is a description of how the product operates.

Chapter 2: Getting Started

Getting Started contains a list of items you should have received with your shipment. A bench test procedure is provided to test the VAC before you begin the permanent installation in Chapter 3, *Installation*.

Chapter 3: Installation

The installation chapter provides guidelines and instructions for you to properly mount the system and make all electrical connections. Included in this chapter is a table of system specifications. Upon completion of this chapter, your system should be completely installed and ready to perform basic operations.

Chapter 4. Tuning & Modifications

This chapter discusses how to use the on-board potentiometers to tune the VAC for specific application needs. It also describes application-dependent hardware modifications for input scaling, noise suppression, drive resolution and custom input voltages; *most of these modifications require PCB soldering skills and must be performed by trained technicians.*

Chapter 5: Troubleshooting

This chapter contains information on identifying and resolving system problems.

Installation Process Overview

To ensure trouble-free operation, you should pay special attention to the environment in which the VAC equipment will operate. Environmental conditions include the layout, mounting, and wiring and grounding practices used. These recommendations are intended to help you easily and safely integrate the VAC into your facility.

Installation Procedures

Before you attempt to install this product, you should complete the following steps. The successful completion of these steps will prevent subsequent performance problems and allow you to isolate and resolve any potential system difficulties before they affect your system's operation.

① Review this entire user guide. Become familiar with the user guide's contents so that you can quickly find the information you need.

② Review Chapter 1, *Introduction*, (and the user documentation for the other components in your system) to develop a basic understanding of the system components, their functions, and interrelationships.

③ Perform the Bench Test provided in Chapter 2, *Getting Started.*

④ Review Chapter 3, *Installation*, to become familiar with the installation process.

⑤ After reading Chapter 3, begin the installation process. Do not deviate from the sequence or installation methods provided.

⑥ Perform as many basic functions as you can with the configuration established in Chapter 3; this will ensure that you have completed the installation process properly. You can perform this task only if you have reviewed the entire user guide.

⑦ After you are sure you have installed the VAC properly, you may proceed to Chapter 4 to tune or modify (if necessary) the VAC for your specific application needs.

Warnings & Cautions

Warning and caution notes alert you to possible dangers that may occur if you do not follow instructions correctly. Situations that may cause bodily injury are presented as warnings. Situations that may cause system damage are presented as cautions. These notes will appear in bold face and the word warning or caution will be centered and in all capital letters. Refer to the examples shown below.

WARNING

Do not touch the motor immediately after it has been in use for an extended period of time. The unit will be hot.

CAUTION

System damage will occur if you power up the system improperly.

Related Publications

The following publications may be helpful resources.

- Current Parker Compumotor Motion Control Catalog
- Schram, Peter (editor). *The National Electric Code Handbook (Third Edition)*. Quincy, MA: National Fire Protection Association

Chapter 1. Introduction

Chapter Objective

The information in this chapter will enable you to understand the product's basic functions and features.

VAC Description

The VAC (Velocity and Acceleration Controller) provides a variety of capabilities by converting analog signals to step and direction outputs compatible with Compumotor stepper and servo drives.

As an analog system, the VAC offers the following advantages:

- ❑ High performance at a low price
- ❑ High resolution
- ❑ Simplicity of interface to real-world signals
- ❑ Continuously variable adjustments with effectively infinite resolution
- ❑ Simple and cost-effective operator interfaces
- ❑ Wide bandwidth
- ❑ Ease of tailoring performance to a wide range of specific applications

Some analog-related disadvantages (compared to digital systems) are increased sensitivity to noise on input signals and power supplies, and drift resulting from component value changes with time and temperature.

Compumotor recommends using a closed-loop system configuration wherever possible to maximize the VAC's advantages and minimize noise sensitivity and drift.

Basic VAC system configurations and application examples are discussed later in this chapter (see *VAC System Configurations*).

The following are available options of the VAC. These options are described in detail in the *Appendix B* to this user guide.

- ❑ **–EVAL** option: Recommended as first unit ordered, it has the following features:
  - Adaptor that breaks out P3 (I/O) connector to screw terminals
  - Integral power supply (**–PS**) that allows operation from 120VAC line
  - Application notes
- ❑ **–PS** option: Integral power supply that allows operation from 120VAC line
- ❑ **–PK** option: Enclosed (packaged)
- ❑ **–IA** option: Uni-directional 4-20mA current-loop input
- ❑ **–IB** option: Bi-directional 4-20mA current-loop input

Figure 1-1 is a system block diagram of the VAC.

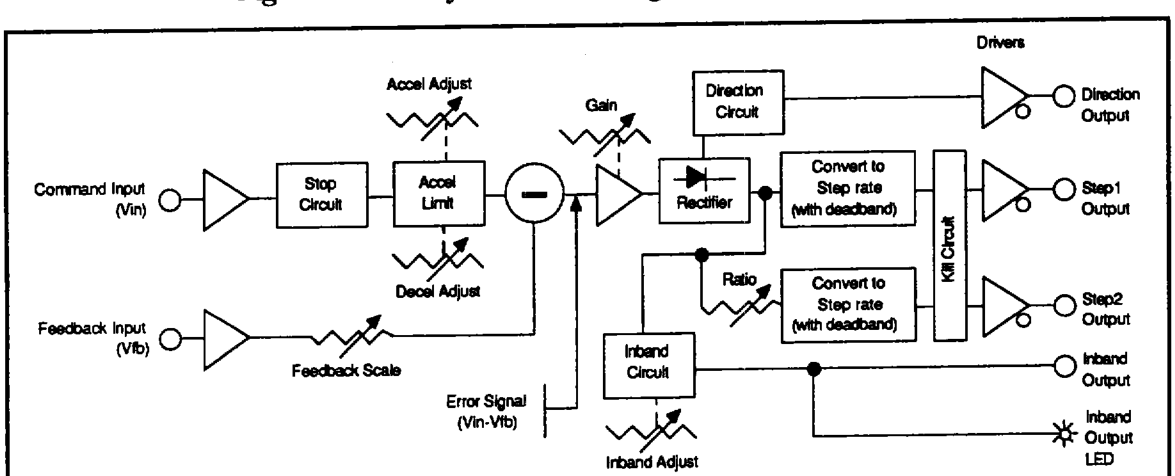


Figure 1-1. VAC Block Diagram

VAC Features

The VAC's basic features are as follows:

- Velocity control from an analog input
- Ability to position to a voltage
- Velocity following at a faster or slower rate
- Jog input
- Kill input
- Limit input
- User-adjustable acceleration and deceleration limits
- Heavy-duty step & direction outputs
- Maximum step pulse rate of 500KHz
- Euro-size card

VAC System Configurations

To help you understand the VAC, this section describes some typical VAC system configurations:

- Open-loop velocity control with acceleration limit
- Open-loop velocity following, at a faster or slower rate, using tachometer
- Closed-loop position control (position-to-voltage), using position sensor feedback
- Velocity control from a 4 - 20mA current loop (**-IA** & **-IB** versions)

A few examples of applications for the VAC are as follows:

- Controlling fluid flow, pressure/vacuum, or level (using a stepper-driven pump, or a stepper-driven valve with a position sensor on it)
- Dancer-arm tensioning or material-feed systems (e.g., to feed wire to a coil-winder on demand while compensating for the change in supply-reel diameter)
- Retrofitting higher-performance/resolution drives into existing ±10V or 4-20mA controller applications
- Providing continuously variable ratioing (*electronic gearing*) between two shaft velocities (i.e., adjustable *stretching*)

Detailed system connection procedures and diagrams are provided in Chapter 3, *Installation*.

Velocity Control

In its simplest version, the VAC converts an analog signal (usually ±10V) to step-and-direction signals suitable for driving any Compumotor drive or servo (see Figure 1-2). Thus, it can provide simple, cost-effective open-loop velocity control from a potentiometer. It provides adjustable acceleration control to protect fragile loads and to prevent stalls in stepper applications where smooth operation of the potentiometer cannot be assumed. The voltage input can come from many sources; potentiometers, joysticks or temperature, pressure, strain, or photo sensors can all be used. If a tachometer is used for the input, an open-loop velocity-follower is formed.

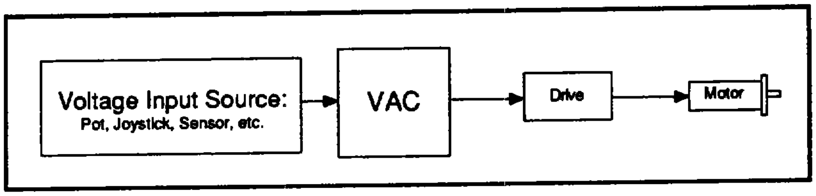


Figure 1-2. Velocity Control (Open-Loop) Functional Block Diagram

Velocity Following

If a tachometer (coupled to the shaft of the *master axis*) is used for input, a simple open-loop velocity follower is formed (see Figure 1-3). The velocity of the *slave axis* will follow changes in the velocity (and direction) of the master axis' shaft driving the tachometer.

The ratio between the two axes' shaft velocities can be continuously varied, and the slave shaft's velocity can be either higher or lower than that of the master.

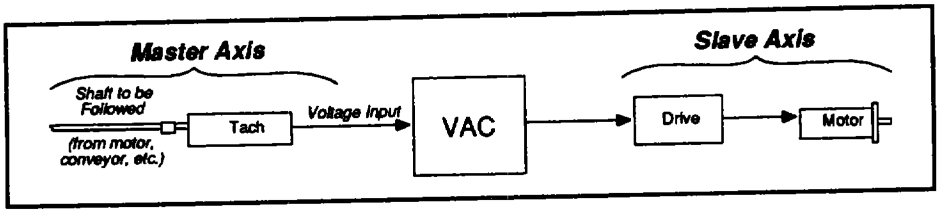


Figure 1-3. Velocity Following (Open-Loop) Functional Block Diagram

Closed-Loop Position Control

Although the VAC is a velocity system, a closed-loop position system is formed when a potentiometer (or other position sensor) is mounted to the load (or leadscrew) to generate position feedback (see Figure 1-4). This configuration provides a position-to-a-voltage function. Position-to-a-voltage operation is discussed in detail in Appendix D.

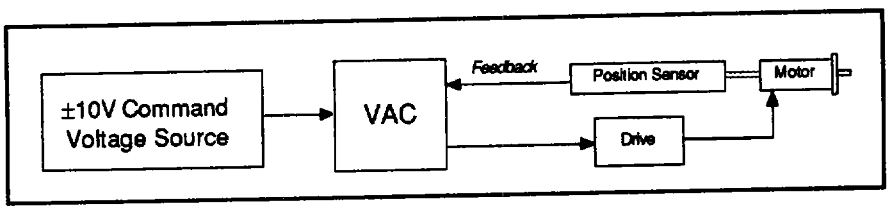


Figure 1-4. Position Control (Closed-Loop) Functional Block Diagram

4 - 20mA Current Loop Control (-IA & -IB Versions)

If you have a **-IA** or **-IB** version of the VAC, you can operate it directly from a dedicated 4 - 20mA current loop in either the uni-directional or bi-directional mode, respectively. Refer to Figure 1-5.

In the uni-directional mode (**–IA** version), a 4mA loop current produces no motion and a 20mA loop current produces motion at maximum velocity. The VAC direction output will indicate CW rotation.

In the bi-directional mode (**–IB** version), a 12mA loop current produces no motion, a 20mA loop current produces maximum CW velocity, and a 4mA loop current produces maximum CCW velocity.

Refer to Chapter 3 for detailed wiring instructions. Refer also to Appendix C for a detailed description of 4-20mA current loop operation.

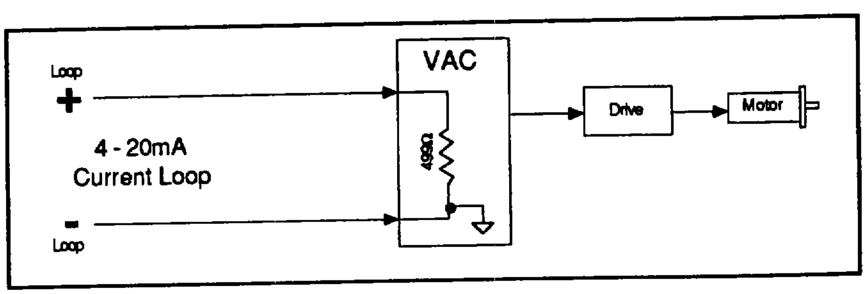


Figure 1-5. 4 - 20mA Current Loop Control Functional Block Diagram

Chapter 2. Getting Started

Chapter Objectives

The information in this chapter will enable you to do the following:

- ❑ Verify that your VAC system has been delivered safely
- ❑ Bench test the VAC system

What You Should Have

Inspect the VAC system upon receipt for obvious damage to its shipping container. Report any damage to the shipping company. *Parker Compumotor cannot be held responsible for damage incurred in shipment.* Table 2-1 lists the items that should be present, according to the option ordered (CP*VAC represents the standard VAC unit).

Part	Part Number	CP*VAC	−EVAL	−PS	−PK	−IA or −IB
3-foot cable with male 25-pin D (to drive)	71-012215-01	1	1	1	1	1
Cable with female 25-pin D (for I/O)	71-012214-01	1	N/A	1	1	1
Cable with female 25-pin D (for power)	71-012214-01	1	N/A	N/A	*	*
Screw-terminal adaptor (for I/O)	43-012142-01	N/A	1	N/A	N/A	N/A
Screw-terminal adaptor cable (for I/O)	71-010729-01	N/A	1	N/A	N/A	N/A
Power cable for direct 120VAC input	71-007547-01	N/A	1	1	**	**
PCB mounting stand-offs (6-32 x 1/2")	52-009034-01	4	4	4	4	4
VAC User Guide	88-012134-01	1	1	1	1	1

* Included if ordered without −PS or −EVAL option

** Included if ordered with −PS or −EVAL option

Table 2-1. Ship Kit List

Bench Test Procedure

This section leads you through step-by-step instructions to bench test your VAC system. ***This is a temporary configuration. The permanent installation will be performed in Chapter 3, Installation.***

> **CAUTION**
>
> Make sure power is removed **before** wiring the VAC.

The procedures in this section include the following steps:

① Connect motor
② Connect drive
③ Disable limit by making sure jumper JU3 is installed
④ Apply power
⑤ Jumper jog input to voltage reference input

Signal connections preceded by **P** refer to the pin-header on the circuit board itself (or to the screw-terminal adaptor for the −EVAL option). Those preceded by **D** refer to the D-connector on the supplied adapter cable. *These two connectors use entirely different numbering systems, so use caution when specifying or constructing cables.*

① Connect Motor

Referring to the user documentation that accompanied your motor and/or drive shipment, connect the motor to the drive. *Before you proceed with the VAC bench test, test the drive and motor to make sure they are functioning properly. Drives usually have a self-test feature for this purpose.*

② Connect Drive

If you are using a Compumotor stepper or servo drive, use the connection information provided in *Compumotor Drives*. If you are using a non-Compumotor drive, use the connection procedures in *Non-Compumotor Drives*.

Compumotor Drives

The VAC is shipped with a 25-pin D-connector compatible with Compumotor stepper and servo drives with 25-pin indexer input connectors. Using the provided three-foot drive cable, connect the drive as illustrated in Figure 2-1. If the drive you are using does not have a 25-pin connector, refer to *Screw Terminal Connections* below.

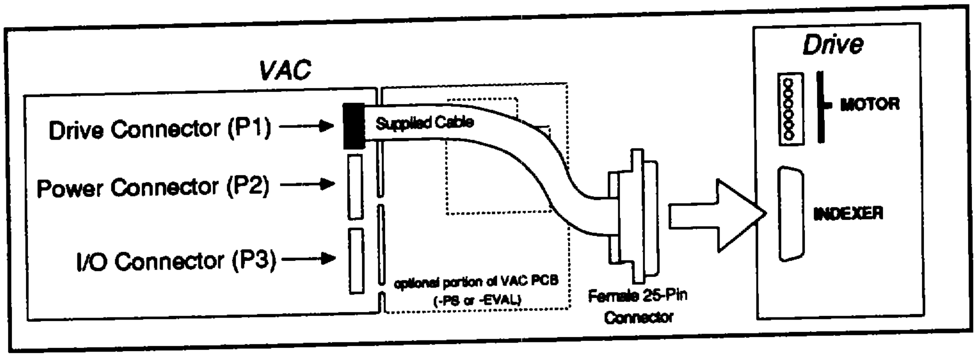


Figure 2-1. Drive Connections

Screw Terminal Connections

If your Compumotor drive has screw terminals instead of a 25-pin connector, wire the drive using the pin outs provided in Table 2-2 below. It is best to use a stripped-lead male 25-pin cable as a *converter cable*; however, you could make your own cable if you wish.

Connector P1 (Step & Direction)		
Signal Name	**Pin (P) Ribbon**	**Pin (D) D-Connector**
STEP1+	P1-1	D-1
STEP1-	P1-2	D-14
DIRECTION+	P1-3	D-2
DIRECTION-	P1-4	D-15
STEP2+	P1-5	N/C (not used in most applications)
STEP2-	P1-6	N/C (not used in most applications)
DIRECTION+	P1-7	N/C (not used in most applications)
DIRECTION-	P1-8	N/C (not used in most applications)

Table 2-2. Pin Outs for Connector P1 (Step & Direction)

Non-Compumotor Drives

If you are using a non-Compumotor drive, connect the drive to the VAC's P1 connector according to the pin out listed in Table 2-2 above. It is best to use a stripped-lead male 25-pin cable as a *converter cable*; however, you could make your own cable if you wish.

Step Outputs

Signal Type: Differential Digital pulse (approx 50% duty cycle). *Although differential operation is recommended, single-ended operation is possible using Step + and digital ground connections (see Figure 2-2).*

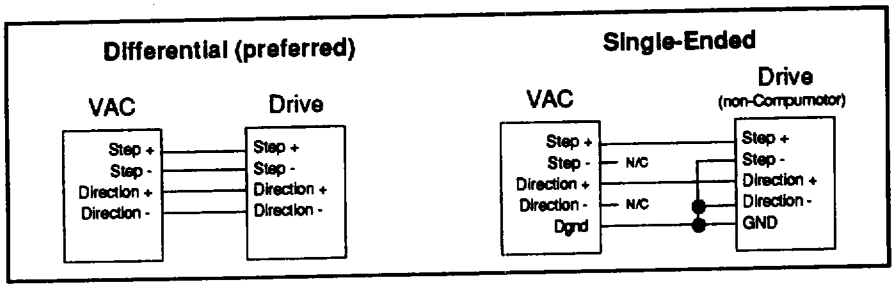


Figure 2-2. Differential vs. Single-Ended Step and Direction Connections

Function: These outputs provide step signals to the drive(s) connected to the VAC. They are differential signals capable of driving long cables at high step rates. These signals are suitable for use with any Compumotor stepper or servo drive. Up to 4 Compumotor drives may be driven in parallel if desired.

The Step2 and Dir2 outputs are available only at P1 and are not carried through to the D-connector. If Step2 and Dir2 are used, a different cable must be used that splits P1 into two D-connectors, one for each drive. This can be constructed using the information in Table 2-2, or contact Compumotor's Custom Product Group.

The two step outputs (Step1 and Step2) can have different step rates, controlled by the Ratio control potentiometer R22 (refer also to the *On-Board Pot Adjustments* section in Chapter 4).

Direction Outputs

Signal Type: Differential Digital level

Function: These outputs provide direction signals to the drive(s) connected to the VAC. They are differential signals capable of driving long cables. The two outputs are copies of the same signal. These signals are suitable for use with any Compumotor stepper or servo drive.

Although the two Step outputs can have different step rates (adjusted by Ratio control R22 (see above), the direction outputs always change state together.

When isolated differential inputs are used (such as those on Compumotor drives), they can be wired to turn in either direction (for positive input voltage) independently; however, they will reverse direction simultaneously. *The outputs are short-circuit protected, but if one direction line is shorted, the other will not function until the short is removed.*

③ *Disable Limit*

For the purposes of this bench test, you must ensure that the limit input is disabled by verifying that jumper JU3 is installed (see Figure 2-3). (Jumper JU3 is factory-installed.)

In some applications, a limit switch is installed to prevent the load from crashing into mechanical stops and/or injuring personnel. Chapter 3, *Installation*, discusses installing the limit switch.

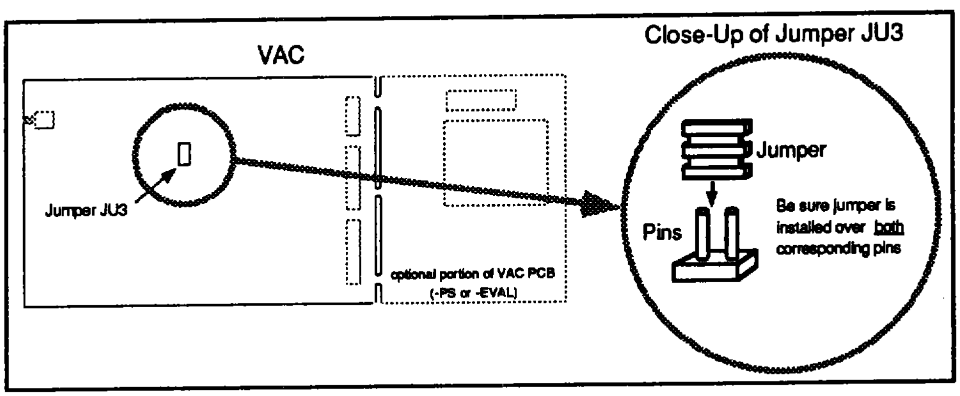


Figure 2-3. Disabling the Limit

④ Apply Power

If you are using a –PS or –EVAL option (has integral power supply), use the connection information provided in *On-Board Power Supply*. If you are using a any other VAC option, use the connection procedures described in *External Power Supply* .

Compumotor recommends wiring the VAC to a non-switched AC power source and left running continuously. Power consumption is only a few watts and continuous operation will avoid power-up transients and maintain the unit at thermal equilibrium to minimize drift.

WARNING

Connect the power to the VAC only as described below. Improper connections can damage the VAC unit and/or injure personnel.

On-Board Power Supply

If you have a –PS or –EVAL option, use the provided power cable (part number 71-007547-01) to connect the power to the VAC as illustrated in Figure 2-4. *(Connector P2 is typically unused if the unit has a power supply.)*

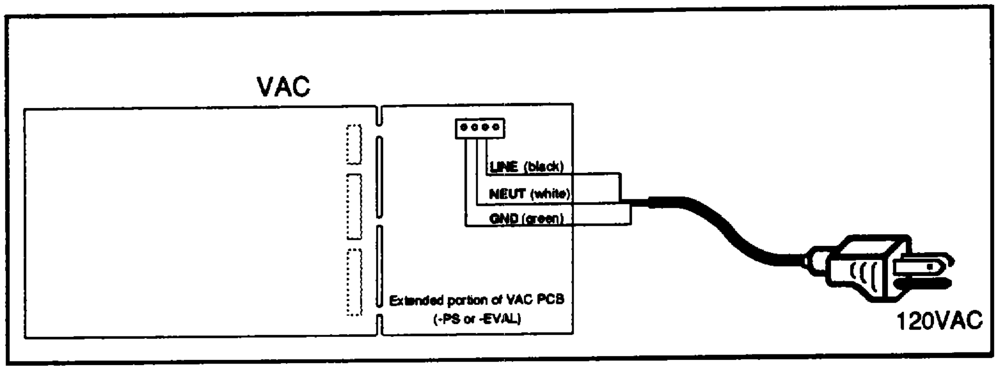


Figure 2-4. Power Connections to –PS and –EVAL Versions

External Power Supply

If you are using a VAC option other than –PS or –EVAL, connect the power to connector P2 as shown in Figure 2-5. Refer to Table 2-3 for pin outs.

CAUTION

You must use a quiet, well regulated supply capable of providing ±15V at 250mA. A linearly regulated supply is recommended, since some switching-type power supplies have high levels of high-frequency noise that can degrade performance or cause erratic operation.

Connector P2 (Power)		
Signal Name	Pin (P) Ribbon	Pin (D) D-Connector
+5V	P2-1	D-1
+5V	P2-2	D-14
DGND	P2-3	D-2
DGND	P2-4	D-15
DGND	P2-5	D-3
DGND	P2-6	D-16
DEGND	P2-7	D-4
DEGND	P2-8	D-17
+15V	P2-9	D-5
+15V	P2-10	D-18
+15CL	P2-11	D-6
+15V	P2-12	D-19
AGND	P2-13	D-7
AGND	P2-14	D-20
AGND	P2-15	D-8
AGND	P2-16	D-21
-15V	P2-17	D-9
-15V	P2-18	D-22
-15CL	P2-19	D-10
AGND	P2-20	D-23

Table 2-3. Pin Outs for Connector P2 (Power)

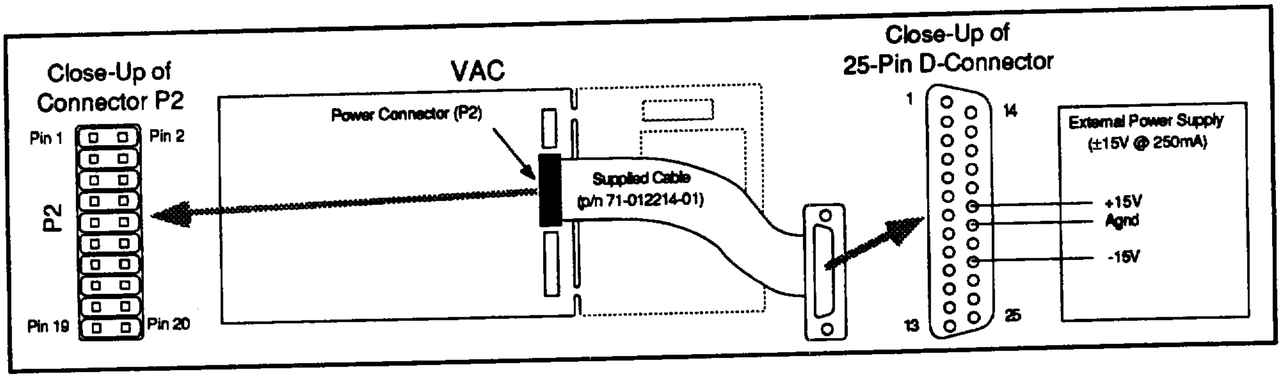


Figure 2-5. Power Connections to Connector P2

⑤ *Jumper Jog Input*

In this step, you will jog the motor to verify that the VAC is producing step pulses properly.

> **CAUTION**
>
> Before you jog the motor, make sure the motor shaft is **not** connected to the load and is free to rotate.

To jog the motor, jumper Jog (P3-10 or D-18) to +Tenref (P3-14 or D-20). Refer to Figure 2-6 for connections to the **–EVAL** version of the VAC. Refer to Figure 2-7 for connections to all other versions.

When this connection is made, the motor should turn CCW at approximately 1.0 rps. The motor jumps immediately (infinite acceleration) to 1.0 rps. *If you are not using a Compumotor motor/drive system, this high acceleration may be enough to stall the motor; if the motor stalls, remove power and discontinue this test.*

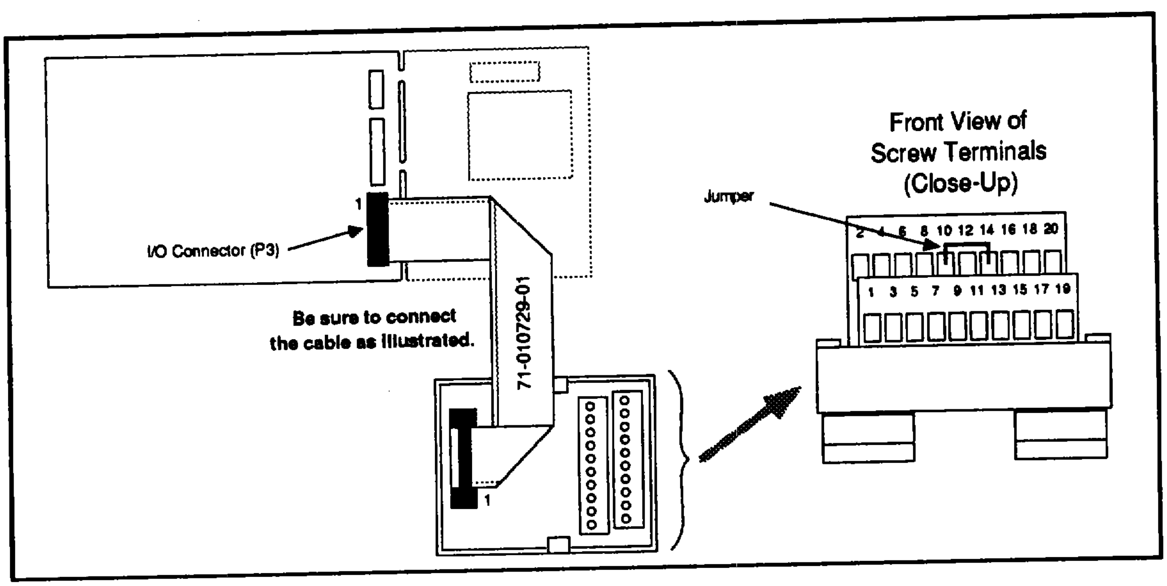


Figure 2-6. Temporary Jog Connections (for **–EVAL** Version)

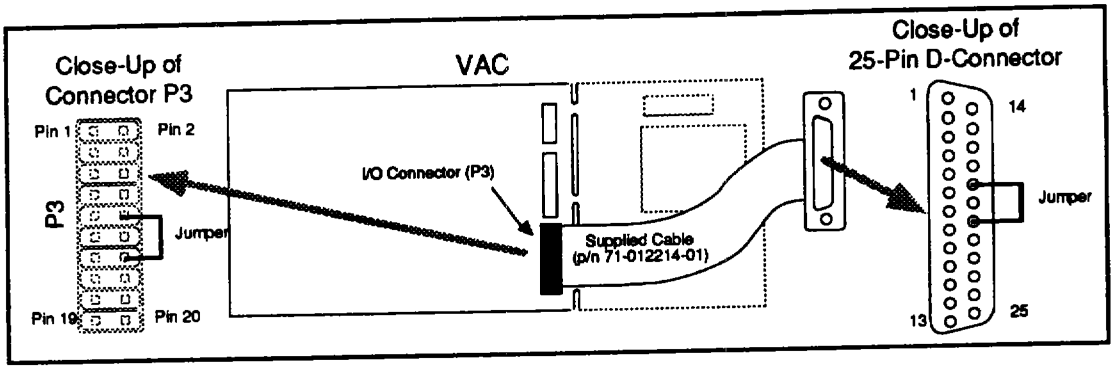


Figure 2-7. Temporary Jog Connections (Versions other than **–EVAL**)

Before You Install the VAC

If you have successfully completed the bench test, do the following to prepare for the detailed installation instructions in Chapter 3, *Installation*:

① Remove power.

② If you intend to use limit switch(es) in your application, remove jumper JU3; if not, leave JU3 installed.

③ Remove the jumper (between Jog and +Tenref) used for jogging the motor.

You are now ready to proceed to Chapter 3 for permanent installation instructions.

Chapter 3. Installation

Chapter Objectives

The information in this chapter will enable you to do the following:

- Mount the VAC unit
- Make all electrical system connections
- Ensure that the complete system is installed properly and functions correctly

You should proceed with this chapter only after you have performed the bench test provided in Chapter 2, Getting Started.

Specifications

Use Table 3-1 as a quick reference for general VAC system specifications. Detailed I/O specifications are provided in the *I/O Connections* section.

Parameter	Specification
Power Requirements	
With Integral Power Supply (-PS)	95 - 132VAC, 6 Watts
Without Integral Power Supply	±15V, 250mA
Input Signals	
Typical	±10VDC
-IA or -IB Options	4 - 20mA
Output Signals	Differential step & direction pulses (can be configured as single-ended), max. pulse frequency = 500KHz TTL-compatible inband output
Drive Compatibility	All Compumotor stepper and servo drives
Environmental	
Operating Temperature	32° to 140°F (0° to 60°C)
Storage Temperature	-4° to 185°F (-20° to 85°C)
Humidity (storage)	95% (non-condensing)

Table 3-1. VAC System General Specifications

Mounting

This section contains a step-by-step procedure to mount the VAC unit.

Mounting Guidelines

The VAC unit can be mounted with other control devices on a panel in a NEMA-approved enclosure, or in a Eurocard-size rack. Because the VAC is an analog device, electrically noisy devices should be housed in separate shielded enclosures or at a distance.

Do not mount large, heat-producing equipment directly beneath the VAC. *Electronic devices may perform unpredictably if they become too hot.* The maximum allowable ambient temperature directly below the VAC is 140°F (60°C). Fan cooling may be necessary if adequate air flow is not provided.

> **CAUTION**
> Varying temperatures around the VAC will cause component value changes that may result in degraded performance and/or drift.

Use the provided PCB stand-offs when mounting the VAC, or mount it in a Eurocard rack (VAC dimensions are standard Eurocard dimensions).

Dimensional Drawing

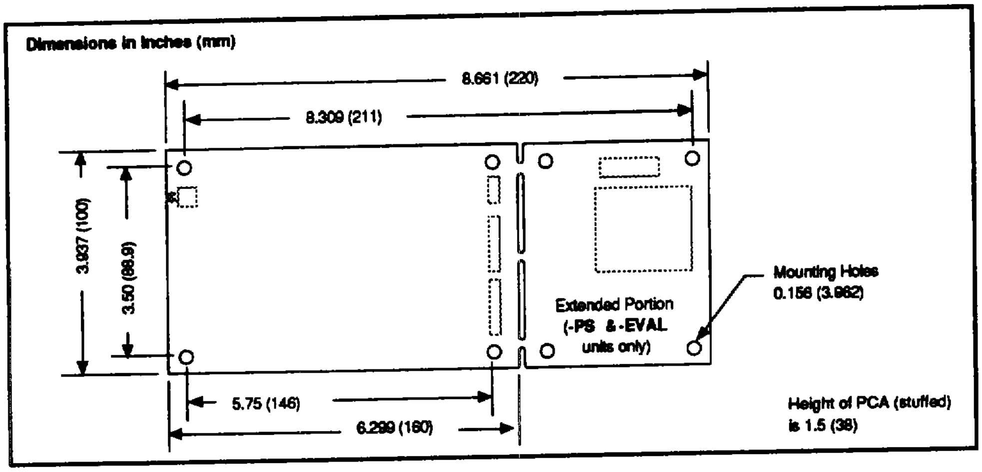


Figure 3-1. VAC Dimensional Drawing

System Connections

Refer to Chapter 2, *Getting Started*, for instructions to connect the power and the drive. VAC system I/O connections and typical input source connections are described in detail in this section.

Wiring Guidelines

Proper grounding of electrical equipment is essential to ensure the safety of personnel. You can reduce the effects of electrical noise due to electromagnetic interference (EMI) by grounding. All Compumotor equipment should be properly grounded. A good source of information on grounding requirements is the National Electrical Code published by the National Fire Protection Association of Boston, Massachusetts.

In general, all components and enclosures must be connected to earth ground through a grounding electrode conductor to provide a low impedance path for ground fault or noise-induced currents. All earth ground connections must be continuous and permanent. Compumotor recommends a single-point (one end only) grounding setup. Prepare components and mounting surfaces prior to installation so that good electrical contact is made between mounting surfaces of equipment and enclosure. Remove the paint from equipment surfaces where the ground contact will be bolted to a panel and use star washers to ensure solid bare metal contact.

Power Use Guidelines

Compumotor recommends wiring the VAC to a non-switched AC power source and left running continuously. Power consumption is only a few watts and continuous operation will avoid power-up transients and maintain the unit at thermal equilibrium to minimize drift. Refer to Chapter 2 for power connection procedures.

> **CAUTION**
>
> Power up the VAC **before** applying input voltages. The VAC will be damaged by input voltages outside its (±15V) supply voltage range. The proper power-up procedure is as follows:
>
> ① Power up the VAC
> ② Apply input voltage (or current) to the VAC
> ③ Power up the drive connected to the VAC

Drive and Motor Wiring

Refer to the manuals provided with your drive and motor to properly wire these components. Ensure that you have performed this wiring step successfully by following any test routines or verification procedures that your motor/drive installation recommends.

Cabling

I/O connections should be made with shielded cables (such as Belden 8451).

Power connections (units without a power supply) should be made with shielded cables if they would otherwise pick up noise from other equipment.

Step and Direction connections should be shielded on runs longer then 10 feet or when routed near sensitive equipment.

I/O Signal Connections

Use this section as a reference for VAC I/O connections. *Refer to Chapter 2 for Step and Direction connections to the drive.*

Figure 3-2 illustrates I/O connector P3 and the D-connector and Figure 3-3 shows the screw terminal adaptor supplied with the **–EVAL** option.

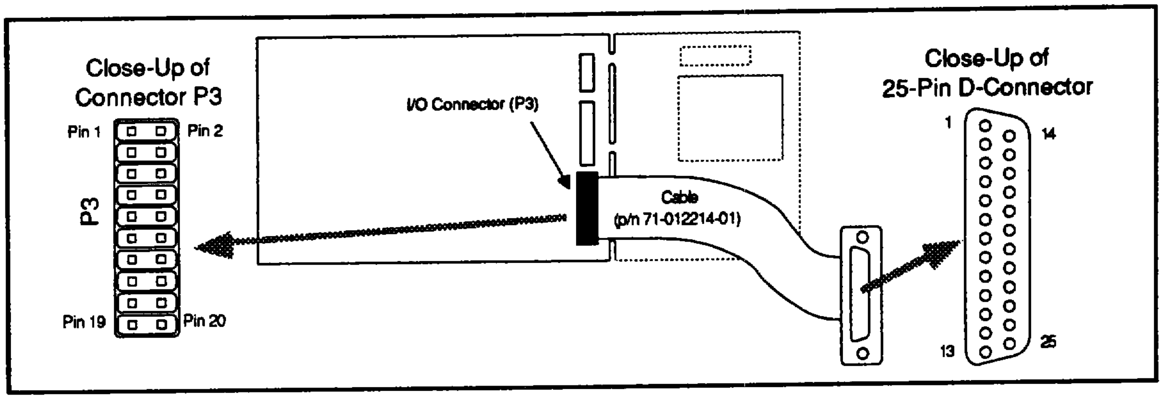


Figure 3-2. I/O Connector P3 and D-Connector

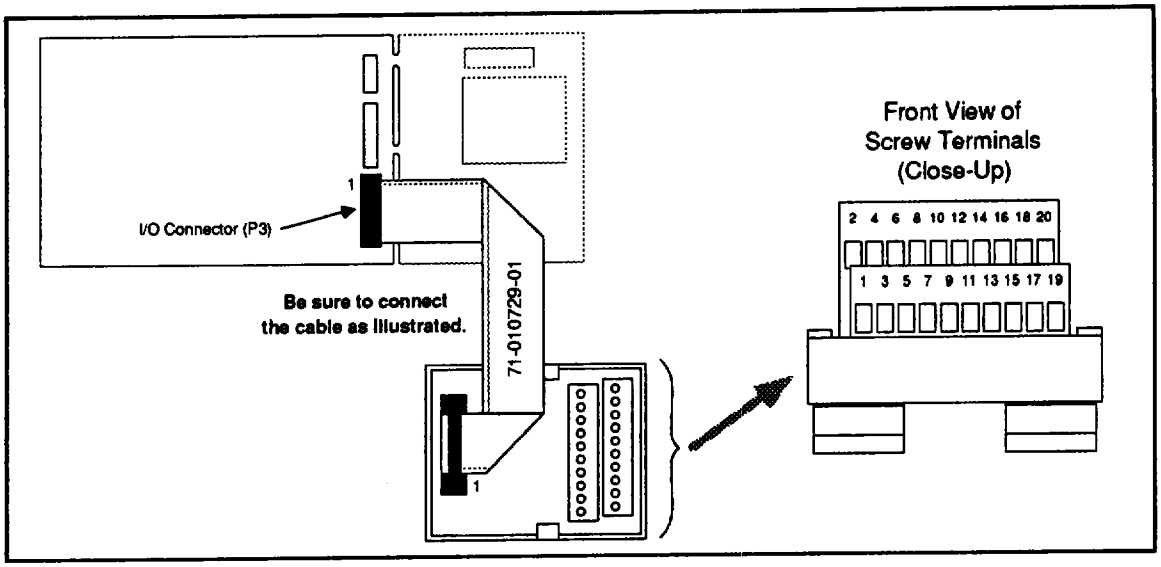


Figure 3-3. I/O Screw Terminal Adaptor for the **–EVAL** Option

Table 3-2 below lists the pin outs for I/O connector P3. Signal connections preceded by **P** refer to the **P3** pin-header on the circuit board, or to the screw-terminal adaptor that comes with the **–EVAL** option (pin outs are identical). Those preceded by *D* refer to the D-connector on the supplied adapter cable. *The* **P** *and* **D** *connectors use entirely different numbering conventions; use caution when specifying or constructing cables.*

Connector P3 (Signal I/O)		
Signal Name	Pin (P) Ribbon	Pin (D) D-Connector
DGND	P3-1	D-1
INBAND Output	P3-2	D-14
DGND	P3-3	D-2
LIMIT Input	P3-4	D-15
DGND	P3-5	D-3
KILL Input	P3-6	D-16
DGND	P3-7	D-4
STOP Input	P3-8	D-17
DGND	P3-9	D-5
JOG Input	P3-10	D-18
AGND	P3-11	D-6
AGND	P3-12	D-19
-TENREF Output	P3-13	D-7
+TENREF Output	P3-14	D-20
VFB- Input	P3-15	D-8
VFB+ Input	P3-16	D-21
Reserved	P3-17	D-9
Reserved	P3-18	D-22
VIN- Input	P3-19	D-10
VIN+ Input	P3-20	D-23

Table 3-2. Pin Outs for Connector P3 (Signal I/O)

Inband Output

Terminal Location: P3-2 (or D-14)
Signal Type: Digital (TTL Compatible), active high
Output Impedance: The output (sourcing) impedance is 2.2KΩ. It can tolerate shorts to ground, but will be **damaged if shorted to +5V**.
Function: A *high on* output indicates that the unit is operating within the range set by the Inband adjustment (see *On-board Adjustments*). The output can be used as a *move-complete* or *in-position* signal.

Limit Input

Terminal Location: P3-4 (or D-15)
Signal Type: Digital (active high with internal pull-up)
Function: This input is intended to be wired to digital ground through normally-closed limit switches. It functions as another kill input (no deceleration when activated). If you are operating a bi-directional system, you can wire two limit input switches in series to cover both ends of travel.

Remove Jumper JU3 if you intend to use limit switches (see also Figure 2-3).

Kill Input

Terminal Location: P3-6 (or D-16)
Signal Type: Digital (active low with internal pull-up)
Input Impedance: LS TTL
Range: 0 to +5V (TTL)
Function: This signal will cut off the step pulses coming from the step output(s). While this input is activated (low), no pulses will be output by the VAC.

CAUTION

There is no acceleration or deceleration limit associated with the kill input. If the kill input is activated at high velocity, a stall is likely. Similarly, if, while the kill input is active, a high velocity is commanded, releasing kill will result in an infinite acceleration command to the drive, causing the drive to either jump to a high velocity (possibility damaging the load) or to stall. This input is intended to be used under low-velocity conditions (e.g., to ensure that the load remains stationary while a measurement is made).

Stop Input

Terminal Location: P3-8 (or D-17)
Signal Type: Digital (active low with internal pull-up)
Input Impedance: LS TTL
Range: 0 - 5V (TTL)
Function: This input is used to stop motion in a controlled manner. When this input is activated (low), the input voltage is reduced to zero at a rate determined by the setting of the **ACCEL** pot (or the **DECEL** pot if jumper JU2 is installed- see also *On-Board Pot Adjustments* in Chapter 4). This will cause the load to decelerate smoothly to zero velocity. *However, in a position system, the effect is quite different — the load will be moved to the position corresponding to zero input voltage.*

In a position system that is at equilibrium (not moving) further motion can be inhibited using the Kill input (see above).

Jog Input

Terminal Location: P3-10 (or D-18)
Signal Type: Analog voltage (re: Analog Ground)
Input Impedance: The impedance of the jog input is 100KΩ
Range: ±15V
Function: This input is intended to be used for jogging (low-velocity set-up moves). In a velocity system, this input would be connected via an SPDT (center-off) switch (and optional jog velocity pot) to the + and - Tenref outputs, or to the +15V or -15V power supply. The +15CL (P2-11; D-6) and -15CL (P2-19; D-10) outputs are provided for this purpose. These outputs are internally connected to the corresponding supplies via 10KΩ resistors.

When the switch is closed, the motor will move in the appropriate direction (see caution note below) at a low velocity until the switch is opened. A resistor or pot in series with the jog input will reduce the jog velocity.

CAUTION

In contrast to the command input (Vin), a positive voltage at the jog input produces CCW motion, and a negative voltage produces CW motion. Be sure to label your jog switch accordingly.

In a position system, the effect will be to deflect the load slightly from its commanded position. The direction and displacement can be controlled as described above.

-Tenref Output

Terminal Location: P3-13 (or D-7)
Signal Type: Analog voltage output (re: Analog Ground)
Output Impedance: This output is intended to drive loads of 2KΩ or higher.
Range: Approx -1.3 to -12VDC.
Function: This output provides a stable source of DC voltage that tracks the +Tenref voltage. It may be used to provide voltage to pots (or other sensors) used as input or feedback elements (see *Typical Input Source Connections*).

+Tenref Output

Terminal Location: P3-14 (or D-20)
Signal Type: Analog voltage output (re: Analog Ground)
Output Impedance: This output is intended to drive loads of 2KΩ or higher.
Range: Approx. +1.3 to +12VDC
Function: This output provides a stable source of DC voltage (derived from a bandgap voltage reference). It may be used to provide voltage to potentiometers (or other sensors) used as input or feedback elements (see *Typical Input Source Connections*). This output is normally set to provide +10VDC.

In the 4-20mA current loop application (**–IA** or **–IB** options), this reference voltage is used to provide *zero* adjustment and has been adjusted at the factory. The only difference between version **–IA** (uni-directional version) and **–IB** (bi-directional version) is the setting of this voltage via pot R14 on the VAC's PCB (see *Tenref Trim* in Chapter 4).

Vfb Inputs

Terminal Locations: Vfb- = P3-15 (or D-8)
Vfb+ = P3-16 (or D-21)

Signal Type: Differential analog voltage.

Input Impedance: The default input impedance is 10kΩ. This can be changed by installing the desired value for R37. High impedances are required when using high-impedance sources such as potentiometers, but lower impedances will provide improved noise immunity when low-impedance sources such as linear variable differential transformers (LVDT) or computers are used.

Range: The normal range of this signal is ±10V (or 0V to +10V) full-scale. It can be scaled to ±1V (or 0V to 1V) — see *Input Scaling* discussed in Chapter 4.

Function: These inputs accept analog voltage feedback to the VAC. This voltage can be derived from a wide variety of sources, including potentiometers, sensors, controllers or computers. This voltage will be subtracted from the voltage applied to Vin, and the difference will become the *internal error signal* that determines what step and direction signals are generated by the VAC.

When connecting to a differential (balanced) output, connect Vfb+ to Vout+ and Vfb- to Vout-, and connect Agnd to the ground on the signal source. When connecting to a single-ended output (or potentiometer), connect Vfb+ to the output, and both Vfb- and Agnd to the ground on the signal source (or the low side of the potentiometer). See also *Typical Input Source Connections.*

If the Vfb inputs are unused (open-loop applications) tie them both to Agnd to disable the feedback inputs and avoid noise pickup.

Vin Inputs

Terminal Locations: Vin- = P3-19 (or D-10)
Vin+ = P3-20 (or D-23)

Signal Type: Differential analog voltage.

Input Impedance: The default input impedance is 1.3MΩ. This can be reduced by installing the desired value for R43. High impedances are required when using high-impedance sources (such as potentiometers), but lower impedances will provide improved noise immunity when low-impedance sources (such as tachometers or computers) are used.

Range: The normal range of this signal is —10V (or 0V to +10V) full-scale. It can be scaled to ±1V (or 0V to 1V) — see *Input Scaling* discussed later in this chapter.

Function: These inputs accept an analog voltage command to the VAC. This will be a velocity command unless a position loop has been closed, in which case it will be a position command. This voltage can be derived from a wide variety of sources, including potentiometers, sensors, controllers or computers. This voltage will have the feedback voltage (if any) applied to Vfb subtracted from it, and the difference will become the internal error signal which will determine what step and direction signals are generated by the VAC.

When connecting to a differential (balanced) output, Vin+ goes to Vout+ and Vin- to Vout- and Agnd goes to the ground on the signal source. When connecting to a single-ended output (or potentiometer), Vin+ goes to the output, and both Vin- and Agnd go to ground on the signal source (or the low side of the potentiometer). See also *Typical Input Source Connections.*

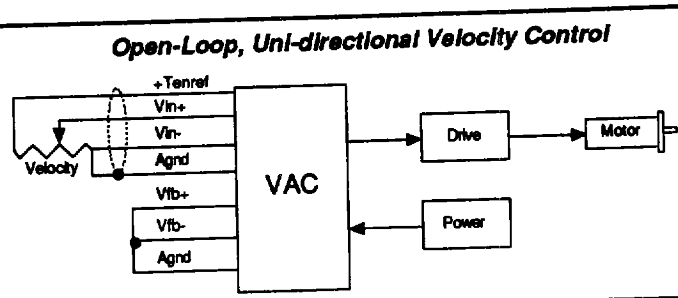
In 4-20mA current loop applications using version –IA or –IB, the positive side of the loop is connected to Vin+ (P3-20; D-23) and the negative side of the loop is connected to Agnd (P3-11 or 12;D-6 or 19). **Vin- (P3-19; D-10) is connected internally to +Tenref (P3-14; D-20) and must not be connected to anything else (see Figure 3-10).**

Typical Input Source Connections

This section illustrates typical control input and feedback source connections for the system configurations described in Chapter 1; the inputs involved (Tenref, Vfb, and Vin) are described in detail in the previous section.

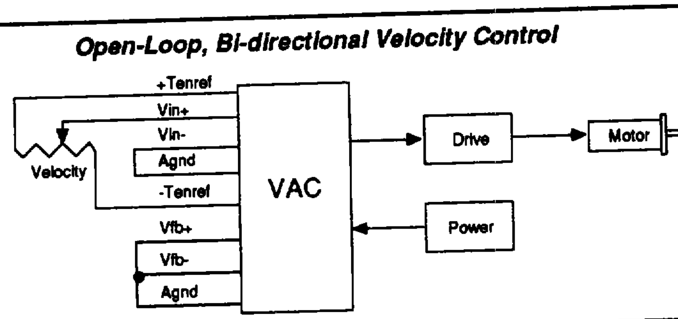
Velocity Control

In its simplest version, the VAC converts an analog signal (usually ±10V) to step-and-direction signals suitable for driving any Compumotor drive or servo. The voltage input can come from many sources; potentiometers, joysticks or temperature, pressure, strain, or photo sensors can all be used. Figures 3-4 and 3-5 illustrate typical input source connections for uni-directional and bi-directional applications, respectively.



Pinouts		
Name	P	D
+Tenref	P3-14	D-20
Vin+	P3-20	D-23
Vin-	P3-19	D-10
Agnd	P3-11	D-6
Vfb+	P3-16	D-21
Vfb-	P3-15	D-8
Agnd	P3-12	D-19

Figure 3-4. Velocity Control Connections (Uni-Directional)

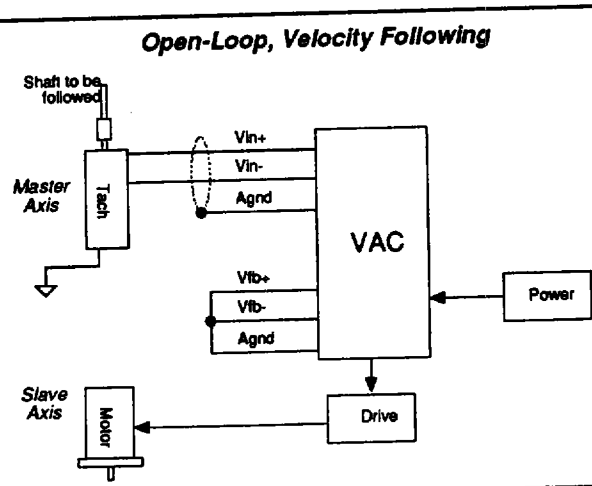


Pinouts		
Name	P	D
+Tenref	P3-14	D-20
-Tenref	P3-13	D-7
Vin+	P3-20	D-23
Vin-	P3-19	D-10
Agnd	P3-11	D-6
Vfb+	P3-16	D-21
Vfb-	P3-15	D-8
Agnd	P3-12	D-19

Figure 3-5. Velocity Control Connections (Bi-Directional)

Velocity Following

If a tachometer (coupled to the shaft of the *master axis*) is used for input, an open-loop velocity follower is formed. The velocity of the *slave axis* will follow changes in the velocity (and direction) of the master axis' shaft driving the tachometer (see Figure 3-6).



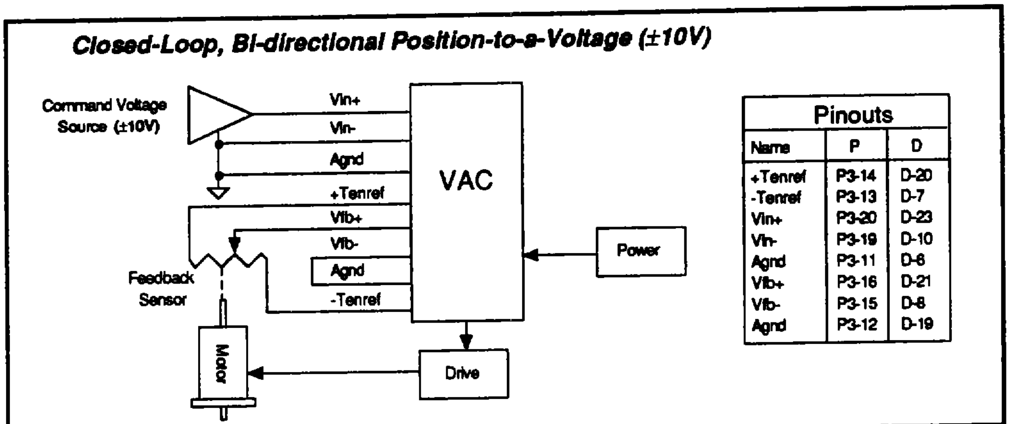
Pinouts		
Name	P	D
Vin+	P3-20	D-23
Vin-	P3-19	D-10
Agnd	P3-11	D-6
Vfb+	P3-16	D-21
Vfb-	P3-15	D-8
Agnd	P3-12	D-19

Figure 3-6. Velocity Following Connections

Closed-Loop Position Control

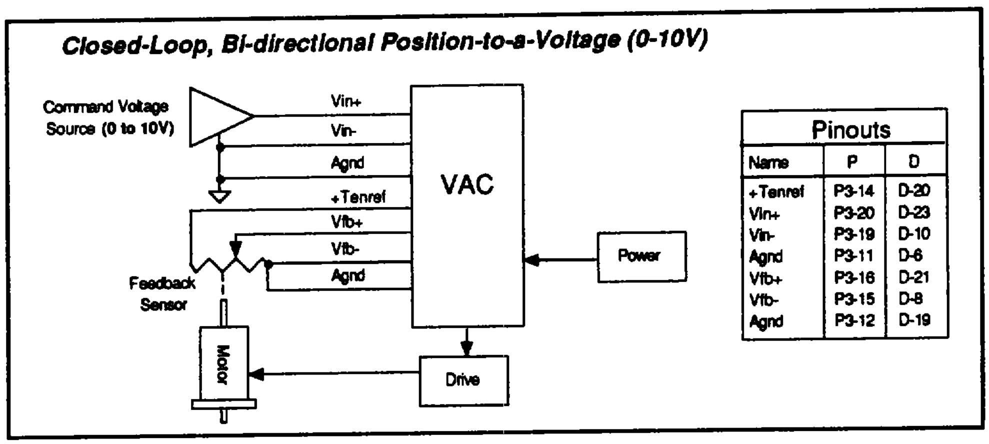
Although the VAC is a velocity system, a closed-loop position system is formed when a potentiometer (or other position sensor) is mounted to the load (or leadscrew) to generate position feedback. This configuration provides a position-to-a-voltage function. Figure 3-7 illustrates a ±10V system and Figure 3-8 shows a 0 - 10V system.

Refer to Appendix D for a detailed description of position-to-a-voltage operation.



Pinouts		
Name	P	D
+Tenref	P3-14	D-20
-Tenref	P3-13	D-7
Vin+	P3-20	D-23
Vin-	P3-19	D-10
Agnd	P3-11	D-6
Vfb+	P3-16	D-21
Vfb-	P3-15	D-8
Agnd	P3-12	D-19

Figure 3-7. ±10V Closed-Loop Position Control Connections



Pinouts		
Name	P	D
+Tenref	P3-14	D-20
Vin+	P3-20	D-23
Vin-	P3-19	D-10
Agnd	P3-11	D-6
Vfb+	P3-16	D-21
Vfb-	P3-15	D-8
Agnd	P3-12	D-19

Figure 3-8. 0 - 10V Closed-Loop Position Control Connections

4 - 20mA Current Loop Control

If you have a **-IA** or **-IB** version of the VAC, you can operate it directly from a *dedicated* 4 - 20mA current loop (see Figure 3-9). *A **dedicated** current loop is one in which the VAC is the only receiver.* When ordered as the **–IA** or **–IB** option, the VAC is equipped with an internal 499Ω resistor.

Refer to Appendix C for a detailed description of 4-20mA current loop operation.

In the uni-directional mode (version **-IA**), a 4mA loop current produces no motion and a 20mA loop current produces motion at maximum velocity. The VAC direction output will indicate CW rotation.

In the bi-directional mode (version **-IB**), a 12mA loop current produces no motion, a 20mA loop current produces maximum CW velocity, and a 4mA loop current produces maximum CCW velocity.

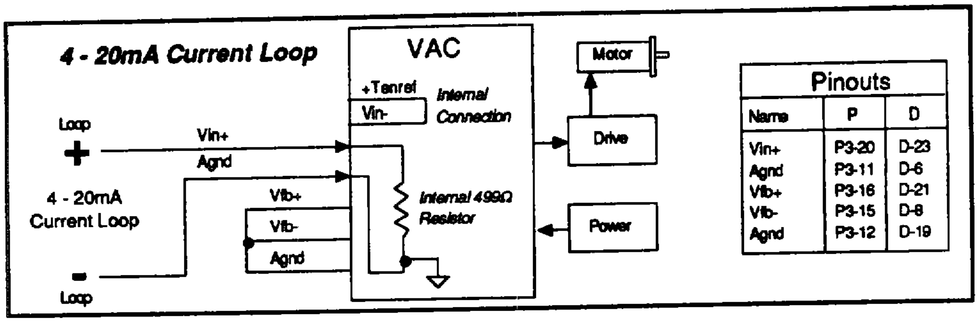


Figure 3-9. 4 - 20mA Current Loop Control Connections

Chapter 4. Tuning & Modifications

Chapter Objectives

Use this chapter as a reference for the following:

- ❑ On-board potentiometer adjustments
- ❑ Application-dependent hardware modifications for input scaling, noise suppression, drive resolution and input voltage (changing/adding resistors, capacitors, attenuators, etc.)

On-Board Pot Adjustments

This section describes how to use the VAC's on-board trimmer potentiometers (pots) to fine-tune the VAC. Figure 4-1 shows the location of each pot on the VAC PCB.

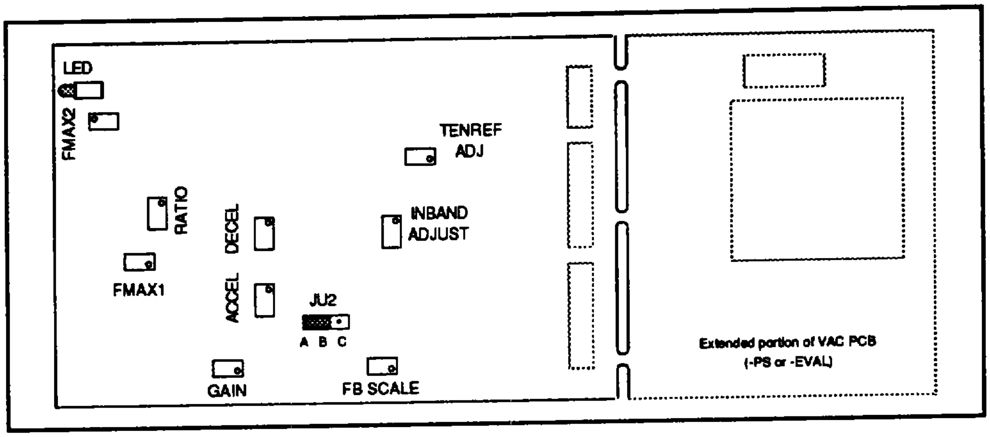


Figure 4-1. Location of Potentiometers, Jumper JU2, and LED

Acceleration Limit (R35)

Function: This control sets the maximum acceleration that will be permitted. It is used to prevent damage to fragile mechanical systems or loads, and to prevent stalls in stepper applications.

This feature is controlled by the setting of jumper JU2. In the default configuration (position A-B), the acceleration limit control affects both acceleration and deceleration equally, and the deceleration limit control (below) has no effect.

CW: Faster acceleration ramp

Range: Standard range is approx 1 second for acceleration from a stop to maximum velocity.

Deceleration Limit (R29)

Function: This control sets the maximum deceleration that will be permitted. It is used to prevent damage to fragile mechanical systems or loads, and to prevent stalls in stepper applications.

This feature is controlled by the setting of jumper JU2. In the default configuration (position A-B), the acceleration limit control affects both acceleration and deceleration equally, and the deceleration limit control has no effect.

To enable this control, place jumper JU2 in the B/C position (move it closer to the I/O connectors).

CW: Faster deceleration ramp

Range: Standard range is approx 1 second for deceleration from maximum velocity to a stop.

Maximum Step Rate (R25 & R6)

Fmax1 (R25) (for Step1 output)
Fmax2 (R6) (for Step2 output)

Function: These controls (R25 & R6) allow matching the maximum step output frequencies to the maximum velocities required and to the resolution of the drives used. When the VAC is used with low-resolution drives, or at very low maximum velocities, improved performance can sometimes be obtained by adjusting the maximum step frequency to a lower value than the standard 500KHz. Refer also to the *Drive Resolution Select Capacitors* section provided later in this chapter.

If you have such an application and cannot obtain satisfactory performance from your system, please contact Compumotor's Applications Department for assistance. ***These controls are factory-adjusted, and will typically require no further adjustments except in the most critical applications.***

CAUTION

Extreme mis-adjustment of these controls can cause the VAC to stop working completely, although no damage will result. Proper setting of these controls requires test equipment.

CW: Increase max step rate

Range: Dependent on values of C26 and C11 respectively. While the range of the control is considerable, in critical applications optimum linearity and dynamic range are obtained when the resistance of this (10KΩ) pot is approximately 8.5KΩ.

Gain (R39)

Function: This control permits adjustment of the proportional gain applied to the difference between the inputs (Vin - Vfb). (In open-loop applications, Vfb = 0, so this difference is equal to Vin.) This gain has the same effect on all frequencies of input, and provides a scaling function to set how much change in velocity will result from a given change in the input voltages.

In position systems, this control will influence the final position accuracy, the correction velocity, and the effective dead band size. In 4-20mA current loop applications, this controls the *span* (the amount of current it takes to produce maximum velocity).

CW: Increase gain

Range: 1 - 10 times

Feedback Scale (R41)

Function: This control adjusts the feedback signal level. The normal setting of this control is CCW. It can be used to match the output voltage of the sensor used for feedback. In conjunction with the Input Scaling Resistor (see *Hardware Modifications*), a wide range of full-scale-voltage sensors can be accommodated.

This control will have an effect on system behavior similar to that of the Gain control (in closed-loop systems). **Care must be taken, however, to ensure that the voltage applied to the Vfb terminals cannot exceed the level appropriate to the Input Scaling Resistor used (±1V or ±10V) to avoid overloading the feedback input circuitry.**

In position systems, this control can be used to fine-tune the range of positions (span) that will correspond to the input voltage range (for example, to adjust the *degrees per volt* of the system).

CW: Decrease feedback sensitivity (increases system gain)

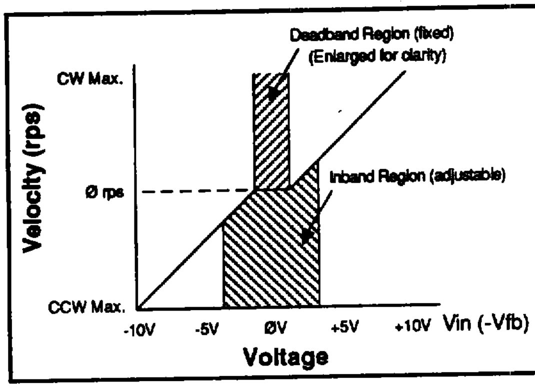
Range: 10-100%

Inband Adjust (R32)

Function: This control allows you to adjust the range of error (or input) that will be considered *inband* (see Figure 4-2). The inband condition is indicated by the LED (see below), and the inband output. If the control is set at or slightly below the fixed deadband, it extinguishes to indicate *not moving* or *in position*.

CW: Increase inband range

Range: Depends on gain setting and input scaling resistors (if installed).



Deadband : The fixed region around ØV (of internal error voltage) within which no steps will be produced. A voltage greater than the deadband will produce steps; the direction is determined by the polarity of the voltage (a positive voltage = CW and a negative voltage = CCW).

Inband : The adjustable region around ØV (of internal voltage) that is considered *inband*. Within this band, the LED will be off and the Inband Output will be active. The size of the inband region is adjusted with pot R32. This will have no effect on steps produced; it affects only the LED and the Inband Output. The default setting is ØV.

Figure 4-2. Inband and Deadband

Inband LED (green)

Function: When the Inband Adjust pot (R32) is set at or slightly below the fixed deadband, this LED extinguishes to indicate *in-position* (for position applications) or *not moving* (for velocity applications). It illuminates when the error (or input) voltage is above the inband set by the Inband Adjust pot (see above). This led will illuminate only if all three of the required supply voltages (±15V, +5V) are present (*although it may still be lit if the voltages are too low for proper operation*).

Tenref Trim (R14)

Function: This control adjusts the Tenref outputs, which provide stable sources of DC voltage (derived from a bandgap voltage reference). They may be used to provide voltage to potentiometers (or other sensors) used as input or feedback elements (see *Typical Input Source Connections* in Chapter 3). The outputs are normally set to provide +10VDC at the +Tenref output and -10VDC at the -Tenref output.

In 4-20mA current loop applications, the +Tenref voltage is used to set the *zero* of the system and has been factory adjusted. *The setting of this control and the Gain control (R39) are the only differences between the* **–IA** *option and the* **–IB** *option.*

CW: Increase Tenref output voltages

Range: Approx +1.3 to +12VDC and -1.3 to -12VDC

Ratio Control (R22)

Function: This control adjusts Step2's output frequency as a percentage of Step1's output frequency (see VAC Block Diagram, Figure 1-1). For example, when you turn the pot to its maximum CW position (100%), Step2's frequency will approximately equal Step1's frequency. When Step2 is not used (most applications) this control will have no effect.

CW: Increase percentage (brings Step2's output frequency closer to Step1's output frequency)

Range: 10% to 100%

Hardware Modifications

This section describes hardware (PCB) modifications you can perform to customize your VAC for your particular application needs. Figure 4-3 shows the location of each related component on the VAC PCB.

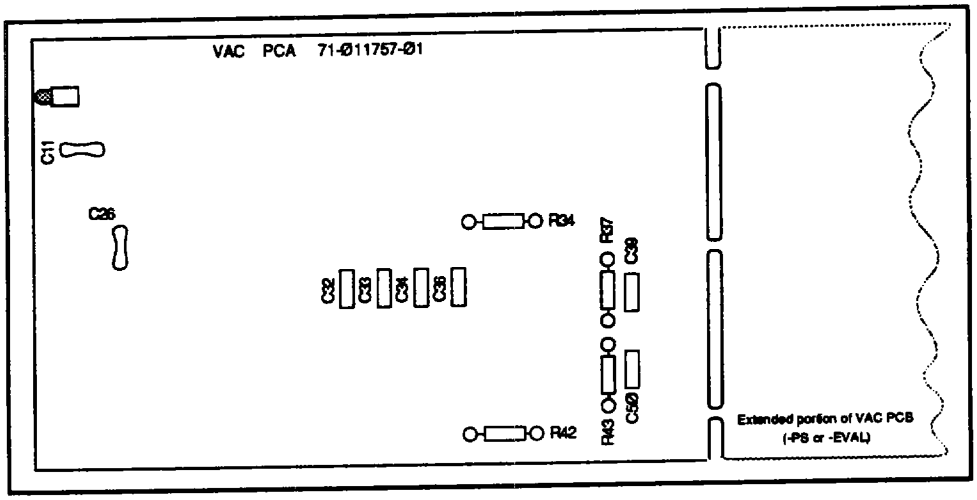


Figure 4-3. Location of Modifiable VAC PCB Components

> **CAUTION**
>
> Modification of some of these components requires soldering skills. Any damages to the VAC resulting from customer soldering will void the warranty. If you are not skilled at soldering, send the VAC to Compumotor for modifications. Contact Compumotor at (800) 358-9070.

Application-Dependent Components

This section describes how you can make hardware modifications to the VAC to suite your specific application requirements.

Input Scaling (Resistors)

The full-scale voltages of the Vin and Vfb inputs can be set with resistors R42 and R34, respectively (see Figure 4-3). With no resistors installed in these locations (the standard configuration), both inputs are intended to be used with ±10V or 0 to +10V signals. By installing 1.10KΩ resistors (supplied) into the sockets at one or both of these locations, the corresponding input can be configured for ±1V or 0 to +1V signals. **These are plug-in resistors — no soldering is required.** Other full-scale voltages can be accommodated as well (refer to the *Non-Standard Voltage Inputs* section provided later in this chapter).

Input Low-pass (Noise) Filters

Both the Vin and Vfb inputs have provisions for low-pass (noise) filters. The components involved are C32, C33, & C50 for Vin,and C34, C36, & C39 for Vfb (see Figure 4-3). The standard VAC includes filtering on both inputs at approximately 50Hz.

The exact frequency will depend on the output impedance of the voltage source, and also on the VAC input resistors since C50 and C39 are directly across the Vin and Vfb inputs, respectively. These values may be changed to provide filtering at another frequency if desired.

To preserve optimum common mode rejection of the differential inputs, C32 should match C33 and C34 should match C36. Capacitors with good high-frequency properties (not electrolytics) should be used if rejection of high-frequency noise is important to the application.

Drive Resolution Selection (Capacitors)

The maximum step frequency of the VAC can be adjusted over a limited range using trimmers R25 (for Step1) and R6 (for Step2). *These are factory adjusted to 500KHz and are appropriate for most applications.* If your application uses a low-resolution drive, or operates at a very low velocity, and you are unable to achieve satisfactory performance, contact the Compumotor Applications Department for information on reducing the maximum step frequency.

The range of output frequencies that can be changed by using a different value for C26 for the main output (Step1) or C11 for the second output (Step2). Refer to Figure 4-3 for the location of C26 and C11. High-quality capacitors of low dielectric absorption should be used to preserve linearity; examples are mica, polypropylene, polystyrene, and teflon. See Table 4-1 below for values.

To use Table 4-1, multiply the maximum velocity (in revs/sec) that will ever be required (usually 20 rps) by the resolution of the drive to be used (in steps/rev) to find the maximum step frequency, (Fmax). For example, to run at 20 rps with a 25000 step/rev drive would require 25000 * 20 = 500KHz. **(This is the maximum step frequency of the VAC.)** Look in the appropriate column to find the value of C26 or C11 that is optimum for that frequency range.

	Fmax < 10KHz	Fmax = 10 - 150KHz	Fmax = 150 - 500KHz
Capacitor Value	0.01µF	1000pF	220pF

Table 4-1. Capacitor Values for Specific Pulse Frequency Ranges

Unless otherwise specified, the VAC will be supplied with the 220pF capacitors installed, and will be adjusted for 500KHz Fmax (to match microstepping drives). *Many stepper drives and servos have user-selectable resolutions.* Using the highest resolution that will allow the required velocity will usually give the best performance.

Non-Standard Voltage Inputs

The standard VAC is configured to operate with command input and feedback voltages of ±10V. Higher voltages can be accommodated by using external attenuator(s), and lower voltages by installing input-scaling resistors at R42 (for the command input, Vin) and/or R34 (for feedback input, Vfb). Refer to Figure 4-3 for component locations.

For ±1V full-scale voltage input, install the 1.10KΩ resistor (supplied with the unit) at R42, R34 or both, as appropriate. For other voltages, see below.

CAUTION

The VAC will be damaged by input voltages outside its supply voltage range of ±15V. In particular, negative voltages (below -15V when the unit is powered up, or below -0.6V when the VAC is not powered) will cause input stage damage. Ensure that these conditions do not occur, especially on power-up and power-down. Compumotor recommends wiring the VAC to non-switched AC power and run continuously. If the internal +Tenref and -Tenref supplies are used for inputs, no additional precautions need be taken.

Input Voltages Greater Than ±10V

Full-scale input voltages greater than ±10V require an external attenuator to reduce the voltage to a safe level. The 680KΩ input impedance from each input to Agnd will not significantly load most attenuators, and can usually be ignored in attenuator calculations. The optional input resistors — R43 for command input (Vin+ to Vin-) and R37 for feedback input (Vfb+ to Vfb-) — can be used as part of the attenuator if desired. **These are plug-in resistors — no soldering is required.** In differential applications, close-tolerance or matched resistors should be used so as not to degrade common-mode rejection.

Input Voltages Less Than ±10V

Full-scale input voltages less than ±10V can easily be accommodated by installing the appropriate-valued resistor in R42 (for command input, Vin) or R34 (for feedback input, Vfb), or both.

For ±1V full-scale voltage input, install the 1.10KΩ resistors (supplied with the unit) at R42, R34 or both, as appropriate. The appropriate value resistor for other full-scale voltages can be calculated using the formula below. The nearest 1% value can be used since final adjustment can be made with the Gain (R39) and Feedback Scale (R41) trimmers if necessary (refer to *On-Board Pot Adjustments* discussed earlier in this chapter).

$$\mathbf{R} = \frac{10000}{(10/\mathbf{V}) - 1}$$

Where: **V** = Desired full-scale voltage
R = Resistor value (in Ohms) to install at R42 and/or R34

Example

For a full-scale voltage of 1V:

$\mathbf{V} = 1$
$10/\mathbf{V} = 10/1 = 10$
$10 - 1 = 9$
$10{,}000/9 = 1111 = 1.111\text{K}\Omega$
Use 1.10KΩ 1%

The default case (V=10; R=infinity, no resistor installed) can cause problems, since not all calculators know that 10,000/0 = infinity.

Chapter 5. Troubleshooting

Chapter Objective

The information in this chapter will enable you to isolate and resolve system hardware and software problems.

Troubleshooting

This section provides methods to identify and resolve possible indexer-related hardware and software problems. You should also refer to the drive's user guide for troubleshooting procedures specific to the drive you are using.

Problem Isolation

When your system does not function properly (or as you expect it to operate), the first thing that you must do is identify and isolate the problem. When you accomplish this, you can effectively begin to eradicate and resolve the problem.

The first step is to isolate each system component and ensure that each component functions properly when it is run independently. You may have to dismantle your system and put it back together piece by piece to detect the problem. If you have additional units available, you may want to use them to replace existing components in your system to help identify the source of the problem.

Try to determine if the problem is mechanical, electrical, or software-related. *Can you repeat or recreate the problem?* Do not attempt to make quick rationalizations about problems. Random events may appear to be related, but they are not necessarily contributing factors to your problem. You must carefully investigate and decipher the events that occur before the subsequent system problem.

You may be experiencing more than one problem. You must solve one problem at a time. Log (document) all testing and problem isolation procedures. You may need to review and consult these notes later. This will also prevent you from duplicating your testing efforts.

Once you have isolated the problem, take the necessary steps to resolve it. Refer to the problem solutions contained in this chapter. If your system's problem persists, contact Parker Compumotor's Applications Department at (800) 358-9070.

WARNING

Be sure to remove power before disconnecting VAC system peripheral components or changing wiring.

Solutions to Common Problems

Table 5-1 lists causes and recommended solutions to problems you may encounter while operating the VAC.

Problem/Symptom	Cause	Remedy
Voltage is applied to Vin, but no steps are produced	Limit switch is open (or jumper JU3 is not installed)	Correct limit switch wiring (or install jumper JU3 if no limits are needed)
Step rate (velocity) fluctuates	Noise on input voltage (or DC power supply lines) or on feedback voltage	Check system grounding. Check Vin+ & Vin- (and Vfb+ & Vfb-, if used) connections. If Vfb+ & Vfb- are not used, they should be tied to Agnd. If you are using a low impedance voltage source (not a pot), you can install a resistor equal to 1 to 5 times this impedance at R43. This will reduce noise pickup (see also *Input Low-pass Filters* in Chapter 4). Use a shielded cable. Remove or shield the noise source.
Motor runs too fast	Gain is too high, or resolution is too low	Reduce gain (turn Gain pot R39 CCW) or increase resolution (see also *Drive Resolution Selection* in Chapter 4).
Motor runs too slow	Gain is too low, or resolution is too high	Increase gain (turn Gain pot R39 CW) or decrease resolution (see also *Drive Resolution Selection* in Chapter 4).
I have only ±1V input to work with	VAC normally operates with ±10V input — must be modified to accommodate a non-standard voltage input	See *Input Scaling* in Chapter 4 for instructions to change resistors to accommodate ±1V input
I am using a 4-20mA current loop and can not get CCW rotation	You have the **-IA** (uni-directional) version, but you need the **-IB** (bi-directional) version	See 4-20mA *Current Loop Control* in Chapter 3 — call Compumotor for assistance
Motor turns slowly with Vin+ & Vin- and Vfb+ & Vfb- all tied to Agnd	Noise on DC power supply	Try a linearly regulated supply close to the unit
DECEL control (pot) has no effect	Jumper JU2 is set to the A-B (default) position — ACCEL control affects both acceleration & deceleration.	Move jumper JU2 to position B-C (see figure 4-1 and the section labeled *Deceleration Limit* in Chapter 4).
Tenref voltage drops when I connect my potentiometer	Pot value is too low. Tenref outputs can drive a load of 2KΩ or higher.	Use a pot of a higher value — 10KΩ is suggested

Table 5-1. Symptoms, Causes, and Remedies

Reducing Electrical Noise

Try to eliminate sources of possible noise interference. Potential noise sources include inductive devices such as solenoids, relays, motors, and motor starters operated by a hard contact.

For more information on identifying and suppressing electrical noise, refer to the Technical Data section of the *Compumotor Programmable Motion Control Catalog*.

Returning the System

If you must return your VAC system to affect repairs or upgrades, use the following steps:

① Get the serial number and the model number of the defective unit, and a purchase order number to cover repair costs in the event the unit is determined by the manufacturer to be out of warranty.

② Before you return the unit, have someone from your organization with a technical understanding of the VAC system and its application include answers to the following questions:

- What is the extent of the failure/reason for return?
- How long did it operate?
- Did any other items fail at the same time?
- What was happening when the unit failed (i.e., installing the unit, cycling power, starting other equipment, etc)?
- How was the product configured (in detail)?
- What, if any, cables were modified and how?
- With what equipment is the unit interfaced?
- What was the application?
- What was the system environment (temperature, enclosure, spacing, unit orientation, contaminants, etc.)?
- What upgrades, if any, are required (hardware, user guide)?

③ In the USA, call Parker Compumotor for a Return Material Authorization (RMA) number. Returned products cannot be accepted without an RMA number. The phone number for Parker Compumotor Applications Department is (800) 358-9070.

Ship the unit to:
Parker Hannifin Corporation
Compumotor Division
5500 Business Park Drive
Rohnert Park, CA 94928
Attn: RMA # xxxxxxx

④ In the UK, call Parker Digiplan for a GRA (Goods Returned Authorization) number. Returned products cannot be accepted without a GRA number. The phone number for Parker Digiplan Repair Department is 0202-690911. The phone number for Parker Digiplan Service/Applications Department is 0202-699000.

Ship the unit to:
Parker Digiplan Ltd.,
21, Balena Close,
Poole,
Dorset,
England.
BH17 7DX

⑤ Elsewhere: Contact the distributor who supplied the equipment.

Appendices

Appendix A: Factory-Customization

Some minor customization of the VAC (input scaling, noise suppression, drive resolution and input voltage) can be performed by the end user as described in the *Hardware Modifications* section in Chapter 4 — **only by qualified technicians**. However, if you do not have the resources to perform your own modifications, or if you require additional customizing or a special-order version of the VAC, Compumotor's Custom Products Group is ready to help. Refer also to the available VAC options described in Appendix B.

In addition to the modifications described in Chapter 4, here are a few examples of the customization the Custom Products Group can perform for you (at additional cost):

- ❑ Custom cables
- ❑ Custom packaging
- ❑ Custom front panels for rack-mount and packaged versions
- ❑ Varying degrees of system integration
- ❑ Operation from +5, +12 or +24 DC voltages

Contact the Custom Products Group at (800) 358-9068 for more information.

Appendix B: Selecting the Appropriate VAC Version

Once you have defined the system configuration, identified the appropriate sensors, and determined the speed-torque requirements for each axis, you can select the version of the VAC that is most suitable.

VAC Options

This section describes the various options available for the VAC. To order the VAC, contact the Compumotor Customer Service Department at (800) 722-2282.

The different VAC options are identified by dash numbers. For example, **CP*VAC-PS-PK** is a VAC (**CP*VAC**) that has an integral power supply (**–PS**) and is enclosed or *packaged* (**–PK**).

CP*VAC is the standard version, requiring the user to supply ±15VDC at 200mA to P2-9,10 (D-5,18) and P2-17,18 (D-9,22) respectively. Voltage input is ±10V. It is not shipped in an enclosure.

All VAC shipments include mounting standoffs, a user guide, a cable to convert P3 (I/O signal connector) to 25-pin D-connector, and a 3-foot step-output cable to connect Step1 and direction signals to any Compumotor drive with a 25-pin D-connector step input.

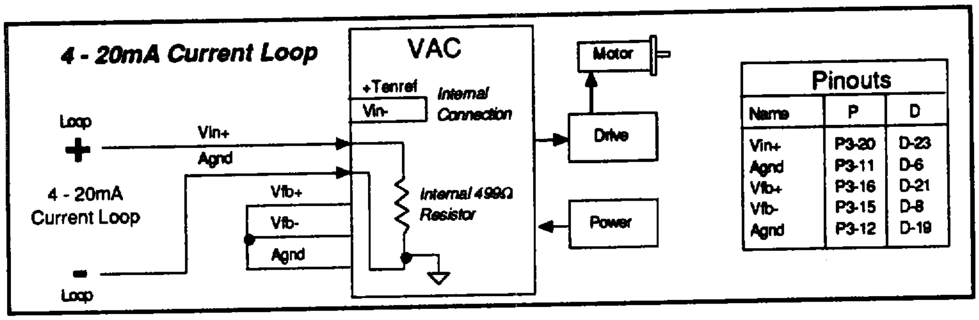
Option	Description	Addition Cost?
–EVAL (Evaluation Unit)	Includes the following: - Board only with power supply (—PS) - Adaptor to break out P3 (signal connector) to screw terminals that will accept bare wires smaller than 12 AWG. - Adjustment tool for trim pots - Complete set of application notes to date To simplify installation and help you to get the application up and running more quickly, Compumotor recommends that the first VAC ordered be a **–EVAL** unit. When reordering, you will know what cables and so on are required and can build or order them as needed.	Yes
–PS (Power Supply Input Option)	Has an integral power supply mounted on the PCB Accepts 90 - 132VAC power input Other power supply voltages accommodated on a custom basis (see Appendix A)	Yes
–PK (Enclosure Option)	VAC is shipped mounted in a portable enclosure	Yes
–IA (Uni-directional Current-loop Input Option)	Command input configured and adjusted for 4 - 20mA current-loop input Uni-directional Mode: 4mA = stop; 20mA = maximum velocity Feedback input remains a voltage input. It can be converted to a current-loop input instead of (or in addition to) the command input by request to Compumotor's Custom Products Group (see Appendix A).	No
–IB (Bi-directional Current-loop Input Option)	Command input configured and adjusted for 4 - 20mA current-loop input Bi-directional Mode: 12mA = stop; 4mA = maximum counter-clockwise velocity; 20mA = maximum clockwise velocity Feedback input remains a voltage input. It can be converted to a current-loop input instead of (or in addition to) the command input by request to Compumotor's Custom Products Group.	No

Appendix C:
4-20mA Current Loop Operation

The VAC can operate directly from a *dedicated** 4-20 mA current loop in either of two modes.

The command or the feedback can be in current form, (or both if they are used in the same mode — see below). *The VAC's +Tenref output is used in both configurations and is not available for other uses.* The VAC can be supplied with the resistor installed internally and with the +Tenref output adjusted for current loop operation (in either mode specified) on request to the Custom Products Group.

Connections for current loop operation are shown in the drawing below.



4-20mA Current Loop Control System Configuration

* A *dedicated* current loop is one in which the VAC is the only receiver in the loop. Strictly, other receivers can be included in the loop only if the loop has sufficient compliance and if the VAC is at the *bottom* of the loop. The low side of the internal 499Ω resistor is tied to the VAC's analog ground, and is also the return line of the control loop. No isolation is provided in this configuration. If a floating or isolated input is required, modules are available from third-party manufacturers (notably Burr-Brown) that convert 4 - 20mA signals to analog voltages suitable for driving the VAC. Contact the Compumotor Custom Products Group for more information.

Mode A: Uni-directional Operation

In the uni-directional mode, a 4mA loop current will produce no motion and a 20mA loop current will produce motion at maximum velocity. The VAC direction output will indicate CW rotation. Direction can be controlled externally if desired.

In this mode, the circuit operates as follows:

> When the control loop supplies 4mA, the voltage at Vin+ is 0.004 * 499 = 1.996V. The +Tenref output is adjusted to match this value, and this voltage is applied to Vin-, so the difference (0V) is the internal command voltage for the VAC. This is within the deadband (Figure 4-2 illustrates deadband) and no motion results.
>
> When the loop current is 20mA, the voltage at Vin+ is 0.020 * 499 = 9.9V. 9.98 - 1.996 = 7.984, so this is the internal VAC command voltage. The GAIN control (R39) is adjusted to provide the desired maximum velocity under these conditions.

Mode B: Bi-directional Operation

In this mode, the current loop supplies 12mA when no motion is desired, 20mA when maximum CW velocity is desired, and 4mA when maximum CCW velocity is desired.

In this mode, the circuit operates as follows:

> When the loop current is 12mA, the voltage at Vin+ is 0.012 * 499 = 5.988V. The +Tenref output is adjusted to match this value, and this voltage is applied to Vin-, so the difference (0V) is the internal command voltage for the VAC. This is within the deadband (Figure 4-2 illustrates deadband) and no motion results.

When the loop current is 20mA, the voltage at Vin+ will be 0.020 * 499 = 9.98V. This results in 9.98 - 5.988 = 3.99V internal command voltage. The GAIN control (R39) is adjusted to provide the desired maximum CW velocity under these conditions.

When the loop current is 4mA, the voltage at Vin+ is 0.004 * 499 = 1.996V. This results in 1.996 - 5.988 = -3.992V internal command voltage. This will result in a maximum CCW velocity equal to the maximum CW velocity set above with the GAIN control.

Appendix D: Position-to-a-Voltage Operation

Although the VAC is a velocity system, a position (position-to-a-voltage) system is formed when analog position feedback is applied to the feedback (Vfb+, Vfb-) terminals. Connections for position-to-a-voltage operation are shown in the *Typical Input Source Connections* section in Chapter 3.

This appendix describes the following important considerations specific to position applications:

- ❑ Control function differences (trimmer pots and the LED function differently)
- ❑ Limitations
- ❑ Feedback polarity test (verify that you performed system connections properly)
- ❑ Initialization (manual and automatic)

Most of this appendix also applies to *position-to-a-current* applications. However, the +Tenref and -Tenref reference voltages are not generally available, since they are used in the 4-20mA input circuitry.

Control Function Differences

The Gain and Feedback Scale on-board trimmer pots on the VAC function differently in a position system. Also, the Inband LED extinguishes to indicate the *in-position* state. These differences are described in the *On-board Pot Adjustments* section in Chapter 4.

Limitations

The first limitation to note is the system's limited travel capability. In applications in which the feedback potentiometer is mounted directly to the motor, the total travel will be limited, in most cases, to less than 10 turns. Although 20-turn pots are available, they are usually *special-order* and have long lead times and high prices.

Ensure that the shaft will not run into the stops inside the pot. The stops are typically weak, and the pot will be damaged if the shaft runs into them repeatedly. This means that the practical travel is limited to approximately 9 turns. The simplest way to ensure this is to limit the command voltage. For example, if you use a feedback pot driven from ±10V, limit the voltage to ±9V; this restricts the travel to the middle 80% of the pot's range. A similar effect is achieved with a ±10V command when the pot is driven from ±11V. This is easily achieved by adjusting the **TENREF ADJUST** (R14) control to provide ±11V (see also *On-Board Pot Adjustments* section in Chapter 4).

It is often possible to mount the pot to the load, or to some other point in the mechanics that has appropriate travel range. You must ensure, however, that the feedback is negative (see *Test Feedback Polarity* below). If the pot is mounted so that it turns in the opposite direction from the motor, be sure to wire it appropriately. In linear applications, either linear pots or LVDTs can be used on the load, or rotary pots on the motor or leadscrew.

In 4-20mA applications, the Tenref voltages will typically not be available and the pot must be driven from another source of voltage. The ±15V supplies can be used, but the travel will then be limited to the middle 2/3 of the pot's range. This is acceptable in some applications, but if longer travel is desired then fixed (or adjustable) resistors can be inserted in series with each of the pot's terminals (except the center one) to increase the travel. These resistors should be less than 1/4 of the pot's value to ensure that at least ±10V of travel is available.

Test Feedback Polarity

To ensure that the feedback is negative, perform the following test:

① Using a voltmeter, power-up the VAC (only) and measure the DC voltage at Vfb+.

② Physically move the motor CW. This should result in an increasingly positive (or decreasingly negative) voltage at Vfb+. If the voltage becomes decreasingly positive, then the feedback polarity is incorrect; switch the connections to the two end terminals of the feedback pot and repeat this test.

Initialization

This kind of position system requires some initialization at power-up to obtain proper operation. This process is analogous to the *homing* routine required by many motion control systems on power-up.

The process is simplified if the VAC is set up so that *inband = deadband*. Compumotor will adjust the VAC appropriately if you write "set inband = deadband" on your order. This will not affect normal operation, but will cause the LED to extinguish (and the inband output to go high) when the (internal) error voltage is below the deadband (i.e., when steps are not being produced).

Situations to avoid are as follows:

- ❑ The system has positive feedback instead of negative, and consequently runs hard into one stop or the other when powered-up.
- ❑ The system powers up with a large position error, so the VAC will generate steps at a high rate as soon as power is applied. When the drive is powered up, it will see a high step rate immediately and will stall, since an infinite acceleration was requested. The VAC will continue to produce steps, but since the motor isn't moving, the error will persist unless the command signal changes to match the actual position.

Initialize (manual)

To initialize manually, the proper sequence and procedure is as follows:

① Power up the VAC (Compumotor suggests wiring the VAC to non-switched power and run continuously).

② Apply the input voltage (or current).

③ EITHER: (a) Physically move the load, or (b) adjust the command signal, until the LED extinguishes (the inband output will also go high). This means that the system is at equilibrium and is not trying to correct a position error (no steps are being produced).

④ Power-up the drive.

⑤ Begin system operation.

Initialize (automatic)

The process can be performed automatically by the PLC as follows:

① Hold the drive in the shutdown mode, or assert (pull low) the KILL input on the VAC.

② Sweep the command voltage (or current) over its full range while monitoring the inband output. **The command must change more slowly than the acceleration limit setting on the VAC.** When the inband output goes high, you have *found* the load. Continue to send this level of voltage or current to the command input.

③ Enable the drive, or release KILL.

④ Begin system operation.

Appendix E: Index