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PS-33xx Series Digital Servo Drives

Installation User's Guide

Doc. #151-PS-33xx Rev D

API Controls

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PREFACE

Congratulations!

You've just purchased the finest amplifier in its class. The PS-33xx Series is designed to provide reliable long-term and economical operation in demanding field environments. Without exception, the PS-33xx Series Digital Servo Drive outperforms every other competitor in the critical areas of performance, integration via its extensive I/O, ease of field service, and the versatility of its all-digital design.

The PS-33xx Series amplifiers are a new generation of digital servo amplifiers available in current ratings from 3 to 20 amps continuous. The product series includes three product families: the **PS-33xxd**, a **Digital** servo drive, the **PS-33xxi**, an **Intelligent** servo drive, and the **PS-33xxc Centennial** servo drive. Each model of the PS-33xxd/i Series utilize a space vector control algorithm and each model of the PS-33xxc Series are DSP based. All models of the PS-33xx Series can be configured to operate Brushless DC servomotors in an analog current reference mode or as an analog velocity (speed) controller. The PS-33xxc Centennial Series can also be configured to operate induction motors in either vector or variable frequency control. In addition, the PS-33xxi and PS-33xxc are easily configured as a standalone programmable position controller and interface to the application via extensive inputs/outputs. All modes of operation offer a PID loop-tuning feature to optimize the performance of the selected servomotor.

Each PS-33xx Series unit is an amplifier, power supply, controller and heatsink integrated into a single standalone package. The compact size and integrated design of the PS-33xx amplifier simplifies the installation process and reduces downtime should the need for replacement arise.

Fundamentally, a PS-33xx amplifier is a computer that is dedicated to motion control. Like every other computer it has its own operating system, data storage capabilities, data manipulation capabilities, and interface for data communications. In addition, its built-in inputs/outputs allow for hard-wired connections for motor feedback and to sensor switches to ensure motion that is "in sync" with a user's environment. All PS-33xx Series servo controllers provide the user with the same basic components, including:

- Communications interface to your host computer or **T-330** Data Terminal for programming or commanding the PS-33xx servo controller. The T-330 can only be utilized to enter user data or system parameters. The host computer is required to create the high-level motion program.

- A graphical user interface program, **APImate 2.0**©, provides the user with the tools to quickly and easily configure the PS-33xx to a specific application. **APImate 2.0** is a Windows-based program that provides Wizards for axis setup, tuning, and high level programming.

- System software including commands, parameters, and user defined variables that allow you to configure the servo controller to your application, to enter and manipulate data, and to tune the performance of the unit to your application.

- Methods of control include the ability to accept Step/Direction, Step-Up/Down, Quadrature, and Analog mode whereby you are commanding the servo system via an analog ±10 VDC reference in either the current or velocity (speed) mode.

- Hardware interfaces for enable, reset, drive-ok, foldback and user programmable inputs (travel limits, home) and outputs that allow you to interface to your machinery/equipment.

The **PS-33xxi** (Intelligent) Series and the **PS-33xxc** (Centennial) Series Servo Controllers accept high level commands directly, eliminating the need for a motion controller and can be operated standalone or networked. Each unit has the ability to store and execute motion programs. Additional features available are:

- Stored program mode refers to a method of control where you create and store "motion programs" on the servo controller system and execute the programs when required. Motion programs provide the user with the ability to perform repetitive functions without having to type each individual command line every time you wish to perform the same function. In this mode you may choose to initiate a program through your communications port or establish a monitor program to allow an input to "trigger" or begin execution of a particular sequence of commands.

- Networked configuration allows for up to 31 axis from a single PC serial port or similar host device. Multi-axis start and stop, along with on-the-fly speed change, are only a few of the networked features available on these units. The user must request the Intelligent Servo Protocol (ISP.doc) and the Intelligent Motion Language (IML.doc) to gain a better understanding of the network requirements.

- Complex SPLINE tables of up to 16 data points on the **PS-33xxi** (Intelligent) Series and 3000 data points on the **PS-33xxc** (Centennial) Series Servo Controllers can be entered to define custom motion profiles as a function of time.

- Complex CAM tables of up to 16 data points on the **PS-33xxi** (Intelligent) Series and 3000 data points on the **PS-33xxc** (Centennial) Series Servo Controllers can be entered to define custom motion profiles as a function of the master encoder input. The Centennial series also offers an Auxiliary PID loop for entry into the CAM tables.

- Master/slave relationships can be developed from the secondary encoder inputs, providing motion output as a RATIO, CAM, or SPLINE.

The **PS-33xxc** (Centennial) Series Servo Controllers are one of the most advanced DSP motion controllers available and will meet your needs into the next century. Additional features for the Centennial are:

- The PS-33xxc Series can also be configured to operate 300volt induction motors in either vector or variable frequency control.

- All modes of operation offer a **Real-time Adaptive Tuning** feature to optimize the performance of the selected servomotor. This Real-time Adaptive Tuning feature is bi-directional and includes load and inertia estimation and compensation. It also provides **an Active Current Loop Compensation** gain and phase. Optimal performance can be obtained on systems with varying inertial loads up to 50:1.

- Additional analog inputs and outputs can be utilized to interface to the user's environment.

- Advanced mathematical capabilities, 40 bit floating point, LOG functions, and trigonometric functions are available to simplify programming of complex motions.

- Complex SPLINE tables of up to 3000 data points can be entered to define custom motion profiles as a function of time.

- Complex CAM tables of up to 3000 data points can be entered to define custom motion profiles as a function of the master encoder input or as a function of the Auxiliary PID loop.

- Master/slave relationships can be developed from the secondary encoder inputs, providing motion output as a RATIO, CAM, or SPLINE.

- Auxiliary PID loop with 100 microsecond update rate can be utilized in conjunction with the analog inputs, SPLINE, CAM, and master/slave capabilities. Applications such as web-tensioning, pump, and motion profiling can be addressed with ease.

API Controls

PS-33xx Series Digital Servo Drives

Installation User's Guide

The information contained in this document is provided for customer use only. Every effort has been made to ensure the accuracy of this information. However, API Controls assumes no responsibility for any errors or omissions. The information contained in this document is subject to change without prior notice. Users' critical evaluation is welcomed to assist in the preparation of future documentation.

Printed in the United States of America.

SUMMARY OF SAFETY CONSIDERATIONS

This section contains duplications of each NOTE, CAUTION, and WARNING presented in the body of this document. These safety considerations are grouped according to the section that they appear in.

It is highly recommended that the safety considerations contained in this section be reviewed prior to equipment installation or operation.

NOTES, **CAUTIONS**, and **WARNINGS** contained in the text provide important information.

	NOTE
	*A **NOTE** provides additional or special information to assist operation/maintenance personnel. Disregarding a **NOTE** may cause inconvenience but will not result in personal injury or equipment damage.*

	CAUTION
	*A **CAUTION** is provided in a procedure whenever electrical or mechanical damage may occur. Failure to heed a **CAUTION** will result in some form of damage to the equipment; however, personal injury is unlikely.*

	WARNING
	*A **WARNING** is provided in a procedure where personal injury may occur if the **WARNING** is not heeded. Electrical or mechanical damage may also occur.*

Installation and Wiring

	WARNING
	*When wiring the servo system, proper wiring procedures must be followed. The wiring is to be performed only by qualified electrical personnel familiar with the construction and operation of this equipment, the hazards involved, and the National Electrical Code (NEC) and local electrical codes. Equipment damage and/or injury could result if these procedures are not observed.* ***The user is responsible for conforming to all applicable local, national and international codes.***

	WARNING
	*If there is a conflict between recommendations in this manual and safety codes, safety requirements must be followed.* ***The user is responsible for conforming to all applicable local, national and international codes.***

	NOTE
	*Allow a minimum distance of 12 inches (305 mm) above and below each drive and a minimum of 3 inches (78 mm) on each side of the drive to eliminate the potential problems of heat generation and electrical noise.*

	NOTE
	*To obtain rated output current from all amplifiers, the ambient air temperature below the amplifiers must be between 0°C and +50°C. No heat generating devices, such as transformers, power supplies, or power resistors, should be mounted directly beneath the modules.*

	NOTE
	*Use ground straps made of 1 inch (25 mm) silver tinned flat copper braid to connect cabinet doors to enclosures, the first sub-panel to the enclosure, and each sub-panel to the next.*

	NOTE
	*Where electrical codes call for the typical green safety ground wires, use them **in addition** to any ground strap suggested in this guide.*

	NOTE
	*Set the unit's axis id and method of communications prior to proceeding with mounting. Once configured, we suggest that the front of each unit be marked with its unique Axis ID to facilitate installation and startup.*

	NOTE
	*Utilizing RS-422/485 communications cards by other manufacturers than those recommended by API Controls may result in erratic behavior and reduced noise immunity. (Use 10k resistors if not in PC Card, install at PC end of communications cable).*

	CAUTION
	*Models of the **PS-33xxi** Series can be purchased with connections, (J4) for a Control Area Network or CAN interface. If you have not purchased this model, **MAKE NO ELECTRICAL CONNECTIONS TO THIS CONNECTOR**.*

	NOTE
	*Read Section 3.3.1 before proceeding with any system wiring!*

	CAUTION
	*Use Star grounding arrangement. Chain grounding or daisy-chain arrangements should not be used.*

	NOTE
	*Where electrical codes call for the typical green safety ground wires, use them **in addition** to any ground strap suggested in this guide.*

	NOTE
	*Do not mix power and control signal wiring in the same conduit, duct, or wire tray without 12 inches (305 mm) of separation.*

	NOTE
	*High power wiring and low power DC signal wiring within the panel or enclosure should not share wire raceways and should be separated by a minimum of 12 inches (305 mm) for parallel runs. If wire paths should cross and touch, they should do so only at right angles to each other.*

	WARNING
	When operating off single-phase VAC, ensure that you have taken into account the amplifiers current de-rating. ***For single phase AC derate current 33% at 115 VAC and 50% at 230 VAC.*** Failure to do so will result in damage to the amplifier and is not covered under the manufacturer warranty.

	WARNING
	*Use care to ensure the correct pinout is used for the main power connections. Improper wiring will result in damage to the amplifier.*

	WARNING
	*The section applies only to models of the PS-33xx that have been purchased with the optional Control Power configuration.* ***Do not make connections to Ctrl+ and Ctrl- terminals; units not factory configured for this option will be damaged.*** *Units damaged, as a result of improper installation will not be covered under API's warranty policy.*

	WARNING
	*The Control power supply must be* ***ISOLATED from chassis ground****; otherwise, equipment damage and/or injury could result.*

	WARNING
	***External regen resistors are connected to the drive d-c bus voltage that can reach 400 VDC. Connections to external regen resistors must be electrically insulated and mechanically shielded for safety. High voltage warning stickers are also recommended.***

	CAUTION
	*The two High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment.* ***If you need to operate these inputs as general-purpose inputs, at 30 VDC, then a current limit 2k W resistor must be installed in series with the input.***

	NOTE
	*The* ***RESET*** *input on the PS-33xxc Series, if active when power is applied, will cause the unit to start its Boot-Load-Manager. This will cause the unit to appear as if it has faulted, the unit will not respond to any IO and will not enable until the RESET input is in the inactive-state and then briefly active-state again.* *Correctly configure your power up sequence(s) to prevent accidentally activating the unit's Boot-Load-Manager.* *See Section 5.3.7 Update New Firmware for additional information.*

APImate 2.0 Software Setup and Installation

	WARNING
	*Before proceeding, REMOVE any previous installations of **APImate 2.0** from your PC to prevent conflicts with older versions. **Use Windows95 ADD/REMOVE Programs to uninstall previous installations.***

	NOTE
	*To obtain **APImate 2.0** upgrades, return the CD-ROM to your point of purchase with a purchase order that will be utilized for tracking shipment. Upgraded software will be installed ONLY on the original CD-ROM.*

	WARNING
	*Before proceeding, make sure that the ENABLE input is INACTIVE to prevent accidental motion during the amplifier configuration process.*

System Startup

	NOTE
	*When the amplifier is shipped from the factory, the parameters are set for velocity mode control.*

	CAUTION
	**The High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment.* **The preferred interface is a differential output for improved noise immunity.**

	WARNING
	*Before proceeding, make sure that the ENABLE input is INACTIVE to prevent accidental motion during the amplifier configuration process.*

	NOTE
	*Flowchart your axis application so that you can determine the function of inputs and outputs, configuration, operating mode, etc. This will save time and assist in the startup of a new application. The importance of this cannot be over emphasized.*

	NOTE
	*The* ***RESET*** *input on the PS-33xxc Series, if active when power is applied, will cause the unit to start its Boot-Load-Manager. This will cause the unit to appear as if it has faulted, the unit will not respond to any IO and will not enable until the RESET input is in the inactive-state and then active-state again.* *Correctly configure your power up sequence(s) to prevent accidentally activating the units Boot-Load-Manager.* *See Section 5.3.7 Update New Firmware for additional information.*

	NOTE
	*Each time the Axis Setup Wizard is accessed, the software will automatically disable the amplifier and change the ENABLE Mode (EM) to Opto-In. This is done to protect the user and the application. If you are utilizing the Software-Enable (SWE) command, the ENABLE Mode (EM) must be changed after visiting the Axis Setup Wizard.*

	CAUTION
	*Low values entered for the Feedback Filter (FBF) may result in an unstable situation. If FBF = 100 Hz, the feedback is sampled every .01 seconds.*

	WARNING
	***When uploading new firmware, the user is prompted to observe safety precautions to prevent accidental damage to the application. The amplifier will be disabled while the firmware is being copied into flash memory. POWER MUST NOT BE INTERUPTED DURING FIRMWARE UPLOAD!***

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1. Introduction

This section provides a summary of model designation and specifications, basic warranty policies, and customer service information.

1.1 About This User's Guide

This User's Guide contains the information necessary to install, wire, start up, operate, and service a PS-33xx Series Digital Servo Drive.

The product series includes three product families: the **PS-33xxd**, a **Digital** servo drive, the **PS-33xxi**, an **Intelligent** servo drive, and the **PS-33xxc Centennial** servo drive. To simplify the use of this User's Guide, we have organized the information into logical sections. In addition, we have created individual sub-sections on each of the PS-33xx models for information specific to that model. When configuration information is specific to a model of the PS-33xx, it will be noted at the beginning of the section. The sections common to all modes of control and configuration are also covered.

1.2 Model Designations and Specifications

Table 1.1 Model Designations and Specifications

		Features @ 40C Ambient							
Model [1]	**Feedback Device**	**Current (RMS) [2]**	**Voltage AC**	**Bus Voltage**	**Regen Internal**	**Regen External**	**Fan**	**Cabinet Watts (max)[4]**	**Inputs Digital**
PS-3303d-E	Encoder/Hall	3/6	90-253VAC 1/3 Phase, 47-63Hz	1.4xVAC nominal, no-load	n/a	47 Ohm 150 Watt	No	60	ENABLE, RESET, plus 2 HSI [3]
PS-3306d-E		6/12			n/a		No	75	
PS-3310d-E		10/20			50 Ohm 50 Watt	10 Ohm 200 Watt	Yes	100	
PS-3320d-E		20/40						150	
PS-3303i-E		3/6			n/a	47 Ohm 150 Watt	No	60	7 Total; ENABLE, RESET plus 3 Isolated, 5-30 VDC, Configure Source or Sink, plus 2 HSI [3]
PS-3306i-E		6/12			n/a			75	
PS-3310i-E		10/20			50 Ohm 50 Watt	10 Ohm 200 Watt	Yes	100	
PS-3320i-E		20/40						150	
PS-3303i-R	Resolver	3/6			n/a	47 Ohm 150 Watt	No	60	
PS-3306i-R		6/12						75	
PS-3310i-R		10/20			50 Ohm 50 Watt	10 Ohm 200 Watt	Yes	100	
PS-3320i-R		20/40						150	
PS-3306c-E	Encoder/Hall	6/12						75	12 Total; ENABLE, RESET plus 8 Isolated, 5-30 VDC, Configure Source or Sink, plus 4 HSI [3]
PS-3306c-R	Resolver							75	
PS-3310c-E	Encoder/Hall	10/20						100	
PS-3310c-R	Resolver							100	
PS-3320c-E	Encoder/Hall	20/40						150	
PS-3320c-R	Resolver							150	

Additional Features to all models:

[1] *APImate2.0 Programming/Configuration Software. Communication via RS-232/422/485*
7 segment diagnostic display and Fault History, PS-33xxC includes Time/Date stamp
I square t, Over-Voltage and Over-Current, PS-33xxC includes Over-Temp protection
Terminal interface for data entry/adjustment. (PS-33xxC includes second com port)

[2] ***For single phase AC derate current, 33% at 115 AC and 50% at 230 AC.***

[3] ***High Speed Inputs, 3.5-7VDC.***

[4] *Does not include regen resistor dissipation.*

Table 1.1 (Continued) Model Designations and Specifications

	Features @ 40C Ambient							
Model [1]	**Inputs Analog**	**Secondary Encoder Input**	**Outputs Digital**	**Outputs Analog**	**Outputs Encoder**	**Control Methods**	**Motor Types**	**Cont. kW**
PS-3303d-E	1 Differential, +/-10VDC, 10 bit Resolution	Utilize the two HSI inputs [3] (2MHz Quadrature)	DRIVEOK, FOLDBACK, Isolated, 5-30 VDC, 5 mA Max	None	Yes	Analog Velocity and Current, Step/Dir, Step+/Step-, Quadrature	Brushless DC	1.1
PS-3306d-E								2.3
PS-3310d-E								3.8
PS-3320d-E								7.6
PS-3303i-E	2 Differential, +/-10VDC, 10 bit Resolution		DRIVEOK, FOLDBACK plus 2 Isolated, 5-30 VDC, 5 mA Max		No	Digital, Position, Program, Network, Analog Velocity and Current, Step/Dir, Step+/Step-, Quadrature		1.1
PS-3306i-E								2.3
PS-3310i-E								3.8
PS-3320i-E								7.6
PS-3303i-R								1.1
PS-3306i-R								2.3
PS-3310i-R								3.8
PS-3320i-R								7.6
PS-3306c-E	3 Differential, +/-10VDC, 14 bit Resolution	Utilize two HSI inputs [3] (2MHz Quadrature)	Total 13; DRIVEOK[5], plus12 Isolated, 5-30 VDC, 30 mA Max, Short Circuit Protected	2 Outputs +/-10 VDC, 12 bit Resolution	Yes	Digital, Position, Program, Analog Velocity and Current, Step/Dir, Step+/Step-, Quadrature	Brushless DC, Brush DC, Induction VF and Vector	2.3
PS-3306c-R								
PS-3310c-E								3.8
PS-3310c-R								
PS-3320c-E								7.6
PS-3320c-R								

Additional Features to all models:

[3] ***High Speed Inputs, 3.5-7VDC.***

[5] *Plus an additional output for SERVO-READY, relay 1 A, 250V*

Table 1.1 (Continued) Model Designations and Specifications

Servo Loop Update				
Model	**Velocity**	**Current**	**Position**	**Encoder following HSI1 & HSI2**
	micro-second	micro-second	micro-second	micro-second
PS-33xxd	400	100	2,000	2,000
PS-33xxi	400	100	2,000	2,000
PS-33xxc	100	100	100	100

Model	Processor	Clock	COMM	Serial	CAN	Math	Ram	Flash
PS-33xxd-E	Siemens C166 RISC	20 MHz	RS-232	19200	No Option	16 bit Fixed Point	64K	128K
PS-33xxi-E			RS-232					
PS-33xxi-R			RS-422					
PS-33xxc-E	TI TMS320 DSP	40 MHz	RS-485			40 bit Floating Point	512K	512K
PS-33xxc-R								

1.3 Warranty

The standard warranty is stated in the "Standard Conditions of Sale". These standard terms and conditions are attached to the quotation form and are part of order acknowledgments sent out from the factory.

1.4 Customer Service

1.4.1 Factory Service

API Controls is committed to quality customer service. We maintain a toll-free telephone number (800-566-5274) staffed by experienced technicians dedicated to providing quick and accurate responses to our customers' application and installation questions.

1.4.2 On-Site Field Service

On-site field service, installation, and startup assistance are offered on an hourly basis. Please contact our Applications Department at (800-566-5274) for current rates and applicable information.

1.4.3 Training

We have found that properly trained support personnel are an important factor in successful and efficient equipment operation. Consequently, we provide formal training seminars aimed specifically at maintenance and operating personnel. These seminars can be conducted at our Amherst facility or at your site. Please contact our Sales Department at (716-691-9100) for additional information.

2. Unpacking, Inspection, and Storage

This section provides information concerning unpacking and inspection of equipment, proper handling procedures, and storage considerations.

2.1 Unpacking and Inspection

Although every precaution is taken to ensure the equipment is delivered in good condition, it is essential that a careful inspection be made upon arrival at your plant. While we make every effort at the factory to fully inspect, test, and package our products so that they reach you defect and damage free, we cannot be responsible for handling by the shipper.

Remove the contents of the carton in which the unit was shipped. Inspect the carton and all components for possible physical damage or discrepancies. If there is any discrepancy in the order or if any damage is discovered, it should be reported immediately to both the carrier and the factory, and a damage claim should be filed immediately with the carrier. This is your responsibility; shipping damage and unreported shortages are not covered by the product warranty.

2.2 Handling

Electronic components in the control equipment are static sensitive. Use proper procedures and common sense when handling the modules to prevent possible inadvertent damage.

Control equipment can be transported by hand or lift-truck. Personnel handling this equipment should be trained in approved and safe handling techniques.

In the unlikely event that a unit needs to be returned to the factory, call our toll-free customer service number described in Section 1.4 to obtain a Return Material Authorization. Be sure to suitably pack the unit to endure the rigors of shipping.

2.3 Storage

It is often necessary to store the control equipment for some period of time before it is actually installed. Since electrical components are delicate and easily damaged, proper storage is very important to the future performance of the equipment. Store the equipment in a clean, dry, non-corrosive location protected from sudden temperature changes, high levels of moisture, shock, and vibration. Ambient temperature should not exceed 60°C; room temperature is recommended. The minimum temperature must remain above 0°C and also above the dew point of the ambient air.

When placing the equipment in storage, cover it to protect it against dust and/or dirt. However, the cover must not be airtight in order to allow air circulation and prevent moisture from being trapped inside.

3. Installation and Wiring

This section summarizes the recommended practices for installation of the servo equipment. These practices are based on and consistent with IEEE Standard 518-1982, "IEEE Guide for Installation of Electrical Equipment to Minimize Electrical Noise Inputs to Controllers from External Sources", particularly Section 6, "Installation, Recommendations and Wiring Practices". This standard must be followed. All equipment grounding should also be in conformance with applicable National and Local electrical codes. Failure to follow recommended procedures might result in incorrect system operation and void the product warranty.

	WARNING
	*When wiring the servo system, proper wiring procedures must be followed. The wiring is to be performed only by qualified electrical personnel familiar with the construction and operation of this equipment, the hazards involved, and the National Electrical Code (NEC) and local electrical codes. Equipment damage and/or injury could result if these procedures are not observed.* ***The user is responsible for conforming to all applicable local, national and international codes.***

3.1 Shielding and Grounding of Electrical Panels

Motion control servo systems contain digital and microprocessor circuitry that can be affected by Electro-Magnetic Interference (EMI). They also contain switching amplifiers that can generate significant EMI at frequencies from 10 kHz to 300 MHz. The potential exists for this switching noise to interfere with the correct operation of both the servo system and any other electrical equipment in the vicinity.

While most manufacturers, including API Controls, design their products to minimize susceptibility to EMI, immunity is greatly affected by installation techniques. Some responsibility for avoiding EMI related problems must fall to the system integrator. This section describes panel layout, wiring, grounding, and shielding techniques effective in designing and integrating a servo system into your application.

	WARNING
	*If there is a conflict between recommendations in this manual and safety codes, safety requirements must be followed.* ***The user is responsible for conforming to all applicable local, national and international codes.***

As in all engineering designs, a trade-off between the perfect solution and what is practical is unavoidable. You may not be able to apply all the suggestions we make, but careful attention to EMI reduction will minimize startup costs and future operating problems in any installation.

3.1.1 Panel Layout - General Placement

How parts are placed on the sub-panel and on the enclosure door will play an important role in reducing the effects of EMI. When designing a control panel for the servo system, the panel builder must recognize a system's two worst enemies: heat generation and electrical noise.

The importance of proper control panel layout cannot be overemphasized. First, it will set the stage for good noise-free wiring practices described later in this section. Second, it will minimize the effects of heat generation.

	NOTE
	*Allow a minimum distance of 12 inches (305 mm) above and below each drive and a minimum of 3 inches (78 mm) on each side of the drive to eliminate the potential problems of heat generation and electrical noise.*

Proper control panel layout can be achieved by following the simple rules listed below. Review additional information on electrical procedures in Section 3-49.

- Do not mix power and control signal wiring in the same conduit, duct, or wire tray without 12 inches (305 mm) of separation.

- Provide separate wire ways for main AC, low power AC, high power DC, and low power DC.

- Restrict all high voltage power wiring and power devices; such as circuit breakers, contactors, fuses, etc., to an area separate from the low-level control wiring as stated above.

- The area above the amplifiers is to be used for the wiring of low level (noise sensitive) control signals, such as analog input and output signals and motor feedback signals.

- When mounting any unit, be sure to remove paint from the unit and the mounting surface to obtain metal-to-metal contact. Use a serrated washer (star washer) to improve the connection. If in doubt use a ground strap to ensure good connection between the unit and the enclosure.

- Use ground straps made of 1 inch (25 mm) silver tinned flat copper braid to connect cabinet doors to enclosures, the first sub-panel to the enclosure, and each sub-panel to the next.

- Where electrical codes call for the typical green safety ground wires, use them *in addition* to any ground strap suggested in this guide.

- Follow the electrical codes for grounding of the main three-phase power transformer.

- It is recommended that all heat-generating resistors be mounted outside the cabinet with a protective enclosure.

- Allow a minimum distance of 12 inches (305 mm) above and below each drive and a minimum of 3 inches (78 mm) on each side of the drive to eliminate the potential problems of heat generation and electrical noise.

- No heat generating devices, such as transformers, inductors, braking resistors, etc., should be mounted directly below the mounting assembly.

- The motor wiring must be properly strain relieved to ensure interconnects, wiring and terminal connections do not become damaged.

	NOTE
	*To obtain rated output current from all amplifiers, the ambient air temperature below the amplifiers must be between 0°C and +40°C. No heat generating devices, such as transformers, power supplies, or power resistors, should be mounted directly beneath the modules.*

3.1.2 Amplifier Placement and Installation

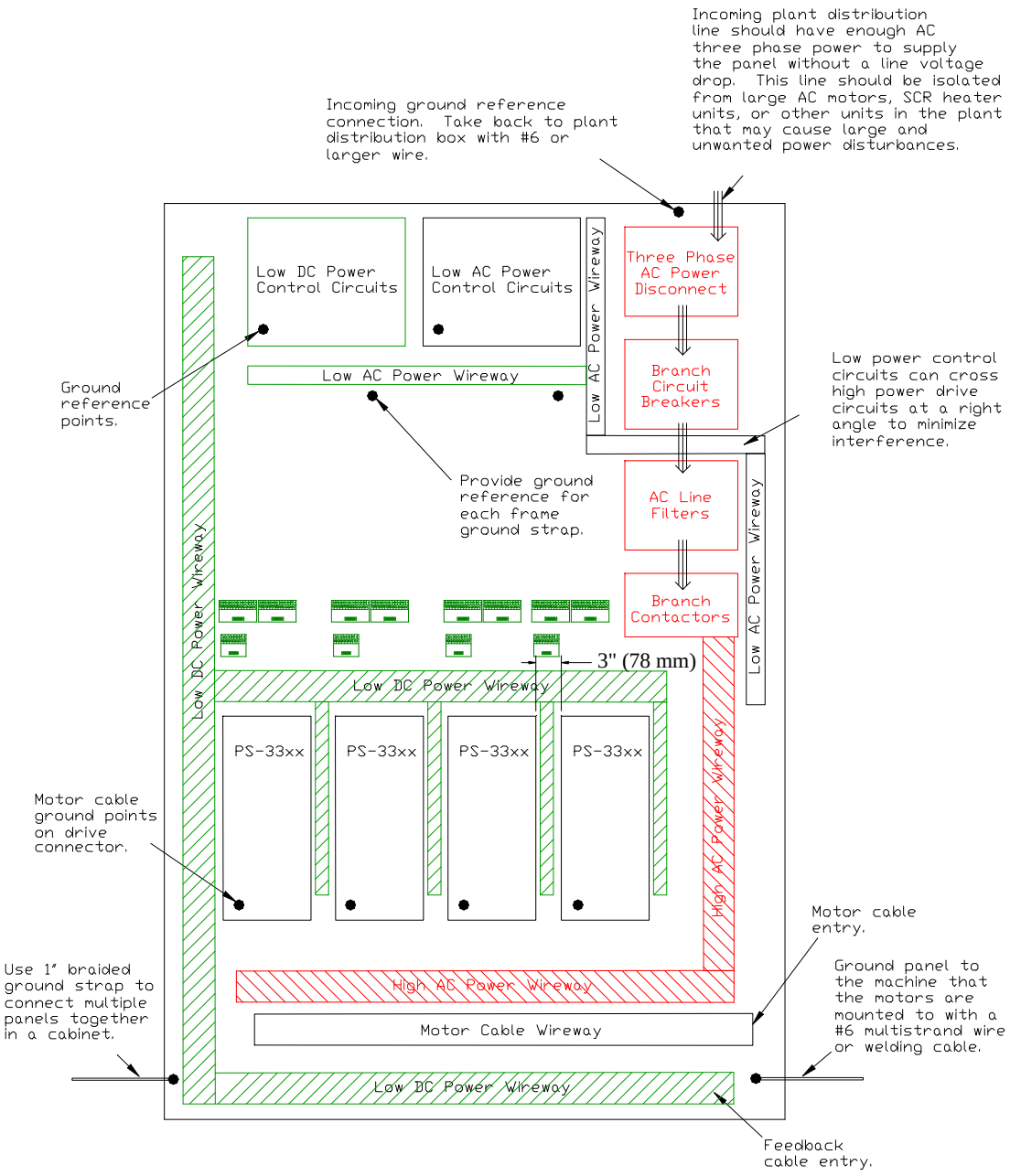
The amplifier module(s) will be installed by the user into an industrial cabinet. Dimensions for the amplifier modules are given in Figure 3-8. Figure 3-1 shows a typical panel layout for four PS-33xx Series modules.

	NOTE
	*Allow a minimum distance of 12 inches (305 mm) above and below each drive and a minimum of 3 inches (78 mm) on each side of the drive to eliminate a servo system's two worst enemies: heat generation and electrical noise.*

	NOTE
	*Use ground straps made of 1 inch (25 mm) silver tinned flat copper braid to connect cabinet doors to enclosures, the first sub-panel to the enclosure, and each sub-panel to the next.*

	NOTE
	*Where electrical codes call for the typical green safety ground wires, use them **in addition** to any ground strap suggested in this guide.*

Figure 3-1 Typical Panel Layout



3.2 Communication Hardware Configuration

The only hardware configuration that must be configured by the user prior to mounting is the method of communication and the node ID.

All models of the PS-33xx Series Digital Servos have identical communications (Comm Port J5), thus making it possible to install a mixed combination of Intelligent and Centennial units for the most demanding applications.

During initial power-up, the PS-33xx's seven-segment status display will briefly indicate the units' node setting. For example, **API id06** will be displayed to indicate that the node ID is "06". For additional information on the status display, consult **Table 6.1** on page 6-1.

	NOTE
	*Set the unit's axis id and method of communications prior to proceeding with mounting. Once configured, we suggest that the front of each unit be marked with its unique Axis ID to facilitate installation and startup.*

The user must configure the PS-33xx Series Digital Servo prior to mounting the unit. To accomplish this task, the cover of the PS-33xx must be removed (no tools are required).

1. Grasp the heatsink in one hand and the enclosure in the other. Gently squeeze the center semi-circle feature of the enclosure to disengage the locking mechanism and slide it off the front of the drive.

2. Locate the 10-position dip-switch and set the unit's AXIS ID and COMMUNICATIONS METHOD per Table 3.1 and Table 3.2 below.

3. After the switches are configured we suggest that the user indicate the axis number on the front of each unit for later identification.

4. To reinstall the cover, gently slide the cover into position until the locking mechanism is engaged.

3.2.1 Node Selection

The user must configure the axis selection switches to define the communications method and axis address of the unit. A unique axis address (from 1 through 31) must be selected for each unit when multiple axes will be on the same communications link. The default factory setting is node 1.

The unique axis address "0" is reserved for applications where the PS-33xx is connected to a **T-330** Data Terminal. *This address will result in the communications port being reconfigured for 9600 baud.* The **T-330** data terminal is used to adjust amplifier parameters in the **PS-33xxd** or entering variables and application data into the **PS-33xxi** or **PS-33xxc** when utilized as a standalone controller.

Table 3.1 Node ID - Switch Selection

Node ID *			
Axis ID	**Switch 12345**	**Axis ID**	**Switch 12345**
0	00000	16	00001
1	10000	17	10001
2	01000	18	01001
3	11000	19	11001
4	00100	20	00101
5	10100	21	10101
6	01100	22	01101
7	11100	23	11101
8	00010	24	00011
9	10010	25	10011
10	01010	26	01011
11	11010	27	11011
12	00110	28	00111
13	10110	29	10111
14	01110	30	01111
15	11110	31	11111

**Node 1 is factory default, node 0 is reserved for terminal mode.*

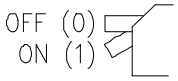


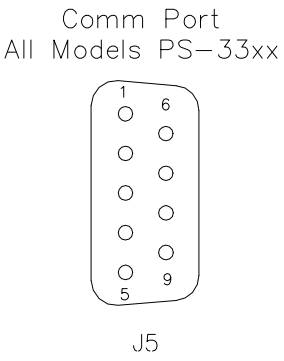
Table 3.2 Communication Method - Switch Selection

Communication Methods	
Switch 678910	**Communication**
0010 0	RS-232 Three Wire
1100 1	RS-422/485 Two Wire *
0000 1	RS-422/485 Four Wire *
xxx1 x	* Switch 9 is ON for termination resistor on last unit

3.2.2 Comm Port (J5)

It should be noted that the PS-33xxc Centennial series controllers have an additional communications port to allow it to pass information to additional units. This feature is useful in applications where the Centennial series controller is acting as a master and the application requires data transfer to slave axis.

Figure 3-2 Comm Port Pin Definition (J5)



J5 - Comm Port			
DB9-F Pin #	**RS-232C**	**RS-422 RS-485**	**RS-485 two wire**
1	NC	Tx+	Rx+/Tx+
2	Tx	Tx-	Rx-/Tx-
3	Rx	Rx-	Rx-/Tx-
4	NC	Rx+	Rx+/Tx+
5	COM	COM	COM
6	Tx*	-	-
7	Rx*	-	-
8	NC	-	-
9	+5VDC**	-	-

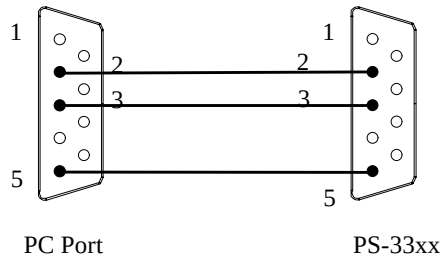
* PS-33xxc only (Comm Port 2).

** The maximum current is limited to 120ma for use with the **T-330** Data Terminal.

RS-232 Three Wire Configuration

This is the factory default configuration. This communication method is used for applications requiring less than 25 feet of communications cable.

Figure 3-3 Schematic of RS-232 Wiring

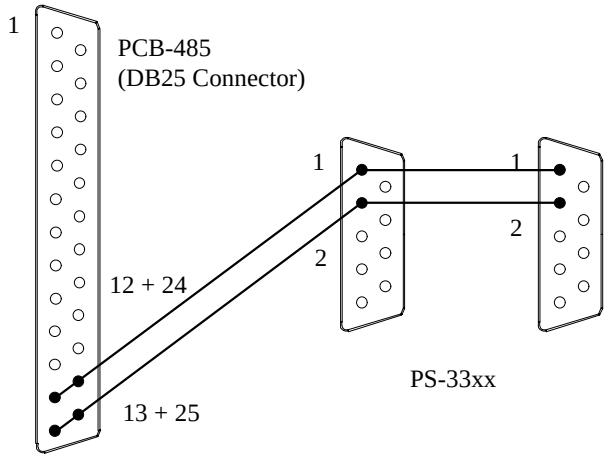


RS-422/485 Two Wire Configuration

This communication method is used for applications requiring less than 5000 feet of communications cable. The **PCB-485** communications card is required. This method is cost-effective and provides increased noise immunity.

	NOTE
	Utilizing RS-422/485 communications cards by other manufacturers than those recommended by API Controls may result in erratic behavior and reduced noise immunity.

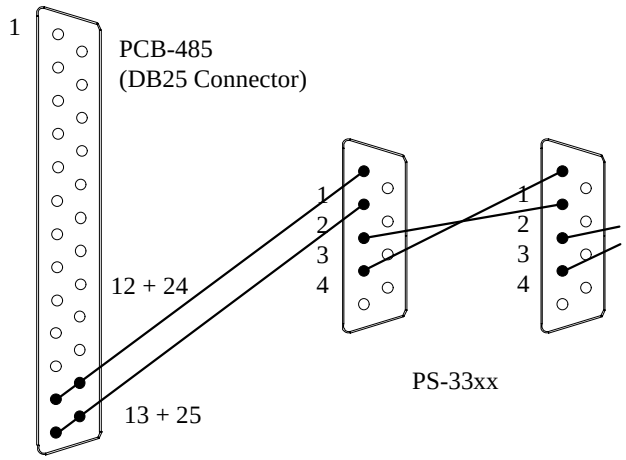
Figure 3-4 Schematic of RS-422/485 Wiring (Two Wire)



This is an alternate method of wiring the inter-axis cable and is used for applications requiring less than 5000 feet of communications cable. The **PCB-485** communications card is required. This method provides additional noise immunity.

	NOTE
	Utilizing RS-422/485 communications cards by other manufacturers than those recommended by API Controls may result in erratic behavior and reduced noise immunity.

Figure 3-5 Schematic of RS-422/485 Wiring (Alternate Two Wire Method)

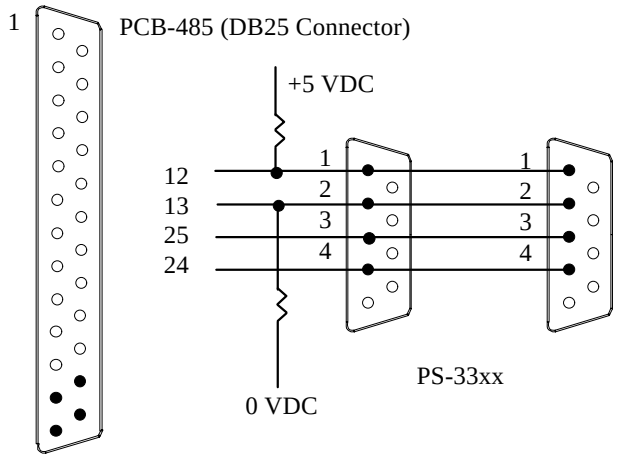


RS-422/485 Four Wire Configuration

This method is used for applications requiring less than 5000 feet of communications cable. The **PCB-485** communications card is required. This method provides the highest noise immunity.

	NOTE
	*Utilizing RS-422/485 communications cards by other manufacturers than those recommended by API Controls may result in erratic behavior and reduced noise immunity. (Use 10k resistors if not in PC Card, install at PC end of communications cable).*

Figure 3-6 Schematic of RS-422/485 Wiring (Four Wire Method)

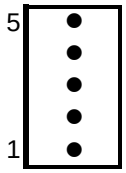


3.2.3 Network (J4)

Models of the **PS-33xxi** Series can be purchased with connections for a Control Area Network or CAN interface. This method of digital control allows the user to communicate to a group of amplifiers at a rate up to 3M baud. The use and function of the CAN interface is covered in a separate document; consult the factory if additional information is required.

	CAUTION
	*Models of the **PS-33xxi** Series can be purchased with connections, (J4) for a Control Area Network or CAN interface. If you have not purchased this model, **MAKE NO ELECTRICAL CONNECTIONS TO THIS CONNECTOR**.*

Figure 3-7 Network Connections for CAN



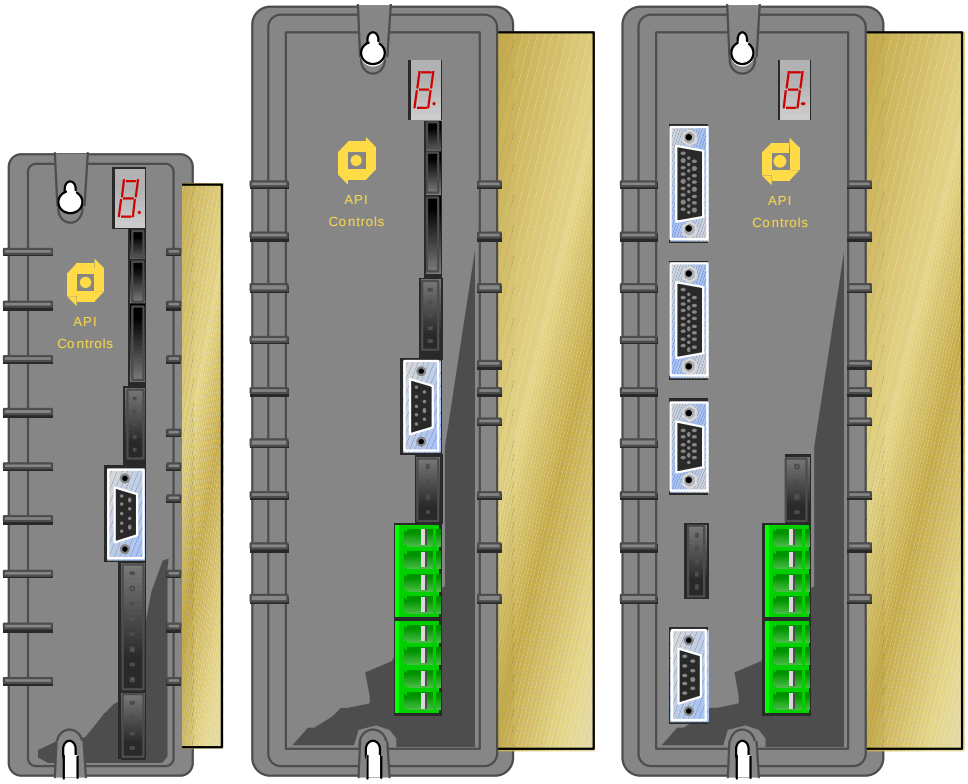
J4 - Network	
Pin #	**Signal**
5	Reserved
4	Reserved
3	Reserved
2	Reserved
1	Reserved

3.2.4 Mounting Dimensions

The PS-33xx is designed for easy installation into an electrical cabinet or sub-panel. The integral heatsink and mounting surface heat-plate design increases the heat dissipation path and the product reliability. The user must attach the PS-33xx to a suitable mounting surface to optimize heat dissipation.

	NOTE
	*Allow a minimum distance of 12 inches (305 mm) above and below each drive and a minimum of 3 inches (78 mm) on each side of the drive to eliminate a servo system's two worst enemies: heat generation and electrical noise.*

Figure 3-8 PS-33xx Series Dimensional Illustration



Consult the **Appendices** for mounting dimensions.

3.3 Electrical Procedures

	NOTE
	***Read this section before proceeding with any system wiring!***

3.3.1 Wiring Precautions

Grounding

To minimize the effects of electrical noise, a systematic rack, panel, and system grounding procedure should be followed. Review Section 3.1, **Shielding and Grounding of Electrical Panels**, for pertinent information.

The panel or rack in which the equipment is installed should provide a Single-Point Ground, hereafter referred to as SPG, stud, or bar. The SPG should be welded or bolted inside the enclosure and be electrically continuous with the mounting assembly. The panel's SPG should, in turn, be tied by a 1-inch (25mm) braided strap to a good Physical Earth (PE) ground, to which other panels, cabinets, and the controlled machinery are similarly grounded.

	NOTE
	*Use ground straps made of 1 inch (25 mm) silver tinned flat copper braid to connect cabinet doors to enclosures, the first sub-panel to the enclosure, and each sub-panel to the next.*

The PE ground could consist of a copper rod driven into the earth (a grounding electrode), a building column which is embedded in the earth, or another mass which has been determined to be at a true earth ground potential. A copper rod driven into the earth is the recommended method.

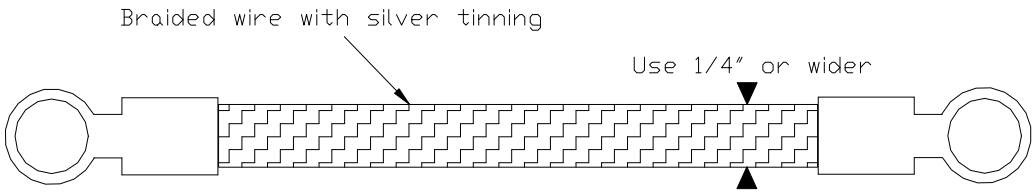
	CAUTION
	*Use Star grounding arrangement. Chain grounding or daisy-chain arrangements should not be used.*

The system ground and equipment grounds for other units on the panel, if any, should be *individually* wired to the SPG, utilizing 10 AWG (5.5 mm^2) stranded copper wire.

In any system connection to a physically separated piece of equipment or another part of the control system, careful attention should be given to the avoidance of ground loops. Ground loops can cause erratic system operation.

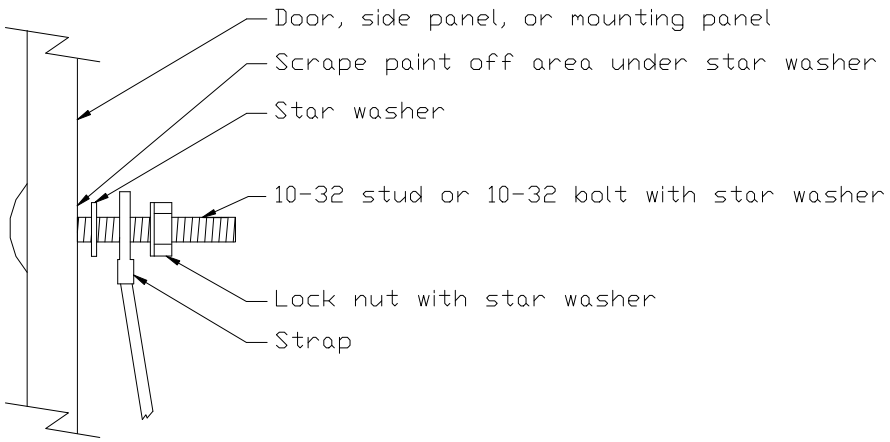
	NOTE
	*Where electrical codes call for the typical green safety ground wires, use them **in addition** to any ground strap suggested in this guide.*

Figure 3-9 Recommended Ground Strap



When mounting any unit, be sure to remove paint from the unit and the mounting surface to obtain metal-to-metal contact. Use a serrated washer (star washer) to improve the connection. If in doubt use a ground strap to ensure good connection between the unit and the panel.

Figure 3-10 Recommended Ground Strap Mounting Technique



Wiring and Shielding

Wired connections to the system are of two categories: high power wiring and low power control signal wiring.

	NOTE
	*High power wiring and low power DC signal wiring within the panel or enclosure should not share wire raceways and should be separated by a minimum of 12 inches (305 mm) for parallel runs. If wire paths should cross and touch, they should do so only at right angles to each other.*

	NOTE
	*Provide separate wire ways for main AC, low power AC, high power DC, and low power DC.*

Low power DC signal level wiring (logic and analog signals) leaving the panel/enclosure on which the system is mounted should run in separate metallic conduits or channels from AC power, motor power conductors, or other power equipment circuits.

The analog and High Speed Inputs of the **PS-33xx** Series Amplifiers are differential inputs. These differential inputs should be driven via the users differential outputs and should be connected with individually shielded twisted pairs to provide the best possible noise immunity.

All control signals interfacing to the system must be wired with twisted cable, with at least one twist per inch, to minimize inductive noise coupling. Encoder and resolver wiring must be wired with individual twisted shielded pairs, using cable equivalent to those listed in Table 3.3 below.

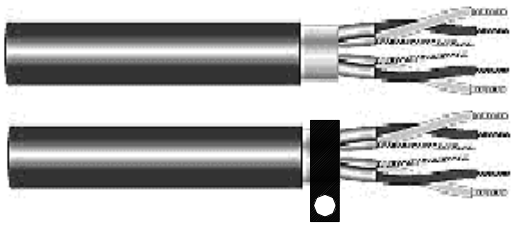


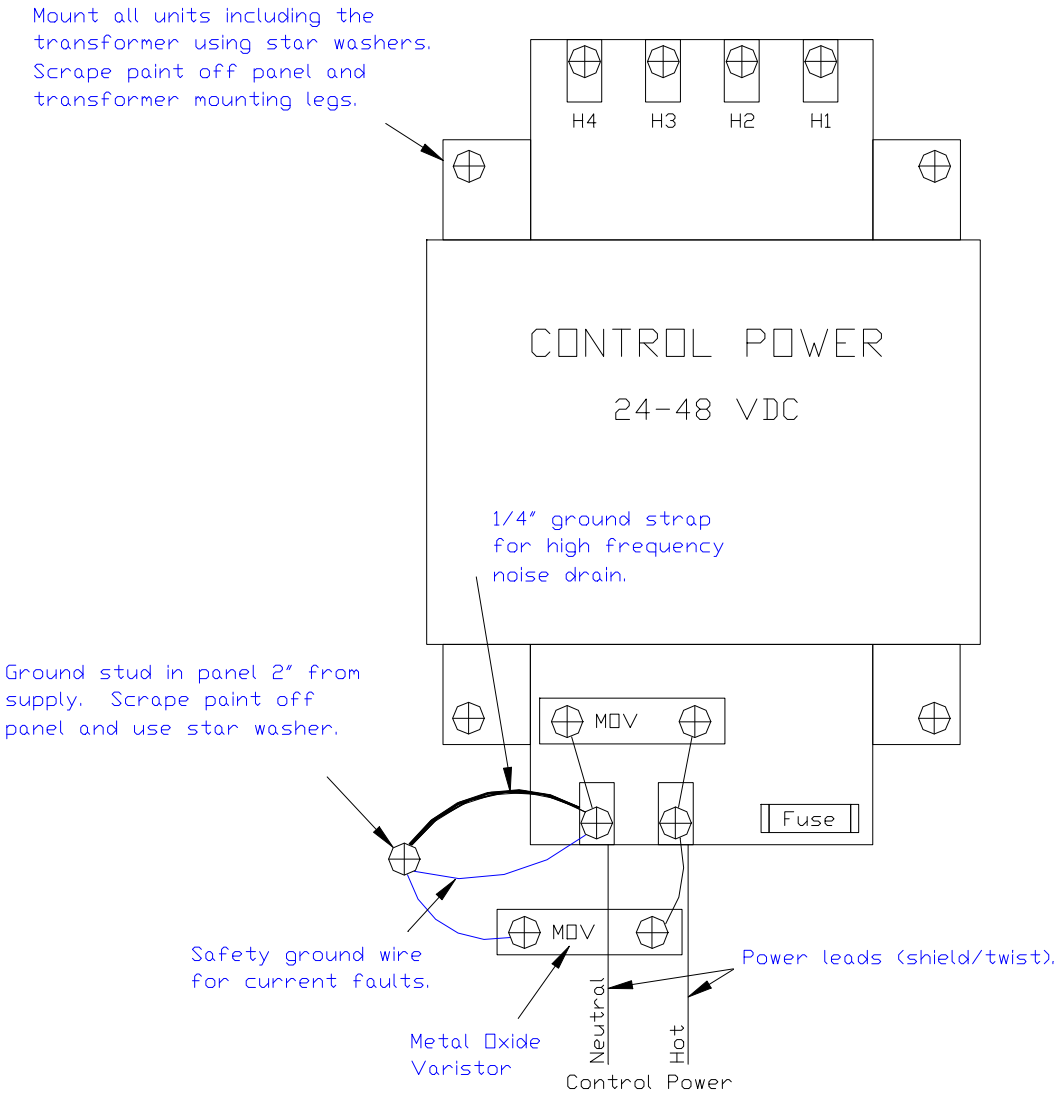
Table 3.3 Suggested Wire

Wire Selection Table		
Purpose	**Description**	**Manufacturer**
Signal	22 AWG, 2 Pair, Shield & Drain	Alpha 5482C
Signal	22 AWG, 3 Pair, Shield & Drain	Alpha 5484C
Signal	24 AWG, 2 Pair, Shield & Drain, Low Capacitance	Belden 8102
Signal	24 AWG, 4 Pair, Shield & Drain, Low Capacitance	Belden 8104
Signal	24 AWG, 8 Pair, Shield & Drain, Low Capacitance	Belden 8108
Signal	28 AWG, 2 Pair, Shield & Drain, Low Capacitance	Alpha 3492C/Belden 8132
Signal	28 AWG, 4 Pair, Shield & Drain, Low Capacitance	Alpha 3494C
Signal	28 AWG, 8 Pair, Shield & Drain, Low Capacitance	Alpha 3498C
Ground Strap		

Unused conductor pairs should be grounded to the SPG at *one end only* to avoid a ground loop. Ensure that any interface cable shield is individually wired to the appropriate cable shield termination point. Shields should be insulated from ground and all other electrostatic shields along the length of the run. *The ungrounded end should have the shield cut back and taped to prevent contact with other conductors or conduits.* If a twisted shielded pair must be broken (at terminal boards or connector pairs), the unshielded length is not to exceed 2 inches (50 mm) and carry the shield through the connection on a separate pin or terminal.

Secondary power (logic commons), if provided by individual equipment, should be directly wired from their source to the SPG utilizing 12 AWG (3.5 mm^2) wire.

Figure 3-11 Ground Strap for Secondary Control Power

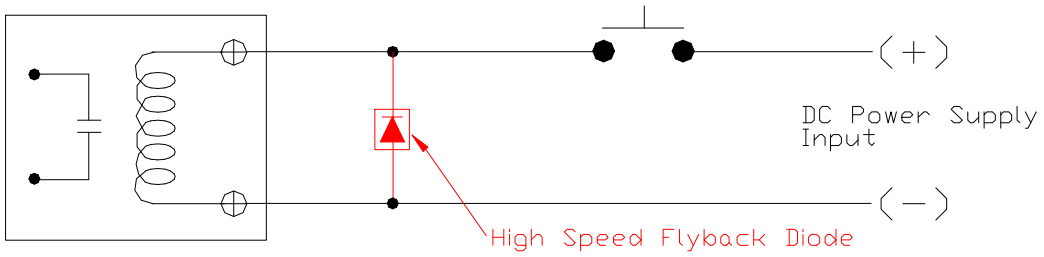


Noise Source Suppression

It is necessary to suppress all relay and contactor coils, both AC and DC. Noise suppressors can be purchased locally and are an effective, inexpensive method of eliminating potential noise problems in the system.

Any connection to an inductive load (such as a DC coil) should be terminated with a high-speed flyback diode to absorb the high-energy spikes caused when the coil is switched off and its magnetic field collapses. Such diodes should be connected close to the inductive load to provide suppression at its source, across the coil with the reverse polarity to the voltage that powers the coil. The amount of energy absorbed is considerable and the diode must be rated accordingly.

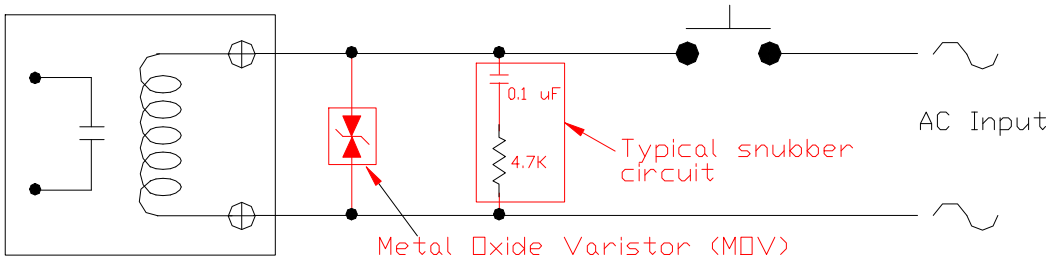
Figure 3-12 Noise Suppression - DC Relay



Any connection to an inductive load (such as an AC coil) should be terminated with an RC snubber circuit or metal oxide varistor (MOV) to absorb the high energy spikes caused when the coil is switched off and its magnetic field collapses. An RC snubber (4.7k ohm resistor in series with a 0.1 µf capacitor) placed across an AC coil will effectively suppress noise generation. Such suppression devices should be connected close to the inductive load to provide suppression at its source. The amount of energy absorbed is considerable and the suppressor must be rated accordingly.

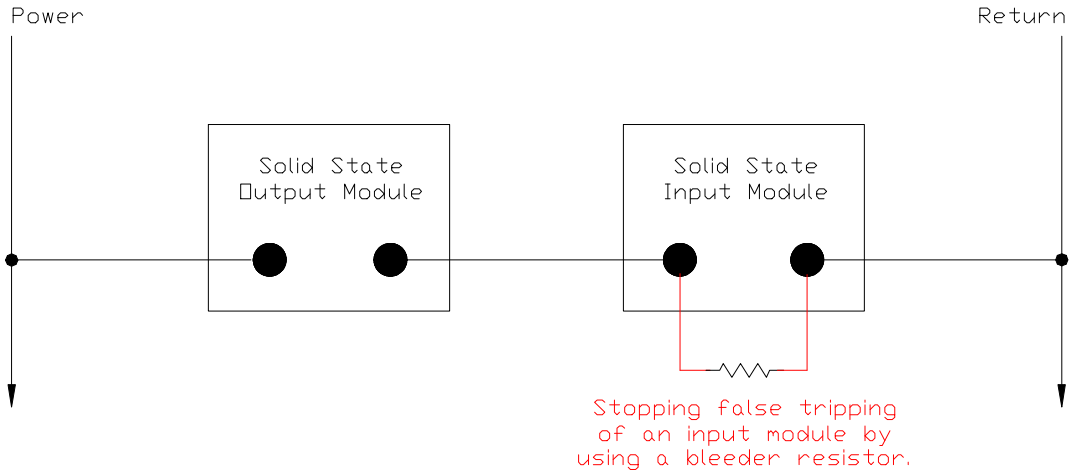
Metal Oxide Varistors (MOV) are less effective than an RC Snubber for noise suppression and tend to degrade over time.

Figure 3-13 Noise Suppression - AC Relay



Solid state inputs that are driven from solid state outputs should have a bleeder resistor across the input to provide a path for the output's leakage current when the output is off. This will help prevent false tripping on the input when the output is off. This is extremely important when utilizing the high-speed inputs of the PS-33xx. The resistor's rating depends on the output device's leakage current and the input device's OFF voltage.

Figure 3-14 Noise Suppression - SS Relay



3.3.2 Power Connections

This section will explain wiring associated with the power section of the PS-33xx Series Digital Servo modules. Refer to Section 7, Appendices, for engineering data on the selection of contactors, fusing, filters, and related information on the specific model being installed. System interconnect diagrams are provided in Section 7.5, Relevant Engineering Prints. Be certain to use the diagram that refers to your system. Review Section 3.1, **Shielding and Grounding of Electrical Panels**, for information on placement of components.

	NOTE
	*High power wiring and low power DC signal wiring within the panel or enclosure should not share wire raceways and should be separated by a minimum of 12 inches (305 mm) for parallel runs. If wire paths should cross and touch, they should do so only at right angles to each other.*

- Provide separate wire ways for main AC, low power AC, high power DC, and low power DC.
- Restrict all high voltage power wiring and power devices; such as circuit breakers, contactors, fuses, etc., to an area separate from the low-level control wiring.
- Constant voltage transformers can be installed if the AC power tends to drop below the specified minimum voltages required to keep the controllers from resetting.
- Where loss of control power is critical or an orderly shutdown in the event of a power loss is required, consider wiring the Control Power from a separate feed. Consult the following section for wiring and specifications.

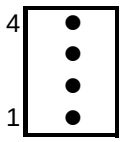
	WARNING
	*Use care to ensure the correct pinout is used for the main power connections. Improper wiring will result in damage to the amplifier.*

The main power wiring is made to the terminal block TB1. Use care to ensure the correct pinout is used for the main power. When operating off 115 VAC, the L1 and L2 connections should be utilized. Ensure that the amplifier's PE ground, pin #1, is taken directly to the panel's SPG.

The preferred AC line over-current protective device, one for each unit, is a three-phase magnetic circuit breaker with a 5-8x instantaneous trip point.

	WARNING
	When operating off single-phase VAC, ensure that you have taken into account the amplifiers current de-rating. ***For single phase AC derate current 33% at 115 VAC and 50% at 230 VAC.*** Failure to do so will result in damage to the amplifier and is not covered under the manufacturer warranty.

Table 3.4 AC Power (TB1)



TB1 - AC Power	
Pin #	**AC IN**
4	L1
3	L2
2	L3
1	GND (PE)

Line Filters

AC power brought into the panel can allow EMI to enter the panel. This is especially true in facilities that have a large number of SCR controlled devices, such as variable speed drives and heating or welding devices. Line filters should be placed in the incoming power lines immediately after the safety circuits and before any critical control components.

The PS-33xx Series controllers do have built-in suppressors to protect them from line induced noise and transients. However, these internal devices cannot prevent such noise from affecting other parts of the system, such as high-speed sensor inputs and analog circuits. Line filters will be necessary to achieve conducted noise levels to meet requirements for the CE Mark. Refer to **Table 7.11** for suggested line filters.

- Mount filters as close as possible to incoming power feed as practical.
- The incoming power feed should be as short and direct as possible.
- Do not bundle clean wiring from filtered sources with dirty unfiltered wiring.

Control Power (TB2-3 / TB3) (Option)

	WARNING
	*The section applies only to models of the PS-33xx that have been purchased with the optional Control Power configuration.* ***Do not make connections to Ctrl+ and Ctrl- terminals; units not factory configured for this option will be damaged.*** *Units damaged as a result of improper installation will not be covered under API's warranty policy.*

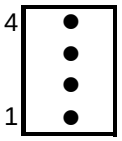
Wiring a separate Control Power should be considered where loss of control power is critical or an orderly shutdown in the event of a power loss is required. Refer to the Table 3.5 for control voltage requirements for each drive model being installed.

	WARNING
	*The Control power supply must be* ***ISOLATED from chassis ground****; otherwise, equipment damage and/or injury could result.*

Table 3.5 Control Power Specifications

Model	Control Power Requirements
PS-33xxd-C1 **PS-33xxi-C1** **PS-33xxc-C1**	24 - 48 VDC, 2 A maximum. This power supply must be **ISOLATED from chassis ground.**
PS-33xxc-R-C0	N/A.

Table 3.6 Control/Regeneration (TB3)



TB3 - Ctrl/Regen	
Pin #	Name
4	Ctrl +
3	Ctrl -
2	Regen +
1	Regen -

3.3.3 High Power DC Connections

External Regen

The PS-33xx can dissipate regeneration energy internally. When applications require hard deceleration that exceeds the unit's ability, an external regen resistor must be added to the system at the two terminals labeled **Regen +** and **Regen -** on TB3. A fuse should be placed in series with the regen resistor to protect the resistor. Specifications of the regeneration circuits are summarized in Table 3.7 and Table 3.8.

It is recommended that all heat-generating resistors be mounted outside the cabinet with a protective enclosure.

	WARNING
	***External regen resistors are connected to the drive d-c bus voltage that can reach 400 VDC. Connections to external regen resistors must be electrically insulated and mechanically shielded for safety. High voltage warning stickers are also recommended.***

Figure 3-15 Regeneration Circuit

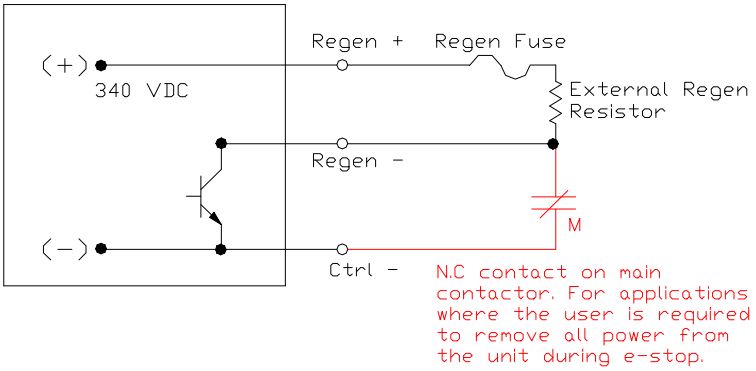


Table 3.7 Regeneration Circuit Specifications

Regen active at	377 VDC
Bus fault /Over-Voltage/ active above	400 VDC
Bus fault /Under-Voltage/ active below	90 VDC

Table 3.8 External Regeneration Resistor Specifications

Model	External Continuous	External Peak	External Regen Resistor Kit
PS-3303	47 Ohm, 150 W	3 kW	RRK-0160-47
PS-3306(d)(i)	47 Ohm, 150 W	3 kW	RRK-0160-47
PS-3306c	10 Ohm, 200 W	14 kW	RRK-0200-10
PS-3310	10 Ohm, 200 W	14 kW	RRK-0200-10
PS-3320	10 Ohm, 200 W	14 kW	RRK-0200-10

Resistor Kits include: resistor, fuse, fuse holder, and 1 meter of wire.

Bus Fault

The PS-33xx's protection circuitry monitors the DC bus in hardware and/or software to determine if excessive regeneration is occurring. Exceeding the regeneration resistor's power rating will cause the regen circuit to be disabled which will result in a bus fault, shutting down the amplifier to safeguard the system, and displaying a fault (see **Table 6.1**). When this bus fault condition exists the motor will become "free-wheeling" and protective measures should be employed to prevent personal injury or damage to the system. This fault condition can be cleared by activating the **Reset** input or through cycling power to the unit. When a bus fault occurs, the user should examine the application to determine if an external regeneration resistor is required, the motion can be slowed, or that the proper equipment has been selected for the application.

During the deceleration phase of motion the motor will regenerate energy into the amplifier. This regeneration will cause the voltage of the DC bus to rise. The regeneration resistor will turn on when the bus voltage exceeds 377 VDC. The peak power dissipation is calculated by the following formula:

$$PeakPower(PS-3320) = \frac{V^2}{R} = \frac{(377)^2}{10} = 14kW$$

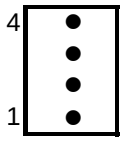
Peak power dissipation occurs the moment the circuit is enabled. As soon as regen is enabled, the regeneration power begins to be dissipated in the resistor and unless the system is generating peak regen power greater than the regen circuit peak-power capability, the bus voltage decreases.

Motor Wiring

The motor is the prime mover in any installation. Special care should be taken to ensure that the motor is not damaged due to improper wiring and installation. Review **Figure 7-9** and **Error! Reference source not found.** for motor dynamic braking interconnect information. Follow the general procedures listed below to ensure proper installation.

- Do not mix power and control signal wiring in the same conduit, duct, or wire tray without 12 inches (305 mm) of separation.
- Utilize shielded four (4) conductor wiring with drain for motor power cabling. Follow electrical codes to ensure the proper wire gauge for the motor and amplifier being installed into your application.
- Provide separate a wire way for the high power DC cables to the motor.
- The motor wiring must be properly strain relieved to ensure that interconnect wiring and connections do not become damaged.
- Motor thermal overloads (MOL's) are required to protect the motor when loads/currents exceed the motor design limits.
- If your motor is provided with an internal thermal Over Temperature (OT) switch, it should be wired to the appropriate connections on the amplifier. Make this mode ACTIVE via parameter COT *Check motor OT input.*

Table 3.9 Motor Connections (TB2)



TB2 - Motor	
Pin #	**Name**
4	Shield
3	Phase U (A)
2	Phase V (B)
1	Phase W (C)

3.3.4 Low Power DC Connections

Special care must be taken to ensure that the proper wiring is employed for the model being installed into your application. Please review Section 3.3 on electrical procedures before proceeding.

	NOTE
	*High power wiring and low power DC signal wiring within the panel or enclosure should not share wire raceways and should be separated by a minimum of 12 inches (305 mm) for parallel runs. If wire paths should cross and touch, they should do so only at right angles to each other.*

All control signals interfacing to the system must be wired with twisted cable, with at least one twist per inch, to minimize inductive noise coupling. Encoder and resolver wiring must be wired with individual twisted shielded pairs, using cable equivalent to those listed in Table 3.10 below.

Table 3.10 Suggested Wire

Wire Selection Table		
Purpose	**Description**	**Manufacturer**
Signal	22 AWG, 2 Pair, Shield & Drain	Alpha 5482C
Signal	22 AWG, 3 Pair, Shield & Drain	Alpha 5484C
Signal	24 AWG, 2 Pair, Shield & Drain, Low Capacitance	Belden 8102
Signal	24 AWG, 4 Pair, Shield & Drain, Low Capacitance	Belden 8104
Signal	24 AWG, 8 Pair, Shield & Drain, Low Capacitance	Belden 8108
Signal	28 AWG, 2 Pair, Shield & Drain, Low Capacitance	Alpha 3492C/Belden 8132
Signal	28 AWG, 4 Pair, Shield & Drain, Low Capacitance	Alpha 3494C
Signal	28 AWG, 8 Pair, Shield & Drain, Low Capacitance	Alpha 3498C
Ground Strap		

3.3.5 PS-33xxd-E Series

Each **PS-33xxd-E** Series unit is an amplifier, power supply, controller and heatsink integrated into a single standalone package. The PS-33xxd-E Series is a digital amplifier that will only accept an **encoder with Hall** or an **encoder with Commutation Tracks encoded on the Z-Channel** as a feedback device.

All PS-33xxd-E Series servo controllers provide the user with the same basic components:

- Communications interface to your host computer for configuring the PS-33xxd-E servo controller.

- A graphical user interface program, **APImate 2.0**©, provides the user with the tools to easily configure the PS-33xxd-E to a specific application. **APImate 2.0** is a Windows-based program that provides Wizards for axis setup and tuning.

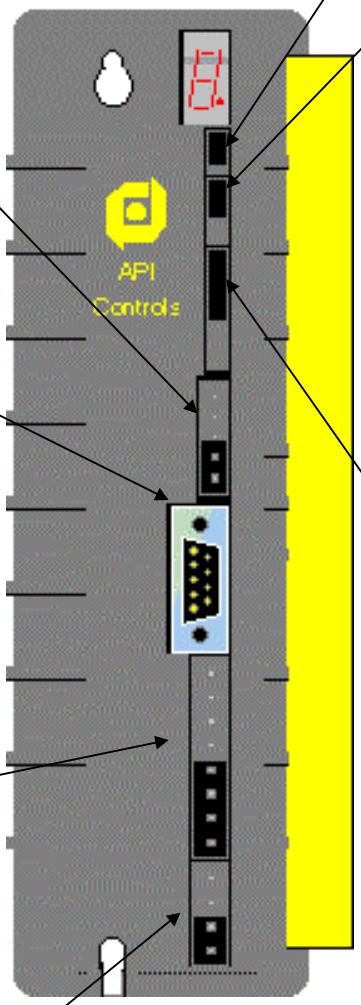
- System software including commands and parameters that allow you to configure the servo controller to your application, to enter and manipulate data, and to tune the performance of the unit to your application.

- Methods of control include the ability to accept Step/Direction, Step-Up/Down, Quadrature, and Analog mode whereby you are commanding the servo system via an analog ±10 VDC reference in either the current or velocity (speed) mode. Determine your required configuration, then review the appropriate section.

- Master/slave relationships can be developed from the secondary encoder inputs, providing motion output as a RATIO.

- Hardware interfaces for ENABLE, RESET, DRIVE OK, and FOLDBACK are dedicated I/O that allow you to interface to your machinery/equipment.

Figure 3-16 PS-33xxd Connector Placement



J2 - Analog I/O			
Pin #	Analog I/O	Pin #	Analog I/O
5	Analog 1, in +	6	Analog 1, in -
3	Shield	4	Shield
1	Spare	2	Spare

J4 - Network	
Pin #	Signal
5	Reserved
4	Reserved
3	Reserved
2	Reserved
1	Reserved

J3 - Feedback, Encoder with Hall			
Pin #	Signal	Pin #	Signal
13	Motor OT +	14	Motor OT -
11	+ 5 VDC Return	12	+ 5 VDC Out
9	HED 2	10	HED 3
7	Shield	8	HED 1
5	Z +	6	Z -
3	B +	4	B -
1	A +	2	A -

J5 - Comm Port			
DB9-F Pin #	RS-232C	RS-422 RS-485	RS-485 two wire
1	NC	Tx+	Rx+/Tx+
2	Tx	Tx-	Rx-/Tx-
3	Rx	Rx-	Rx-/Tx-
4	NC	Rx+	Rx+/Tx+
5	COM	COM	COM
6	Tx*	-	-
7	Rx*	-	-
8	NC	-	-
9	+5VDC**	-	-

J1 - Digital I/O			
Pin #	Isolated IO	Pin #	Isolated IO
23	Shield	24	Shield
21	Drive OK +	22	Drive OK -
19	Foldback +	20	Foldback -
17	Spare	18	Spare
15	Z+ out	16	Z- out
13	B+ out	14	B- out
11	A+ out	12	A- out
9	Spare	10	Spare
7	**HSI 2 -**	8	**HSI 2 +**
5	**HSI 1 -**	6	**HSI 1 +**
3	Reset -	4	Reset +
1	Enable -	2	Enable +

TB2-3 - Ctrl/Regen	
Pin #	Name
8	**Ctrl +**
7	**Ctrl -**
6	Regen +
5	Regen -
4	Shield
3	Phase U (A)
2	Phase V (B)
1	Phase W (C)

TB1 - AC Power	
Pin #	AC IN
4	L1
3	L2
2	L3
1	GND (PE)

PS-33xxd-E Digital Inputs/Outputs (J1)

The PS-33xxd Series is a digital amplifier with limited I/O capability. The unit has optically isolated predefined hardware inputs for ENABLE and RESET inputs, and hardware outputs for SERVO-OK and FOLDBACK. Suggested wiring of these I/O points is shown below.

The drive RESET input, when active, will cause the amplifier to immediately remove power from the motor and clear any re-settable fault conditions.

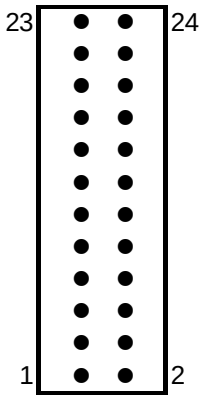
The SERVO-OK output is active when main power is applied and no fault conditions exist.

The FOLDBACK output is active when I^2t is actively reducing the motor output current to protect either the amplifier or the motor.

	CAUTION
	*The two High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment.* ***If you need to operate these inputs as general-purpose inputs, at 30 VDC, then a current limit 2k W resistor must be installed in series with the input.***

All models of the **PS-33xxd-E** Series have two High Speed Inputs (HSI) that can be utilized for the purpose of supplying Step/Direction, Step+/Step-, or a Quadrature input command to the unit. Software configuration of the unit's **Command Mode**, parameter **CM**, must be performed to utilize the two HSI's as command signals.

Figure 3-17 PS-33xxd-E Digital I/O Connector J1



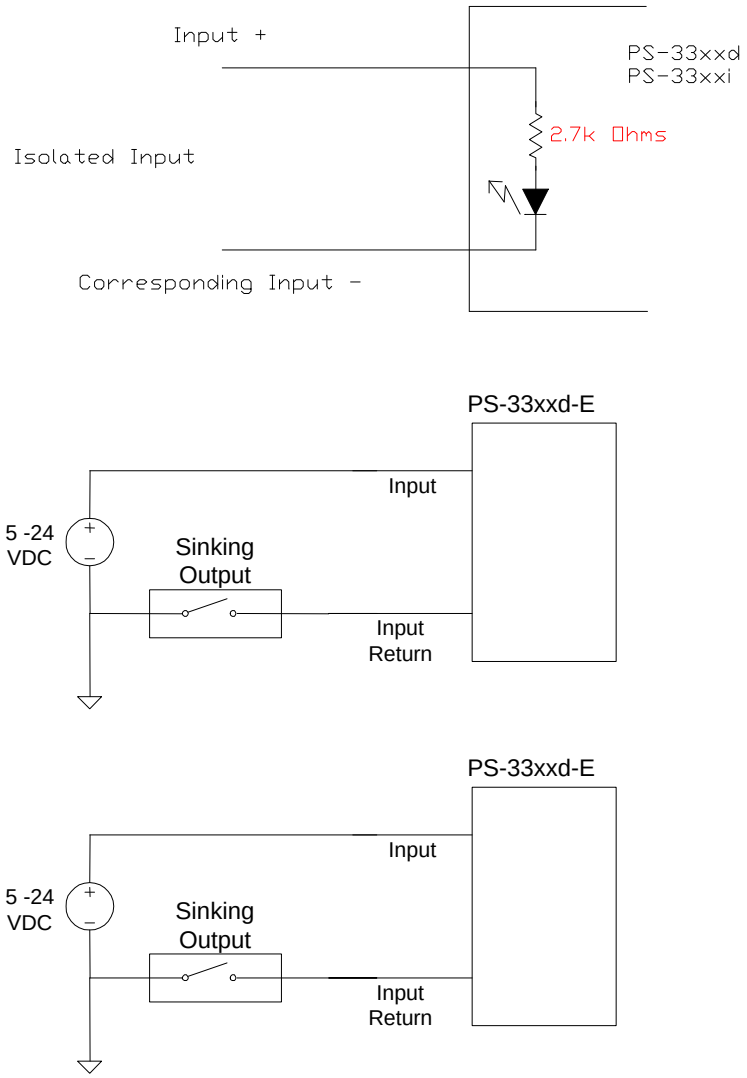
J1 - Digital I/O			
Pin #	**Isolated IO**	**Pin #**	**Isolated IO**
23	Shield	24	Shield
21	Drive OK +	22	Drive OK -
19	Foldback +	20	Foldback -
17	Spare	18	Spare
15	Z+ out	16	Z- out
13	B+ out	14	B- out
11	A+ out	12	A- out
9	Spare	10	Spare
7	**HSI 2 -**	8	**HSI 2 +**
5	**HSI 1 -**	6	**HSI 1 +**
3	Reset -	4	Reset +
1	Enable -	2	Enable +

	CAUTION
	*The two High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment.* ***If you need to operate these inputs as general-purpose inputs, at 30 VDC then a current limit 2k W resistor must be installed in series with the input.***

A cable assembly, **CA-F24-2**, may be purchased to facilitate wiring the J1 connector. This cable assembly provides flying leads, pre-wired to the mating connector, two feet in length.

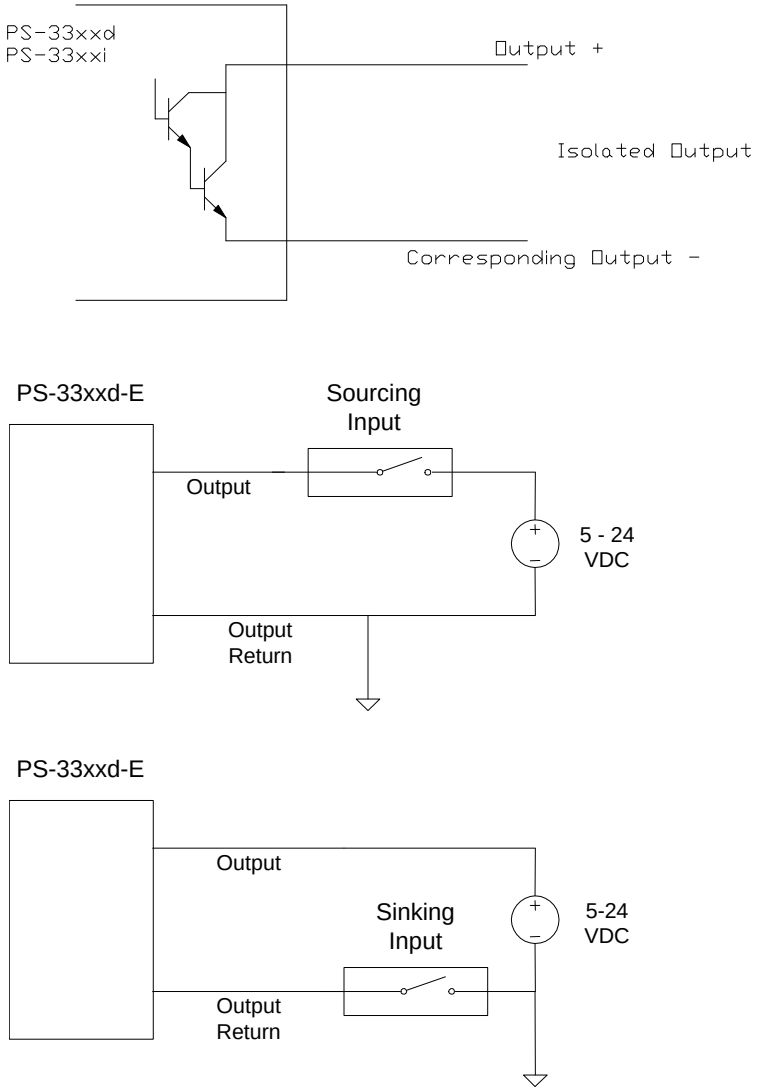
The optically isolated inputs, RESET and ENABLE are current activated.

Figure 3-18 PS-33xxd-E Digital Inputs



The outputs, DRIVE-OK and FOLDBACK can be wired as "current sourcing" or "current sinking", with a maximum "sink" of 35 ma per output. An additional external power source of 5-30 VDC is required. These outputs are not short-circuit protected.

Figure 3-19 PS-33xxd-E Digital Outputs



The encoder outputs of the PS-33xxd-E are not buffered. Special care must be taken maintain the signal integrity.

Figure 3-20 PS-33xxd-E Encoder Outputs

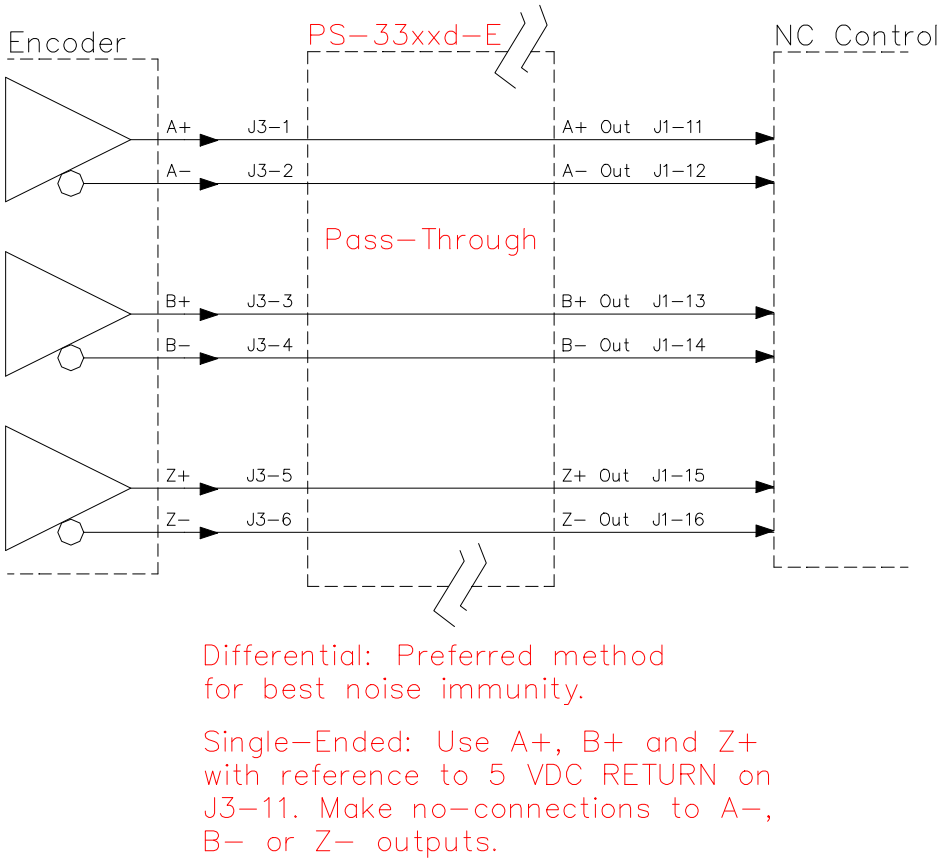


Figure 3-21 PS-33xxd-E HSI Signals

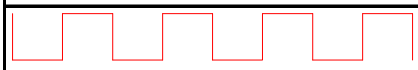
Signals for High Speed Inputs		
Mode	**HSI1**	**HSI2**
Step/Dir	**Direction** 0 = CCW, 1 = CW	**Step** when falling
		
Step+/Step-	**Step CCW** when HSI2 = 0	**Step CW** when HSI1 = 0
		
		
Quadrature	**Phase A Quadrature**	**Phase B Quadrature**
	CCW on A (HSI1) rising with B (HSI2) low	
		
		

Figure 3-22 HSI Signal Timing

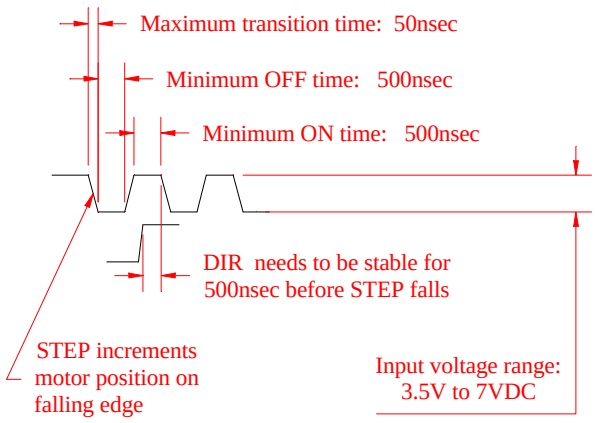
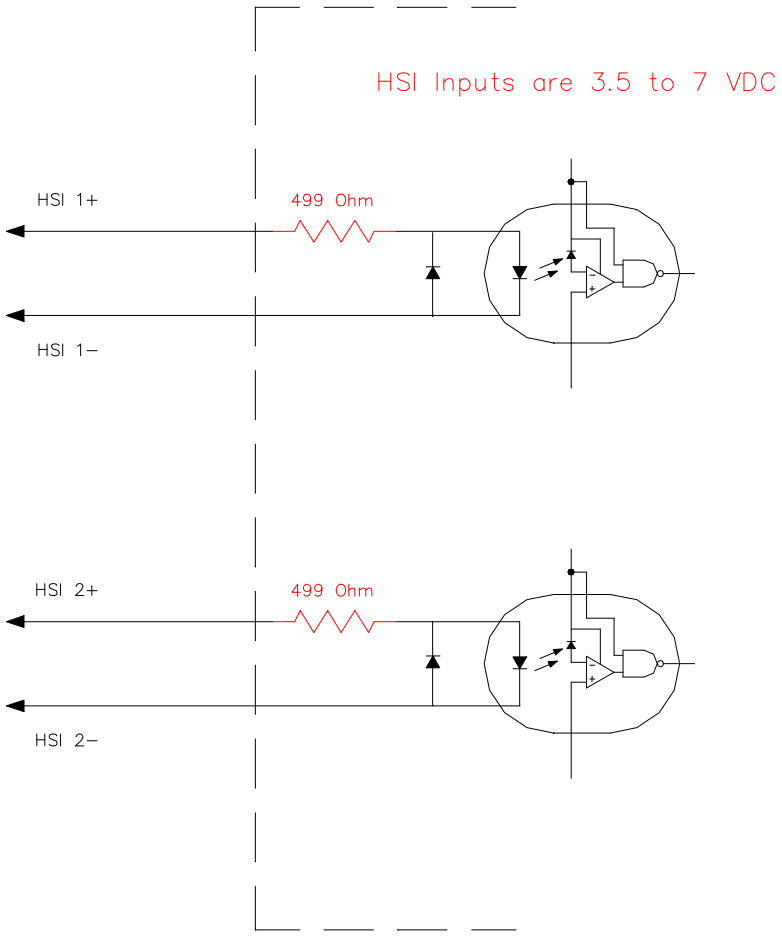


Figure 3-23 Schematic of PS-33xxd-E HSI Inputs



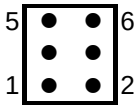
	CAUTION
	The two High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment.

PS-33xxd-E Analog Input (J2)

If you are using the HSI inputs for command input, you may skip this section.

The **PS-33xxd-E** analog I/O connector J2 contains connections for a single analog input. This differential analog input is intended to provide ±10 VDC control signal to the amplifier. The differential input should be driven via the users differential outputs and should be connected with individually shielded twisted pairs to provide the best possible noise immunity. Depending on the software configuration, the analog signal (software name ADC1) can be utilized to provide a "velocity" or "current" command, 10 bit resolution, to provide the required motion.

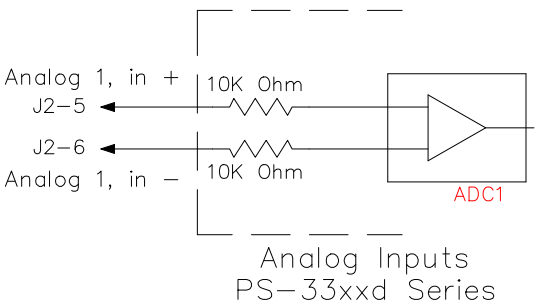
Figure 3-24 PS-33xxd-E Analog I/O Connector J2



J2 - Analog I/O			
Pin #	**Analog I/O**	**Pin #**	**Analog I/O**
5	Analog 1, in +	6	Analog 1, in -
3	Shield	4	Shield
1	Spare	2	Spare

A cable assembly, **CA-F6-2**, may be purchased to facilitate wiring the J2 connector. This cable assembly provides flying leads, pre-wired to the mating connector, two feet in length.

Figure 3-25 Schematic of PS-33xxd-E Analog Inputs



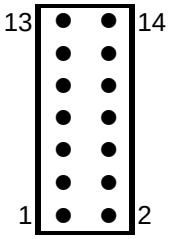
PS-33xxd-E Motor Feedback (J3)

The **PS-33xxd-E** motor feedback connector J3 is a 14-pin dual-row connector that contains connections for Hall Effect Device (HED) and encoder feedback. The connections also include an non-isolated +5 VDC supply for the HED, Encoder power, and motor over temperature sensor (OT). If a motor over temperature sensor is being utilized, you must enable this feature in the software configuration. Make this mode **ACTIVE** via parameter **COT** *Check motor OT input.*

The **PS-33xxd-E** Series is a digital amplifier that will only accept an **encoder with Hall** or an **encoder with Commutation Tracks encoded on the Z-Channel** as a feedback device.

Refer to section 7.2.2 for Commutating Encoder Specifications compatible with encoder based controllers.

Figure 3-26 PS-33xxd-E Feedback Connector J2



J3 - Feedback, Encoder with Hall			
Pin #	**Signal**	**Pin #**	**Signal**
13	Motor OT +	14	Motor OT -
11	+ 5 VDC Return	12	+ 5 VDC Out
9	HED 2	10	HED 3
7	Shield	8	HED 1
5	Z +	6	Z -
3	B +	4	B -
1	A +	2	A -

A cable assembly, **CA-F14-2**, may be purchased to facilitate wiring the J3 connector. This cable assembly provides flying leads, pre-wired to the mating connector, two feet in length.

3.3.6 PS-33xxi Series

Each **PS-33xxi** (Intelligent) Series unit is an amplifier, power supply, intelligent controller, and heatsink integrated into a single standalone package. They will accept high level commands directly, eliminating the need for a motion controller, and can be operated stand-alone, networked, or as a digital amplifier. Each unit has the ability to store and execute motion programs.

The PS-33xxi-E Series is a digital amplifier that will only accept an **encoder with Hall** or an **encoder with Commutation Tracks encoded on the Z-Channel** as a feedback device.

The **PS-33xxi-R** Series is a digital amplifier that will only accept a resolver as the feedback device.

All **PS-33xxi** Series servo controllers are intended to be utilized as stand-alone controllers and thus do *not* provide an encoder-out signal.

All **PS-33xxi** Series servo controllers provide the user with the same basic components:

- A graphical user interface program, **APImate 2.0**©, provides the user with the tools to easily configure the PS-33xx to the specific application. **APImate 2.0** is a Windows-based program that provides Wizards for axis setup, tuning, and high level programming language.

- Methods of control include stored program mode, digital mode, and the ability to accept Step/Direction, Step-Up/Down, Quadrature, and Analog inputs whereby you are commanding the servo system via an analog ±10 VDC reference. Determine your required configuration, then review the appropriate section.

- Complex SPLINE tables of up to 16 data points can be entered to define custom motion profiles as a function of time.

- Complex CAM tables of up to 16 data points can be entered to define custom motion profiles as a function of the master encoder HSI inputs.

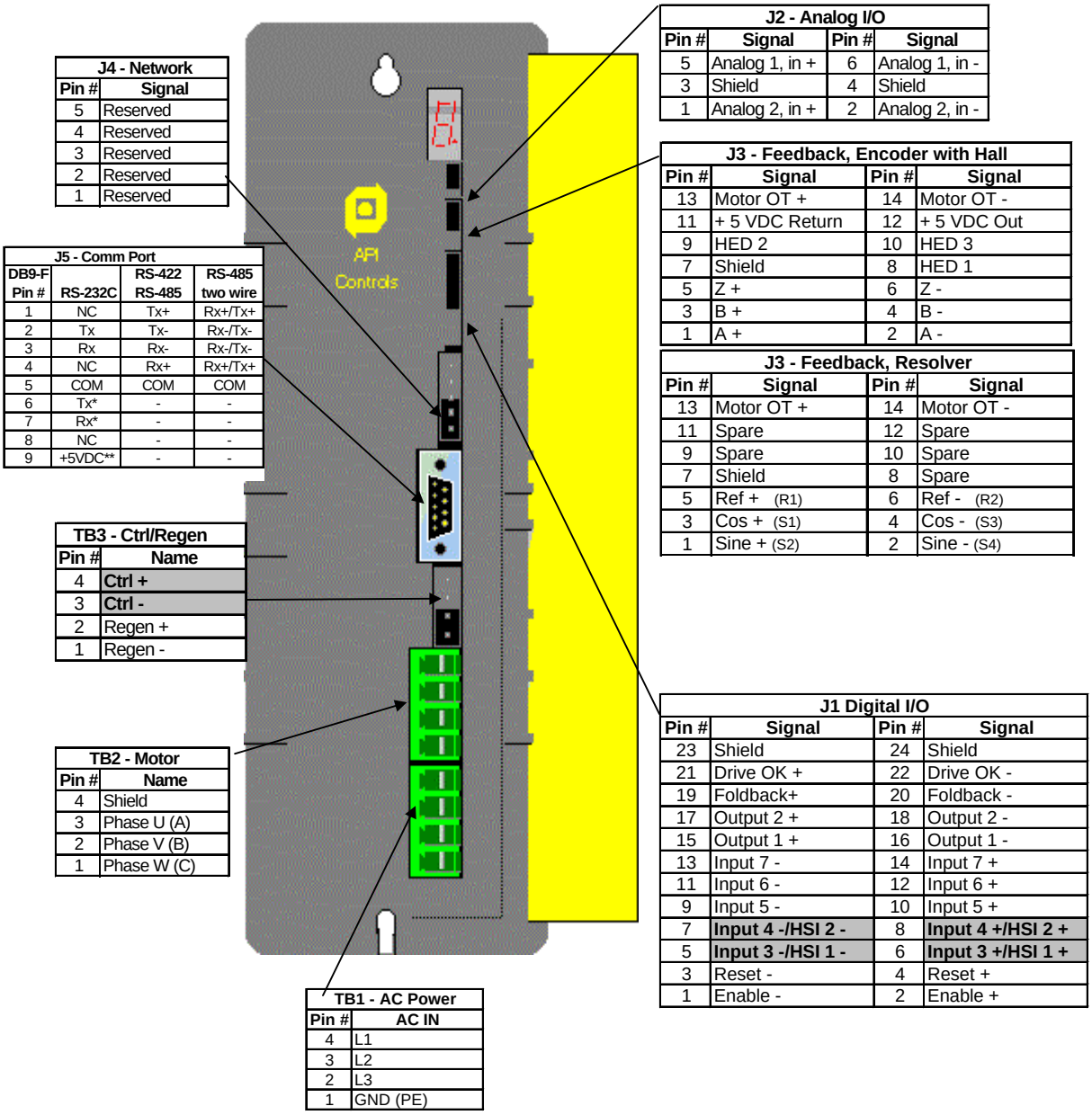
- Master/slave relationships can be developed from the master encoder HSI inputs, providing motion output as a CAM, or RATIO of the input command.

- With the communications port configured for RS-422/485, hardware and software allows for up to 31 axis to be digitally controlled from a single PC serial port or similar host device. Multi-axis start and stop, along with on-the-fly speed change, are only a few of the features available on these units.

- A network communications port allows the user to configuration each unit as a device in a Control Area Network. (consult factory for availability).

- Hardware interfaces for ENABLE, RESET, DRIVE OK, and FOLDBACK are dedicated I/O that allow you to interface to your machinery/equipment.

Figure 3-27 PS-33xxi Connector Placement



J4 - Network	
Pin #	Signal
5	Reserved
4	Reserved
3	Reserved
2	Reserved
1	Reserved

J5 - Comm Port			
DB9-F Pin #	RS-232C	RS-422 RS-485	RS-485 two wire
1	NC	Tx+	Rx+/Tx+
2	Tx	Tx-	Rx-/Tx-
3	Rx	Rx-	Rx-/Tx-
4	NC	Rx+	Rx+/Tx+
5	COM	COM	COM
6	Tx*	-	-
7	Rx*	-	-
8	NC	-	-
9	+5VDC**	-	-

TB3 - Ctrl/Regen	
Pin #	Name
4	**Ctrl +**
3	**Ctrl -**
2	Regen +
1	Regen -

TB2 - Motor	
Pin #	Name
4	Shield
3	Phase U (A)
2	Phase V (B)
1	Phase W (C)

TB1 - AC Power	
Pin #	AC IN
4	L1
3	L2
2	L3
1	GND (PE)

J2 - Analog I/O			
Pin #	Signal	Pin #	Signal
5	Analog 1, in +	6	Analog 1, in -
3	Shield	4	Shield
1	Analog 2, in +	2	Analog 2, in -

J3 - Feedback, Encoder with Hall			
Pin #	Signal	Pin #	Signal
13	Motor OT +	14	Motor OT -
11	+ 5 VDC Return	12	+ 5 VDC Out
9	HED 2	10	HED 3
7	Shield	8	HED 1
5	Z +	6	Z -
3	B +	4	B -
1	A +	2	A -

J3 - Feedback, Resolver			
Pin #	Signal	Pin #	Signal
13	Motor OT +	14	Motor OT -
11	Spare	12	Spare
9	Spare	10	Spare
7	Shield	8	Spare
5	Ref + (R1)	6	Ref - (R2)
3	Cos + (S1)	4	Cos - (S3)
1	Sine + (S2)	2	Sine - (S4)

J1 Digital I/O			
Pin #	Signal	Pin #	Signal
23	Shield	24	Shield
21	Drive OK +	22	Drive OK -
19	Foldback+	20	Foldback -
17	Output 2 +	18	Output 2 -
15	Output 1 +	16	Output 1 -
13	Input 7 -	14	Input 7 +
11	Input 6 -	12	Input 6 +
9	Input 5 -	10	Input 5 +
7	**Input 4 -/HSI 2 -**	8	**Input 4 +/HSI 2 +**
5	**Input 3 -/HSI 1 -**	6	**Input 3 +/HSI 1 +**
3	Reset -	4	Reset +
1	Enable -	2	Enable +

Digital Inputs/Outputs (J1)

The **PS-33xxi** Series is an intelligent amplifier with I/O capability. The PS-33xxi digital I/O connector J1 contains connections for 5 inputs, plus 2 HSI inputs and 4 outputs to allow the user to interface to the most demanding application. The user must supply a 5-30 VDC voltage to utilize the optically isolated I/O. Since the digital inputs are current activated, the user may utilize PNP or NPN outputs to the drive. The various methods of wiring I/O are described in this section.

	CAUTION
	*The two High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment.* ***If you need to operate these inputs as general-purpose inputs, at 30 VDC then a current limit 2k W resistor must be installed in series with the input.***

All models of the PS-33xxi Series have two High Speed Inputs that can be utilized for the purpose of supplying a Step/Direction, Step-Up/Down, or a Quadrature input command to the unit. Software configuration of the Command Mode, parameter CM must be performed to utilize the two HSI's as command signals. See Figure 3-33 Schematic of PS-33xxi HSI Inputs if HSI1 and HSI2 are to be utilized as general purpose inputs3 and 4.

The drive RESET input, when active, will cause the amplifier to immediately remove power from the motor and clear any re-settable fault conditions.

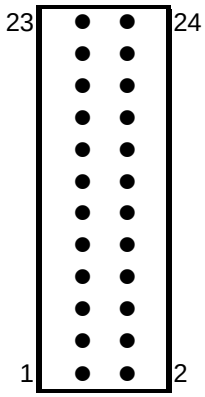
The ENABLE input is dedicated and cannot be reassigned. The user must configure the software EVENT of *Enable-on-rise* to start the active program on active-state of the ENABLE input. Likewise the program execution will stop on fall or inactive-state of the input, disabling the controller.

The SERVO-OK output is active when main power is applied and no fault conditions exist.

The FOLDBACK output is active when I^2t is actively reducing the motor output current to protect either the amplifier or the motor.

Outputs on the PS-33xxi can be utilized as current sink or source outputs. This supply may be separate from the input supply.

Figure 3-28 PS-33xxi Digital I/O Connector J1



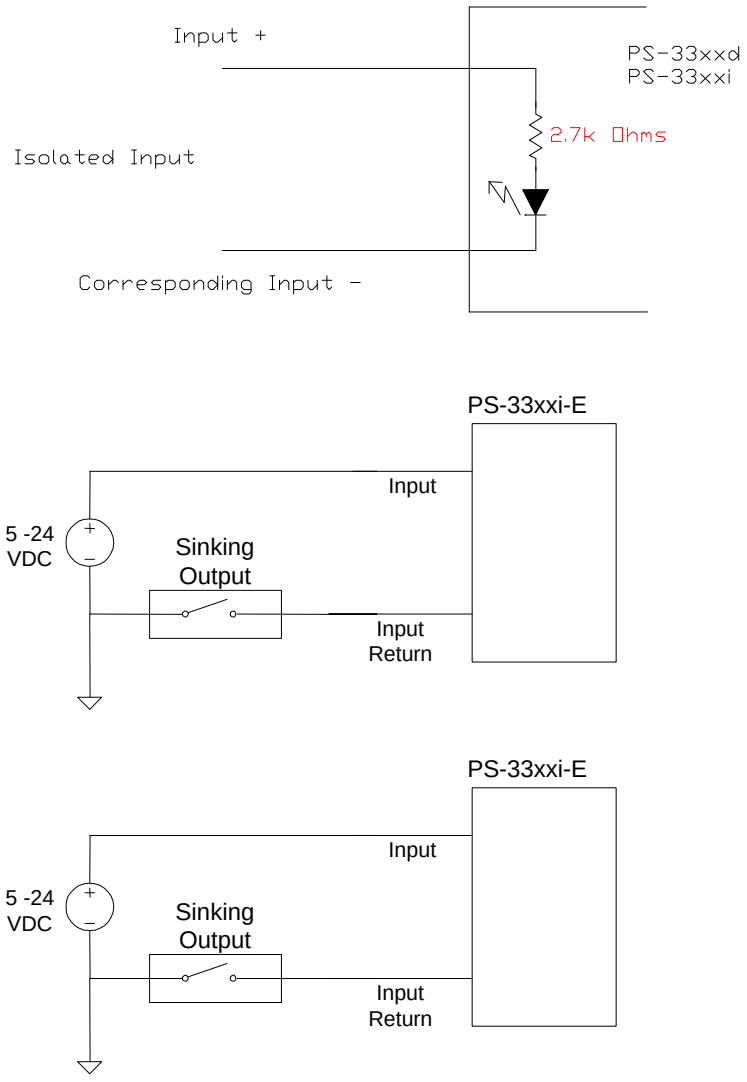
J1 Digital I/O			
Pin #	**Signal**	**Pin #**	**Signal**
23	Shield	24	Shield
21	Drive OK +	22	Drive OK -
19	Foldback+	20	Foldback -
17	Output 2 +	18	Output 2 -
15	Output 1 +	16	Output 1 -
13	Input 7 -	14	Input 7 +
11	Input 6 -	12	Input 6 +
9	Input 5 -	10	Input 5 +
7	**Input 4 -/HSI 2 -**	8	**Input 4 +/HSI 2 +**
5	**Input 3 -/HSI 1 -**	6	**Input 3 +/HSI 1 +**
3	Reset -	4	Reset +
1	Enable -	2	Enable +

	CAUTION
	*The two High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment.* ***If you need to operate these inputs as general-purpose inputs, at 30 VDC then a current limit 2k W resistor must be installed in series with the input.***

A cable assembly, **CA-F24-2**, may be purchased to facilitate wiring the J1 connector. This cable assembly provides flying leads, pre-wired to the mating connector, two feet in length.

The optically isolated inputs, (ENABLE, RESET, Inputs 5, 6 and 7) are current activated, 10 mA minimum.

Figure 3-29 PS-33xxi Digital Input



The DRIVE-OK, FOLDBACK and outputs 1 and 2 can be wired as "current sourcing" or "current sinking", with a maximum "sink" of 35 mA per output. An additional external power source of 5-30 VDC is required. The outputs are not short-circuit proof.

Figure 3-30 PS-33xxi Digital Output

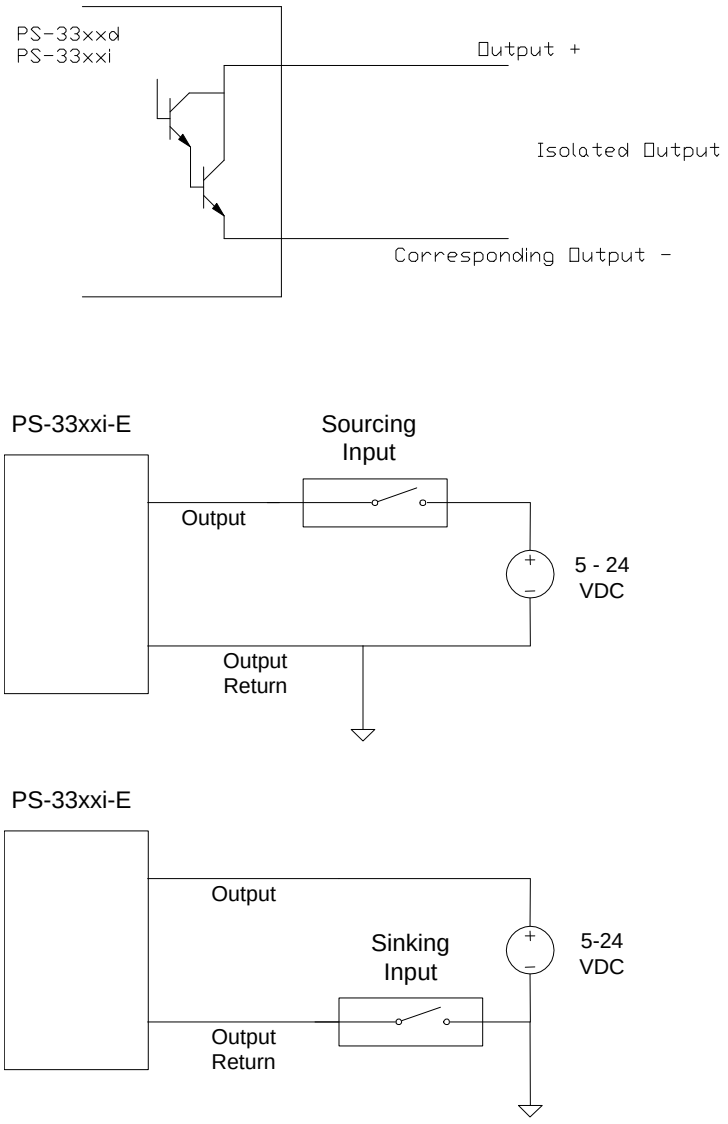


Figure 3-31 PS-33xxd-E HSI Signals

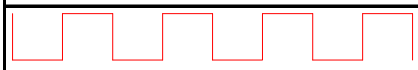
Signals for High Speed Inputs		
Mode	**HSI1**	**HSI2**
Step/Dir	**Direction** 0 = CCW, 1 = CW	**Step** when falling
		
Step+/Step-	**Step CCW** when HSI2 = 0	**Step CW** when HSI1 = 0
		
		
Quadrature	**Phase A Quadrature**	**Phase B Quadrature**
	CCW on A (HSI1) rising with B (HSI2) low	
		
		

Figure 3-32 HSI Signal Timing

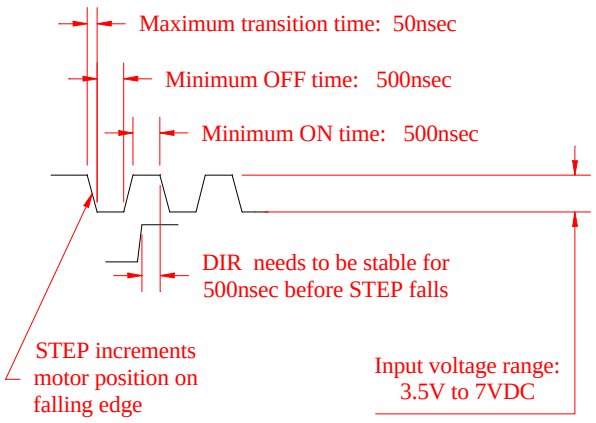
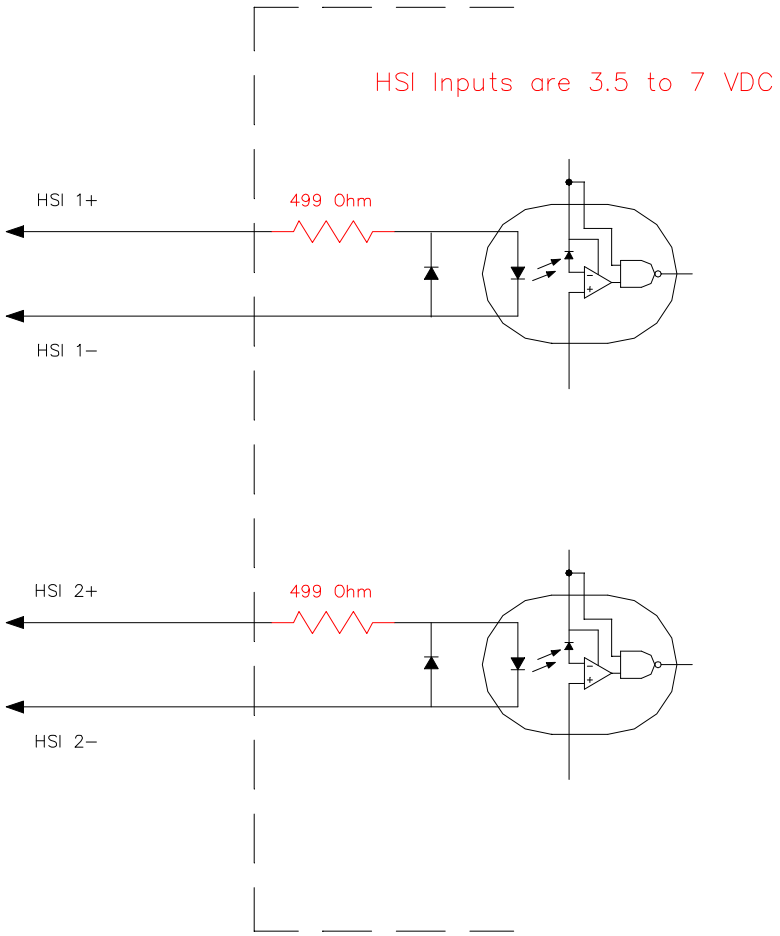


Figure 3-33 Schematic of PS-33xxi HSI Inputs



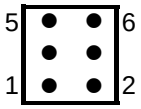
	CAUTION
	The two High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment

Analog Input/Outputs (J2)

If you are using the HSI inputs for command input, you may skip the following section on Analog Inputs.

The PS-33xxi analog I/O connector J2 contains connections for two analog inputs. The analog inputs are software defined as ADC1 and ADC2. They are to be utilized as differential inputs to provide ±10 VDC control signals to the amplifier. These differential inputs should be driven via the users differential outputs and should be connected with individually shielded twisted pairs to provide the best possible noise immunity. Depending on the software configuration, the analog signal (software name ADC1) can be utilized to provide a "velocity", "current", or "user defined" 10 bit analog signal to provide the required motion.

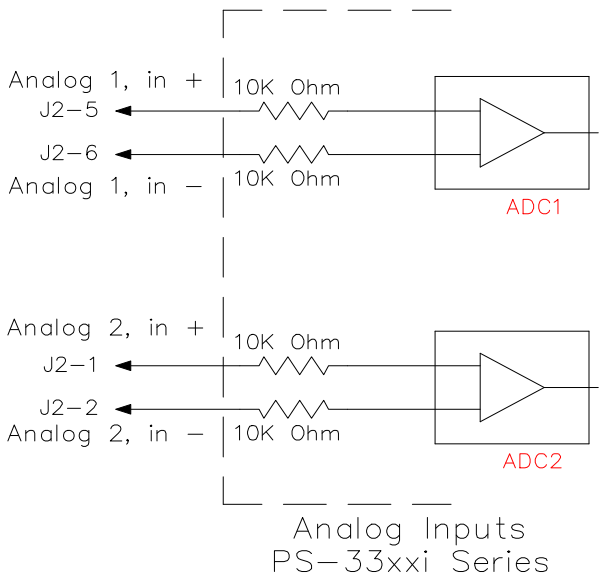
Figure 3-34 PS-33xxi Analog I/O Connector J2



J2 - Analog I/O			
Pin #	**Signal**	**Pin #**	**Signal**
5	Analog 1, in +	6	Analog 1, in -
3	Shield	4	Shield
1	Analog 2, in +	2	Analog 2, in -

A cable assembly, **CA-F6-2**, may be purchased to facilitate wiring the J2 connector. This cable assembly provides flying leads, pre-wired to the mating connector, two feet in length.

Figure 3-35 Schematic of PS-33xxi Analog Inputs



PS-33xxi Motor Feedback (J3)

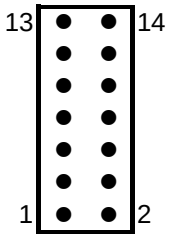
The PS-33xxi-E motor feedback connector J3 is a 14 pin dual-row connector that contains connections for Hall Effect Device (HED) and encoder feedback.

The **PS-33xxi-E** Series is a digital amplifier that will only accept an **encoder with Hall** or an **encoder with Commutation Tracks encoded on the Z-Channel** as a feedback device.

Refer to section 7.2.2 for Commutating Encoder Specifications compatible with encoder based controllers.

The connections also include a non-isolated +5 VDC supply for the HED, Encoder power, and motor over-temperature sensor (OT). If a motor over temperature sensor is being utilized, you must enable this feature in the software configuration. Make this mode ACTIVE via parameter **COT** *Check motor OT input.*

Figure 3-36 PS-33xxi-E Feedback Connector J3



J3 - Feedback, Encoder with Hall			
Pin #	**Signal**	**Pin #**	**Signal**
13	Motor OT +	14	Motor OT -
11	+ 5 VDC Return	12	+ 5 VDC Out
9	HED 2	10	HED 3
7	Shield	8	HED 1
5	Z +	6	Z -
3	B +	4	B -
1	A +	2	A -

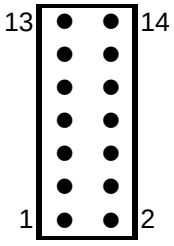
A cable assembly, **CA-F14-2**, may be purchased to facilitate wiring the J3 connector. This cable assembly provides flying leads, pre-wired to the mating connector, two feet in length.

The **PS-33xxi-R** motor feedback connector J3 is a 14-pin dual-row connector that contains connections for resolver feedback.

The **PS-33xxi-R** Series is a digital amplifier that will only accept a resolver as the feedback device. Refer to section 7.2.1 for Commutating Resolver Specifications compatible with resolver based controllers.

The connections also include a non-isolated +5 VDC supply for motor over-temperature sensor (OT). If a motor over temperature sensor is being utilized, you must enable this feature in the software configuration.

Figure 3-37 PS-33xxi-R Feedback Connector J3



J3 - Feedback, Resolver			
Pin #	**Signal**	**Pin #**	**Signal**
13	Motor OT +	14	Motor OT -
11	Spare	12	Spare
9	Spare	10	Spare
7	Shield	8	Spare
5	Ref + (R1)	6	Ref - (R2)
3	Cos + (S1)	4	Cos - (S3)
1	Sine + (S2)	2	Sine - (S4)

A cable assembly, **CA-F14-2**, may be purchased to facilitate wiring the J3 connector. This cable assembly provides flying leads, pre-wired to the mating connector, two feet in length.

3.3.7 PS-33xxc Series

Each **PS-33xxc** (Centennial) Series unit is an amplifier, power supply, DSP motion controller, and heatsink integrated into a single standalone package. They will accept high level commands directly, eliminating the need for a motion controller and can be operated stand-alone, networked, or as a digital amplifier. Each unit has the ability to store and execute motion programs.

The **PS-33xxc-E** Series digital amplifier will only accept an **encoder with Hall** or an **encoder with Commutation Tracks encoded on the Z-Channel** as a feedback device. Refer to section 7.2.2 for Commutating Encoder Specifications compatible with encoder based controllers.

The **PS-33xxc-R** Series is a digital amplifier that will only accept a resolver as the feedback device. Refer to section 7.2.1 for Commutating Resolver Specifications compatible with resolver based controllers.

Available features include:

- A graphical user interface program, **APImate 2.0**©, provides the user with the tools to easily configure the PS-33xx to his specific applications. **APImate 2.0** is a Windows95-based program that provides Wizards for axis setup, tuning, and high level programming language.

- Methods of control include stored program mode, digital mode, and the ability to accept Step/Direction, Step-Up/Down, Quadrature, and Analog inputs whereby you are commanding the servo system via an analog ±10 VDC reference. Determine your required configuration, then review the appropriate section.

- With the communications port configured for RS-422/485, hardware and software allows for up to 31 axis to be digitally controlled from a single PC serial port or similar host device. Multi-axis start and stop, along with on-the-fly speed change, are only a few of the features available on these units.

- Hardware interfaces for ENABLE, RESET, and DRIVE OK are dedicated I/O that allow you to interface to your machinery/equipment.

- The PS-33xxc Series can also be configured to operate 300 volt induction motors in either vector or variable frequency control.

- All modes of operation offer a PID loop-tuning feature to optimize the performance of the selected servomotor.

- All modes of operation offer a **Real-time Adaptive Tuning** feature to optimize the performance of the selected servomotor. This Real-time Adaptive Tuning feature is bi-directional and includes load and inertia estimation and compensation. It also provides **an Active Current Loop Compensation** gain and phase. Optimal performance can be obtained on systems with varying inertial loads up to 50:1.

- Additional analog inputs and outputs can be utilized to interface to the user's environment.

- Advanced mathematical capabilities, 40 bit floating point, LOG functions, and trigonometric functions are available to simplify programming of complex motions.

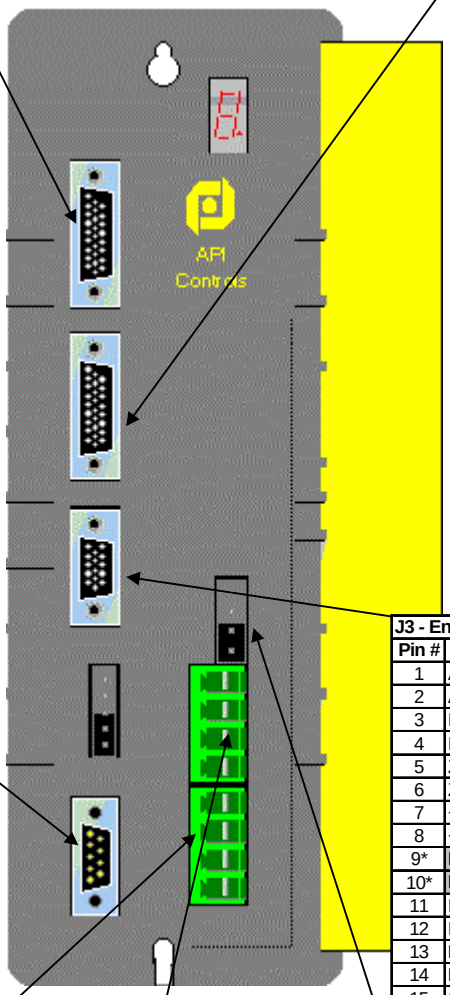
- Complex SPLINE tables of up to 3000 data points can be entered to define custom motion profiles as a function of time.

- Complex CAM tables of up to 3000 data points can be entered to define custom motion profiles as a function of the master encoder HSI inputs or the Auxiliary PID's output.

- Master/slave relationships can be developed from the master encoder HSI inputs, providing motion output as a RATIO, CAM, or SPLINE.

- Auxiliary PID loop with 100 microsecond update rate can be utilized in conjunction with the analog inputs, SPLINE, CAM, and master/slave capabilities. Applications such as web-tensioning, pump, and motion profiling can be addressed with ease.

Figure 3-38 PS-33xxc Connector Placement



J1 Digital I/O	
Pin #	Isolated IO
1	Input 1
2	Input 2
3	Input 3
4	Input 4
5	Input 5
6	Input 6
7	Input 7
8	Input 8
9	Reset (9)
10	Enable (10)
11	Output Power
12	Output COM
13	Output 1
14	Output 2
15	Output 3
16	Output 4
17	Output 5
18	Output 6
19	Output 7
20	Output 8
21	Output 9
22	Output 10
23	Output 11
24	Output 12
25	Input Power
26	N.C., M (shell)

J2 - Analog I/O	
Pin #	Analog I/O
1	**HSI 4 +**
2	**HSI 4 -**
3	Analog 1 in + (ADC1)
4	Analog 1 in -
5	Analog 2 in + (ADC2)
6	Analog 2 in -
7	Analog 1 Out
8	Drive OK
9	Analog 2 Out
10	Shield
11	Analog Out Common
12	Analog 3 in + (ADC3)
13	Analog 3 in -
14	**HSI 2+ /B+**
15	**HSI 2 - /B-**
16	**HSI 1 + /A+**
17	**HSI 1 - /A-**
18	Drive OK Return
19	Shield
20	Encoder Out A+
21	Encoder Out A-
22	Encoder Out B+
23	Encoder Out B-
24	Encoder Out Z+
25	Encoder Out Z-
26	N.C., M (shell)

J5 - Comm Port			
DB9-F Pin #	RS-232C	RS-422 RS-485	RS-485 two wire
1	NC	Tx+	Rx+/Tx+
2	Tx	Tx-	Rx-/Tx-
3	Rx	Rx-	Rx-/Tx+
4	NC	Rx+	Rx+/Tx+
5	COM	COM	COM
6	Tx*	-	-
7	Rx*	-	-
8	NC	-	-
9	+5VDC**	-	-

J3 - Encoder Feedback	
Pin #	Signal
1	A +
2	A -
3	B +
4	B -
5	Z +
6	Z -
7	+ 5 Encoder/Hall
8	+ 5 VDC Return
9*	**HALL 1/HSI 3 +**
10*	**HSI 3 -**
11	Motor OT +
12	Motor OT -
13	**HALL 2**
14	**HALL 3**
15	Shield
16	N.C., M (shell)

J3 - Resolver Feedback	
Pin #	Signal
1	Sine + (S2)
2	Sine - (S4)
3	Cos + (S1)
4	Cos - (S3)
5	Ref + (R1)
6	Ref - (R2)
7	+ 5 Encoder/Hall
8	+ 5 VDC Return
9	**HSI 3 +**
10	**HSI 3 -**
11	Motor OT +
12	Motor OT -
13	Spare
14	Spare
15	Shield
16	N.C., M (shell)

TB1 - AC Power	
Pin #	AC IN
4	L1
3	L2
2	L3
1	**GND (PE)**

TB2 - Motor	
Pin #	Name
4	Shield
3	Phase U (A)
2	Phase V (B)
1	Phase W (C)

TB3 - Ctrl/Regen	
Pin #	Name
4	**Ctrl +**
3	**Ctrl -**
2	Regen +
1	Regen -

Digital Inputs/Outputs (J1)

The **PS-33xxc** digital I/O connector J1 is a 26 pin sub-D that contains connections for 10 inputs and 12 outputs to allow the user to interface to the most demanding application. The user must supply a 5-30 VDC voltage to utilize the optically isolated I/O. Since the digital inputs are current activated, the user may utilize PNP or NPN outputs to the controller. The various methods of wiring inputs are shown in this section.

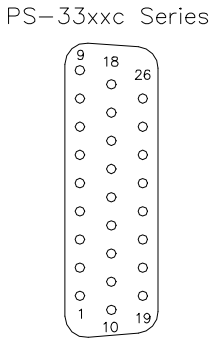
The drive RESET input, when active, will cause the amplifier to immediately remove power from the motor and clear any re-settable fault conditions.

	NOTE
	*The **RESET** input on the PS-33xxc Series, if active when power is applied, will cause the unit to start its Boot-Load-Manager. This will cause the unit to appear as if it has faulted, the unit will not respond to any IO and will not enable until the RESET input is in the inactive-state and then briefly active-state again.* *Correctly configure your power up sequence(s) to prevent accidentally activating the unit's Boot-Load-Manager.* *See Section 5.3.7 Update New Firmware for additional information.*

The ENABLE input is dedicated and cannot be reassigned. The user must configure the software EVENT of enable-on-rise to start the active program on active-state of the ENABLE input. Likewise the program execution will stop on fall or inactive-state of the input, disabling the controller.

Outputs on the PS-33xxc can be utilized as current sink or source outputs. Connections for Output-Power and Output-Com are provided for purposes of optical isolation. This supply may be separate from the input supply. The various methods of wiring inputs are shown in this section.

Figure 3-39 PS-33xxc Digitial I/O Connector (J1)

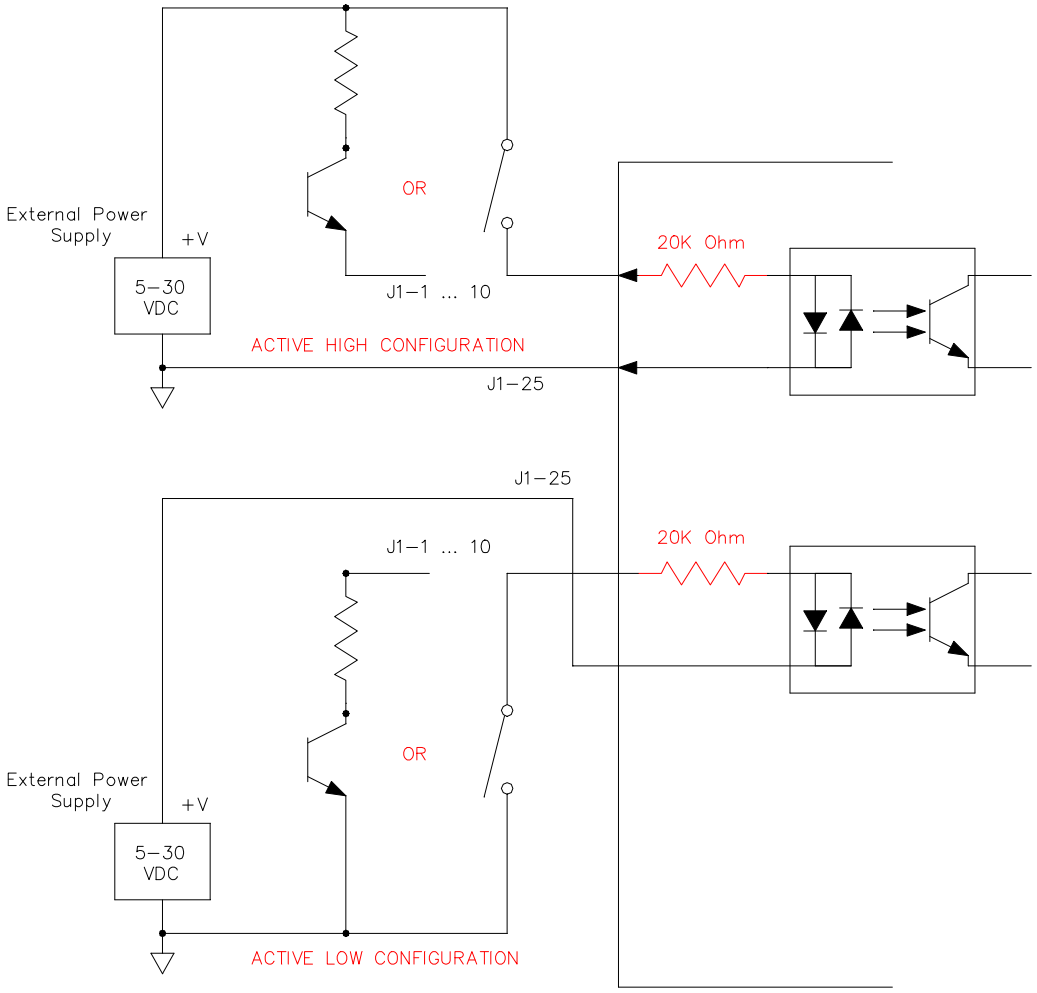


J1 Digital I/O	
Pin #	**Isolated IO**
1	Input 1
2	Input 2
3	Input 3
4	Input 4
5	Input 5
6	Input 6
7	Input 7
8	Input 8
9	Reset (9)
10	Enable (10)
11	Output Power
12	Output COM
13	Output 1
14	Output 2
15	Output 3
16	Output 4
17	Output 5
18	Output 6
19	Output 7
20	Output 8
21	Output 9
22	Output 10
23	Output 11
24	Output 12
25	Input Power
26	N.C., M (shell)

A cable assembly, **CA-SD26-KIT**, may be purchased to facilitate wiring the J1 connector. This cable assembly includes a three-foot cable with a DIN-3 mount terminal strip.

Inputs are activated by current flow. The choice of ACTIVE-HIGH or ACTIVE-LOW is at the user's discretion.

Figure 3-40 Schematic of PS33xxc Inputs



Analog Input/Outputs (J2)

The PS-33xxc analog I/O connector J2 is a 26 pin sub-D that contains connections for simulated encoder output, two High Speed Inputs (HSI), three analog inputs, two analog outputs, and their associated signals. The DRIVE-OK is also provided on this connector.

DRIVE-OK

The DRIVE-OK is a N.O. relay contact that is active when main power is applied and no fault conditions exist.

Analog Inputs

The three analog inputs are to be utilized as differential input's to provide ±10 VDC control signals to the amplifier. These differential inputs should be driven via the user's differential outputs and should be connected with individually shielded twisted pairs to provide the best possible noise immunity.

Depending on the configuration, the primary analog input 1 (software defined as ADC1) to provide a "velocity", "current", or a "user defined" 14 bit analog signal to generate the required motion. Analog inputs 2 and 3 (software defined as ADC2 and ADC3) are available to provide additional input signals for transducers as required in applications such as web-tensioning, pump, or clamping operations.

Analog Outputs

The two analog outputs, first and second AUX DAC's are factory defined as "SPEED" and "CURRENT" outputs. The user may wish to re-assign the AUX DAC's to a system or user variable to provide an additional interface to the user's environment. A scale factor must be set to properly scale the variable to the 10 volts range of the DAC. Analog outputs are updated every 400µseconds.

High Speed Inputs

The two HSI inputs, HSI1 and HSI2 are dedicated as a master encoder input.

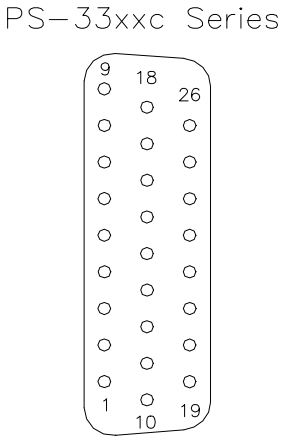
An auxiliary PID loop with a 100 microsecond update rate is available on the PS-33xxc controller. The AUXILIARY PID can be utilized in conjunction with the master encoder inputs HSI1 and HSI2 and/or analog inputs, along with SPLINE, CAM, and Master/Slave capabilities for applications such as web-tensioning, pump, and motion profiling.

The High Speed Input HSI3 on the motor feedback connector J3, is also used as a Hall Effect Device input, thus is not available when configured for motors utilizing HED's.

Software commands for utilization of the High Speed Inputs HSI3 and HSI4 will be supported with future releases of Firmware and APImate2 enhancements.

	CAUTION
	*The High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment.* ***If you need to operate these inputs as general-purpose inputs at 30 VDC, then a current limit 2k W resistor must be installed in series with the input.***

Figure 3-41 PS-33xxc Analog I/O Connector (J2)



J2 - Analog I/O	
Pin #	**Analog I/O**
1	**HSI 4 +**
2	**HSI 4 -**
3	Analog 1 in + (ADC1)
4	Analog 1 in -
5	Analog 2 in + (ADC2)
6	Analog 2 in -
7	Analog 1 Out
8	Drive OK
9	Analog 2 Out
10	Shield
11	Analog Out Common
12	Analog 3 in + (ADC3)
13	Analog 3 in -
14	**HSI 2+ /B+**
15	**HSI 2 - /B-**
16	**HSI 1 + /A+**
17	**HSI 1 - /A-**
18	Drive OK Return
19	Shield
20	Encoder Out A+
21	Encoder Out A-
22	Encoder Out B+
23	Encoder Out B-
24	Encoder Out Z+
25	Encoder Out Z-
26	N.C., M (shell)

A cable assembly, **CA-SD26-KIT**, may be purchased to facilitate wiring the J2 connector. This cable assembly includes a three-foot cable with a DIN-3 mount terminal strip.

Figure 3-42 Schematic of PS-33xxc Analog Inputs

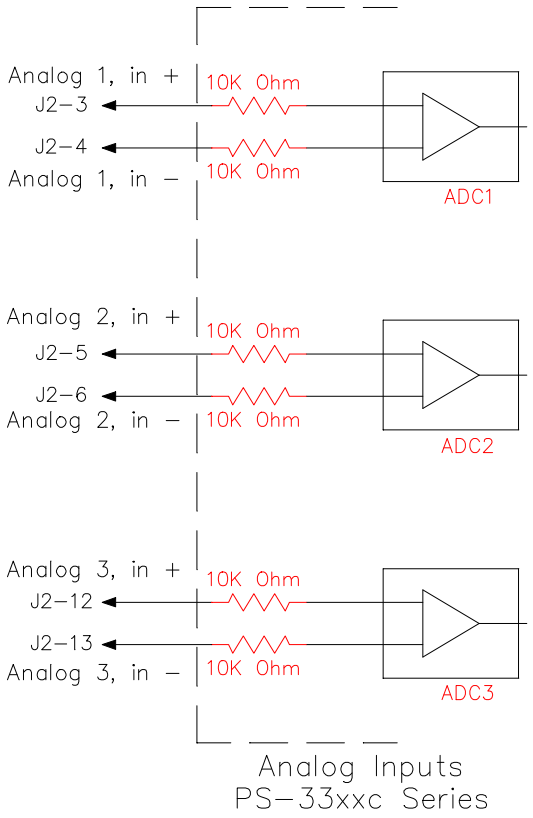


Figure 3-43 Schematic of PS-33xxc DRIVE-OK Output

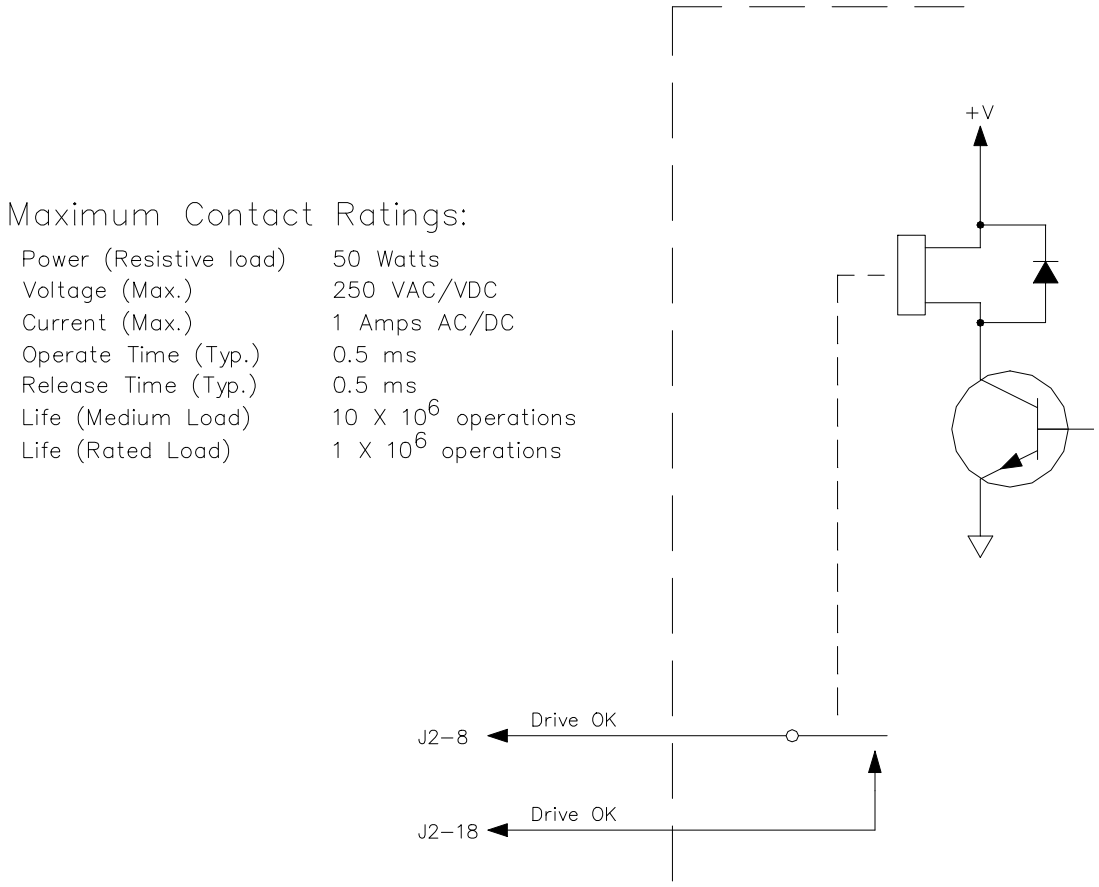


Figure 3-44 Schematic of PS-33xxc Encoder Outputs

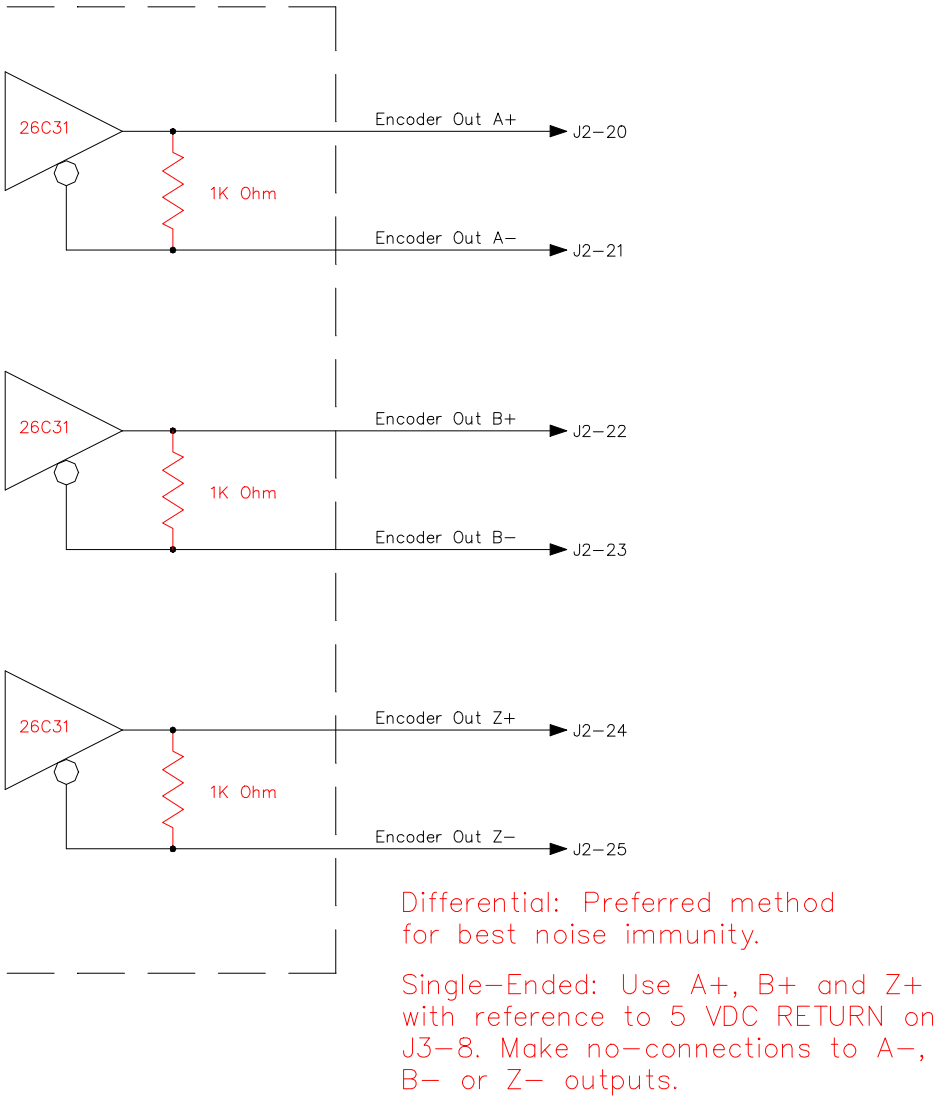


Figure 3-45 PS-33xxd-E HSI Signals

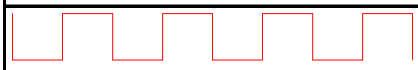
Signals for High Speed Inputs		
Mode	**HSI1**	**HSI2**
Step/Dir	**Direction** 0 = CCW, 1 = CW	**Step** when falling
		
Step+/Step-	**Step CCW** when HSI2 = 0	**Step CW** when HSI1 = 0
		
		
Quadrature	**Phase A Quadrature**	**Phase B Quadrature**
	CCW on A (HSI1) rising with B (HSI2) low	
		
		

Figure 3-46 HSI Signal Timing

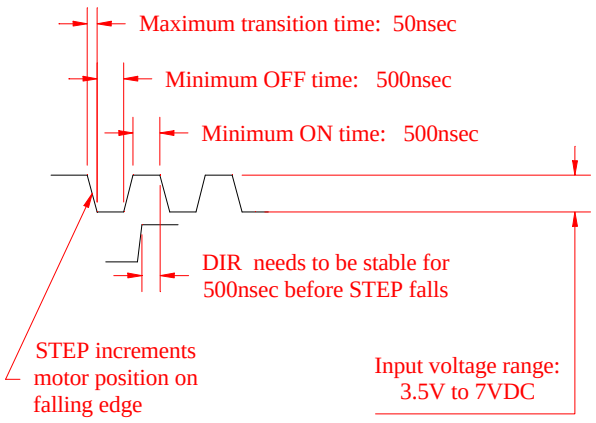
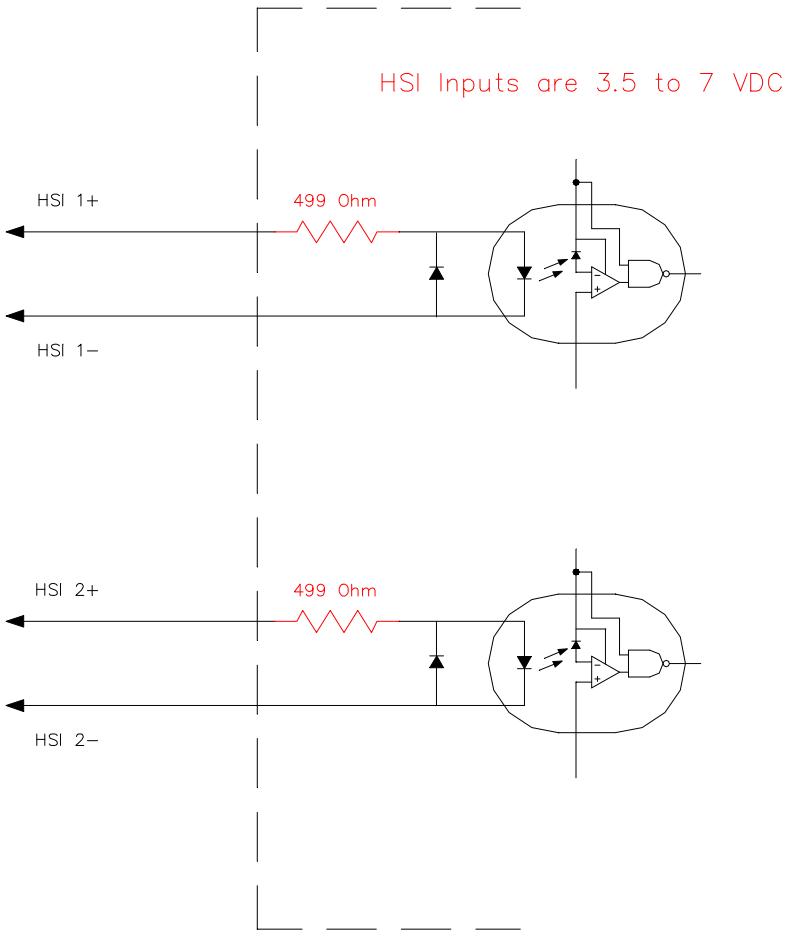
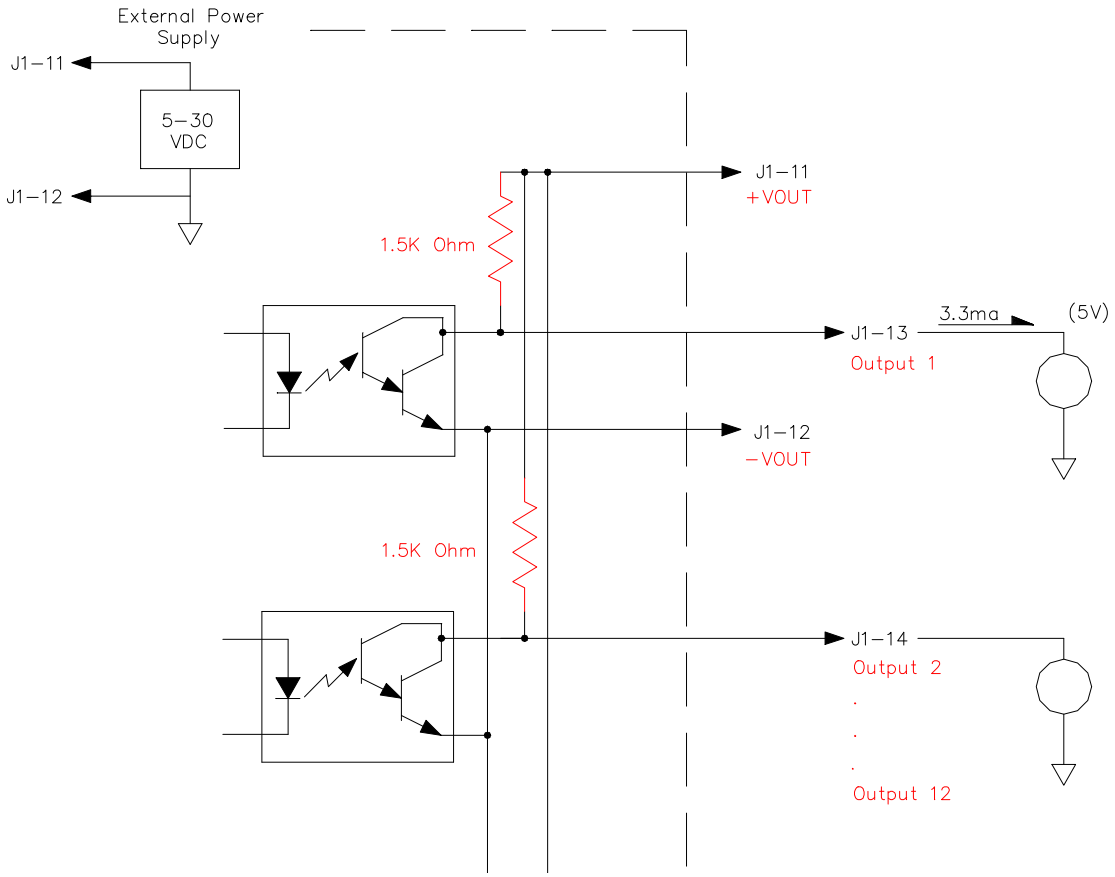


Figure 3-47 Schematic of PS-33xxc HSI Inputs



	CAUTION
	The four High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment.

Figure 3-48 Schematic of PS-33xxc Isolated Outputs



The two analog outputs, first and second AUX DAC's are factory defined as "SPEED" and "CURRENT" outputs. The user may wish to re-assign the AUX DAC's to a system or user variable to provide an additional interface to the users environment. A scale factor must be set to properly scale the variable to the 10 volts range of the DAC. Analog outputs are updated every 400µseconds.

Figure 3-49 Schematic of PS-33xxc Analog Outputs

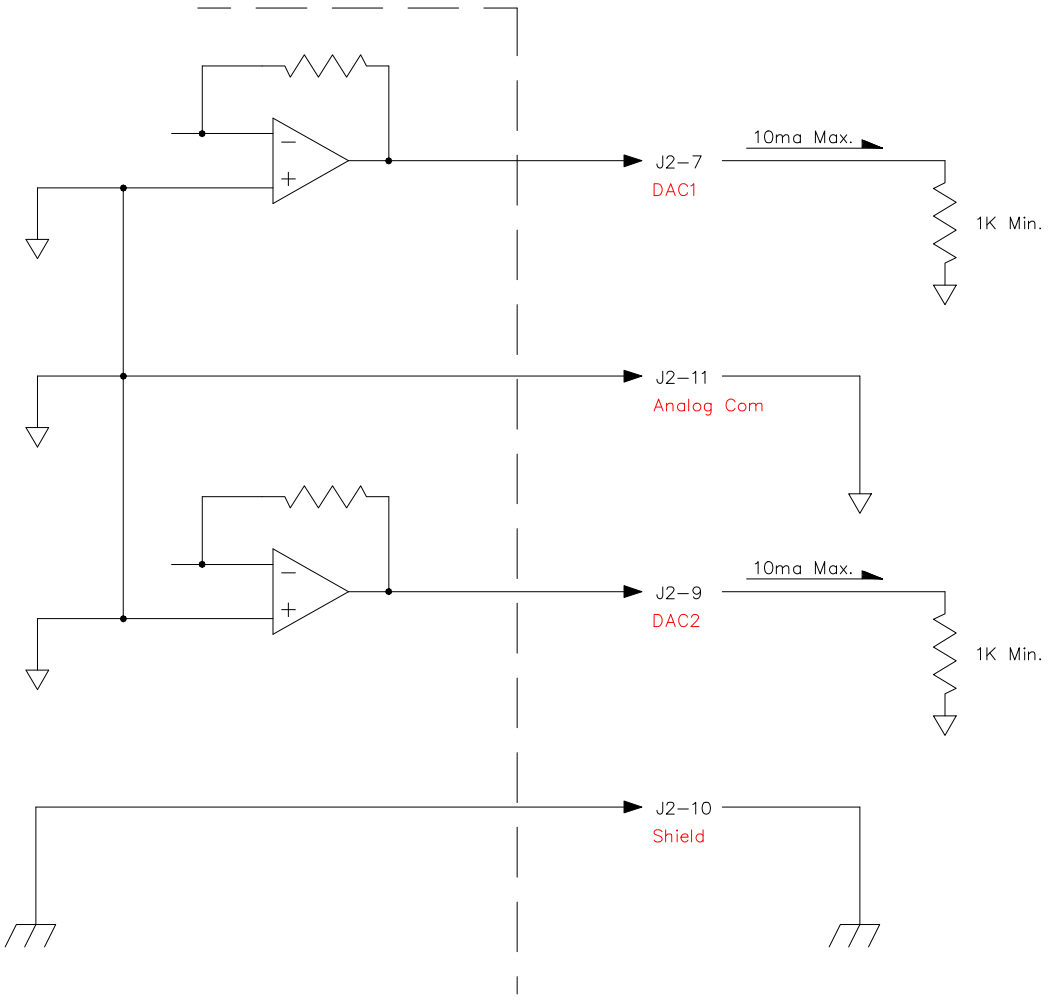


Figure 3-50 Typical Master/Slave Configuration

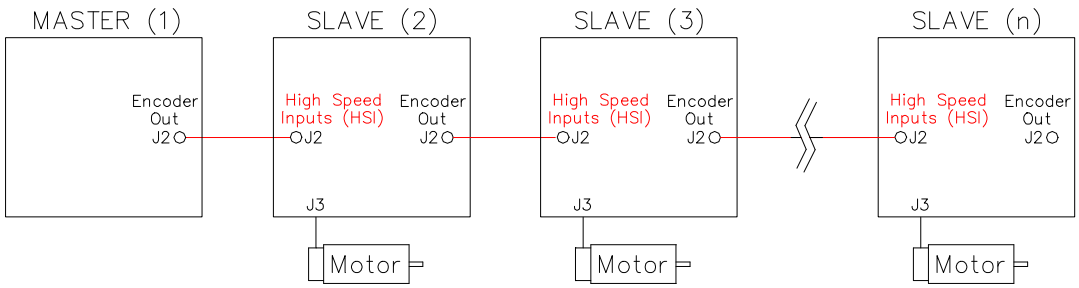
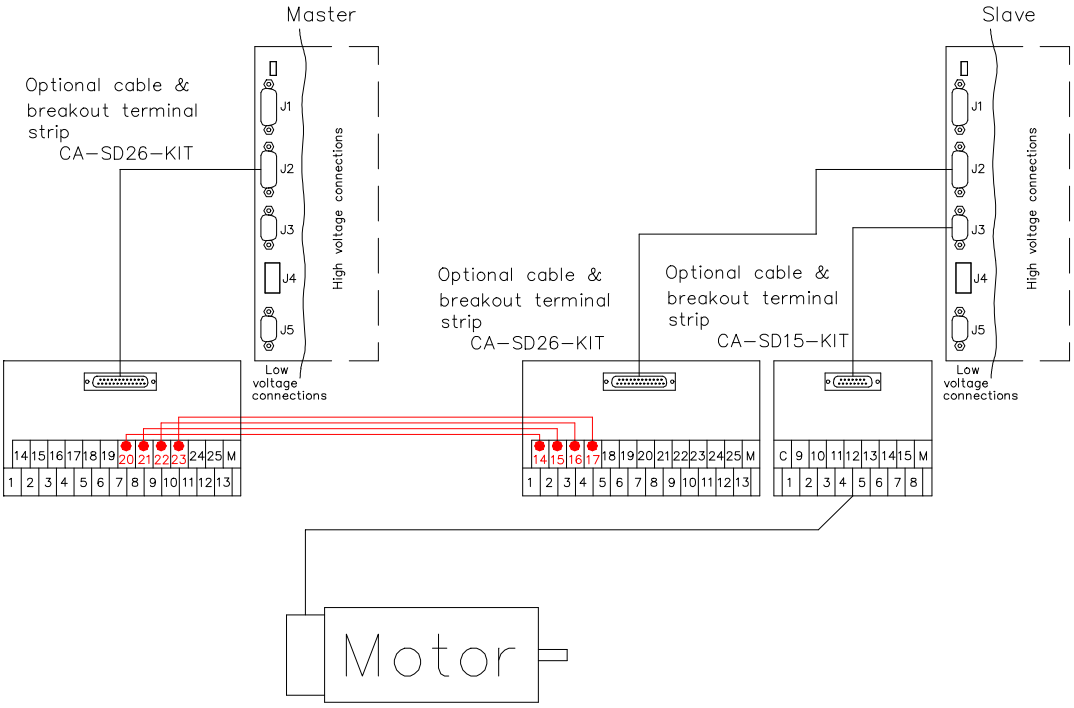


Figure 3-51 Master/Slave Drive Interconnect



Motor Feedback (J3)

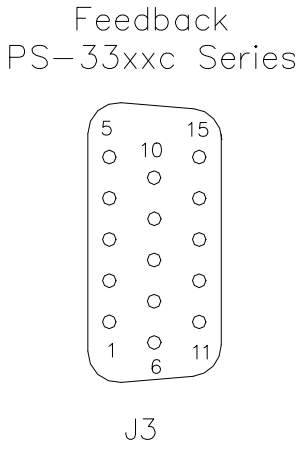
The **PS-33xxc-E** Series digital amplifier will only accept an **encoder with Hall** or an **encoder with Commutation Tracks encoded on the Z-Channel** as a feedback device. Refer to section 7.2.2 for Commutating Encoder Specifications compatible with encoder based controllers.

The PS-33xxc-E motor feedback connector J3 is a 15 pin sub-D that contains connections for encoder feedback. The connections also include an isolated +5 VDC supply for hall and encoder power. If a motor over temperature sensor is being utilized, you must enable this feature in the software configuration. Make this mode ACTIVE via parameter COT *Check motor OT input.*

The High Speed Input HSI3 on the motor feedback connector J3, is also used as a Hall Effect Device input, thus is not available when configured for motors utilizing HED's. This High Speed Input can be used as registration inputs for applications using motors with Z-Channel encoded Commutation Tracks.

Software commands for utilization of the High Speed Inputs HSI3 and HSI4 will be supported with future releases of Firmware and APImate2 enhancements.

Figure 3-52 PS-33xxc-E Encoder Feedback Connector (J3)



J3 - Encoder Feedback	
Pin #	**Signal**
1	A +
2	A -
3	B +
4	B -
5	Z +
6	Z -
7	+ 5 Encoder/Hall
8	+ 5 VDC Return
9*	**HALL 1/HSI 3 +**
10*	**HSI 3 -**
11	Motor OT +
12	Motor OT -
13	**HALL 2**
14	**HALL 3**
15	Shield
16	N.C., M (shell)

	CAUTION
	The four High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment. ***If you need to operate these inputs as general-purpose inputs at 30 VDC, then a current limit 2k W resistor must be installed in series with the input.***

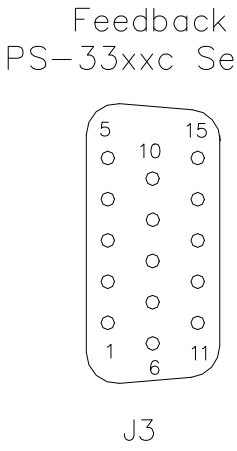
A cable assembly, **CA-SD15-KIT**, may be purchased to facilitate wiring the J3 connector. This cable assembly includes a three-foot cable with a DIN-3 mount terminal strip.

The **PS-33xxc-R** Series is a digital amplifier that will only accept a resolver as the feedback device. Refer to section 7.2.1 for Commutating Resolver Specifications compatible with resolver based controllers.

The PS-33xxc-R motor feedback connector J3 is a 15 pin sub-D that contains connections for a resolver feedback and two High Speed Inputs, HSI3 and HSI4. The connections also include an isolated +5 VDC supply for customer usage. If a motor over temperature sensor is being utilized, you must enable this feature in the software configuration. Make this mode ACTIVE via parameter COT *Check motor OT input.*

Software commands for utilization of the High Speed Inputs HSI3 and HSI4 will be supported with future releases of Firmware and APImate2 enhancements.

Figure 3-53 PS-33xxc-R Resolver Feedback Connector (J3)



J3 - Resolver Feedback	
Pin #	**Signal**
1	Sine + (S2)
2	Sine - (S4)
3	Cos + (S1)
4	Cos - (S3)
5	Ref + (R1)
6	Ref - (R2)
7	+ 5 Encoder/Hall
8	+ 5 VDC Return
9	**HSI 3 +**
10	**HSI 3 -**
11	Motor OT +
12	Motor OT -
13	Spare
14	Spare
15	Shield
16	N.C., M (shell)

	CAUTION
	The four High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment. ***If you need to operate these inputs as general-purpose inputs at 30 VDC, then a current limit 2k W resistor must be installed in series with the input.***

A cable assembly, **CA-SD15-KIT**, may be purchased to facilitate wiring the J3 connector. This cable assembly includes a three-foot cable with a DIN-3 mount terminal strip.

3.3.8 System Accessories

Cable Assemblies

Table 3.11 PS-33xx d/i Cable Assemblies

CA-F6-2	CABLE ASSEMBLY, ANALOG, FLYING LEADS, 2 FT
CA-F14-2	CABLE ASSEMBLY, FEEDBACK, FLYING LEADS, 2 FT
CA-F24-2	CABLE ASSEMBLY, IO, FLYING LEADS, 2 FT
CA-ID24-OPTO	CABLE ASSEMBLY, IO, FLYING LEADS, 2 FT, I-SERVO
CA-DB9-232-6	CABLE ASSEMBLY, DB9, RS-232, 6 FT

Crimping Tools can be obtained from:

USA: Schuster Electronics Tel: 1-800-521-1358. (P/N DF11-TA2428HC)
CE: Hirose (D) Tel: 07-11-456-0021, Hirose (UK) Tel: 01-90-826-0616.

Table 3.12 PS-33xxc Cable Assemblies

CA-SD26-KIT	CABLE ASSEMBLY FOR IO, 26SUB D, DIN BREAKOUT
CA-SD15-KIT	CABLE ASSEMBLY, FEEDBACK, 15SUB D, BREAKOUT
CA-SD26-OPTO	CABLE ASSEMBLY FOR OPTO22, 26SUB D-25D
CA-DB9-232-6	CABLE ASSEMBLY, DB9, RS-232, 6 FT

The PS-33xxc requires two cable assemblies, CA-SD26-KIT.

Customers wishing to manufacturer their own cable sets may purchase the mating connectors from the table of PS-33xxc connectors below.

Description	Adam Tech Part Number
DB9 (male) solder cup Aluminum Back Shell Grommet Tree	DE09PD DE09-DH-AL-TS GS-DE09-HD
SD15 (female) solder cup Aluminum Back Shell Grommet Tree	HDT15SD DE09-DH-AL-TS GS-DA15-HD
SD26 (female) solder cup Aluminum Back Shell Grommet Tree	HDT26SD DA15-HD-AL-TS GS-DA26-HD

Table 3.13 Wire Selection Table

Wire Selection Table		
Purpose	**Description**	**Manufacturer**
Signal	22 AWG, 2 Pair, Shield & Drain	Alpha 5482C
Signal	22 AWG, 3 Pair, Shield & Drain	Alpha 5484C
Signal	24 AWG, 2 Pair, Shield & Drain, Low Capacitance	Belden 8102
Signal	24 AWG, 4 Pair, Shield & Drain, Low Capacitance	Belden 8104
Signal	24 AWG, 8 Pair, Shield & Drain, Low Capacitance	Belden 8108
Signal	28 AWG, 2 Pair, Shield & Drain, Low Capacitance	Alpha 3492C/Belden 8132
Signal	28 AWG, 4 Pair, Shield & Drain, Low Capacitance	Alpha 3494C
Signal	28 AWG, 8 Pair, Shield & Drain, Low Capacitance	Alpha 3498C
Ground Strap		

Table 3.14 Motor Cable Selection Table

Motor Cable Selection Table		
Purpose	**Description**	**Motor Series**
CS-1723-010	CABLE SET, PWR/FB, T17,T23, 10 FT	MAC-T17x/MAC-T23x
CS-1723-025	CABLE SET, PWR/FB, T17,T23, 25 FT	MAC-T17x/MAC-T23x
CS-3442-010	CABLE SET, PWR/FB, T34,T42, 10 FT	MAC-T34x/MAC-T42x
CS-3442-025	CABLE SET, PWR/FB, T34,T42, 25 FT	MAC-T34x/MAC-T42x
CS-5666-010	CABLE SET, PWR/FB, T56,T66, 10 FT	MAC-T56x/MAC-T66x
CS-5666-025	CABLE SET, PWR/FB, T56,T66, 25 FT	MAC-T56x/MAC-T66x
CS-1631-10	CABLE SET, PWR/FB, M16, M24,M31, 10 FT	MAC-M16x/M24x/M31x
CS-1631-25	CABLE SET, PWR/FB, M16, M24,M31, 25 FT	MAC-M16x/M24x/M31x
CS-5100-010	CABLE SET, PWR/FB, M51, 10 FT	MAC-M51x
CS-5100-025	CABLE SET, PWR/FB, M51, 25 FT	MAC-M51x
CS-7100-010	CABLE SET, PWR/FB, M71, 10 FT	MAC-M71x
CS-7100-025	CABLE SET, PWR/FB, M71, 25 FT	MAC-M71x

External Regen Resistors

Table 3.15 External Regeneration Resistors

Model	External Continuous	External Peak	External Regen Resistor Kit
PS-3303	47 Ohm, 150 W	3 kW	RRK-0160-47
PS-3306(d)(i)	47 Ohm, 150 W	3 kW	RRK-0160-47
PS-3306c	10 Ohm, 200 W	14 kW	RRK-0200-10
PS-3310	10 Ohm, 200 W	14 kW	RRK-0200-10
PS-3320	10 Ohm, 200 W	14 kW	RRK-0200-10

Resistor Kits include: resistor, fuse, fuse holder, and 1 meter of wire.

Line Filters

Table 3.16 Suggested Line Filters

Filter Selection Table (AC Line In)		
Part Number	**Description**	**Schaffner P/N**
LF-1-8	Line Filter, Single Phase, 8 A	FN350-8/29
LF-1-12	Line Filter, Single Phase, 12 A	FN350-12/29
LF-1-20	Line Filter, Single Phase, 20 A	FN350-20/29
LF-1-30	Line Filter, Single Phase, 30 A	FN350-30/33
LF-3-8	Line Filter, Three Phase, 8 A	FN351-8/29
LF-3-16	Line Filter, Three Phase, 16 A	FN351-16/29
LF-3-25	Line Filter, Three Phase, 25 A	FN351-25/33
LF-3-50	Line Filter, Three Phase, 50 A	FN2351-50/33
LF-3-80	Line Filter, Three Phase, 80 A	FN351-80/34
LF-3-110	Line Filter, Three Phase, 110 A	FN351-110/35

Required to comply with EC directive 89/336/EEC.

4. APImate 2.0 Software Setup and Installation

This section will guide the user through the APImate 2.0© **or** APImate Lite© **software installation.** APImate 2.0 **is a Windows95-based program that provides Wizards for axis setup, tuning, and high level programming.** APImate Lite **is a Windows95-based program that provides Wizards for axis setup, tuning of the digital models only. The graphical user interface of the** APImate **programs provides the user with the tools to easily configure the PS-33xx to his specific application.**

4.1 Hardware Requirements

To take full advantage of the tools available within **APImate 2.0**, the system integrator must have a PC with Windows95, a hard disk with a minimum of 10M free space, a communications port, a mouse, and a CD-ROM drive.

4.2 Software Installation

4.2.1 Preliminary Steps

The **APImate 2.0** user interface program is provided on a CD-ROM. The purchased copy is considered a site license. The end user may make backup copies for multiple installations of this software. When available, software and firmware upgrades may be made available to end users with purchased copies. To obtain upgrades, return the CD-ROM to your point of purchase with a purchase order that will be utilized for tracking shipment. Upgraded software will be installed on the original CD-ROM and returned.

It is recommended that the OEM or system integrator purchase a copy of the **APImate 2.0** software for each installation and their end user for additional tuning and maintenance of the equipment.

	WARNING
	*Before proceeding, REMOVE any previous installations of **APImate 2.0** from your PC to prevent conflicts with older versions. **Use Windows95 ADD/REMOVE Programs to uninstall previous installations.***

	NOTE
	*To obtain **APImate 2.0** upgrades, return the CD-ROM to your point of purchase with a purchase order that will be utilized for tracking shipment. Upgraded software will be installed ONLY on the original CD-ROM.*

4.2.2 Installation Procedure

The **APImate 2.0** user interface program is supplied on a read/write CD ROM disk. Install this disk in the CD ROM drive of your PC, select the Add/Remove Programs icon, and follow the instructions for adding a program.

An Install Shield is provided to guide you through the installation process. Follow the instructions presented in the Install Shield.

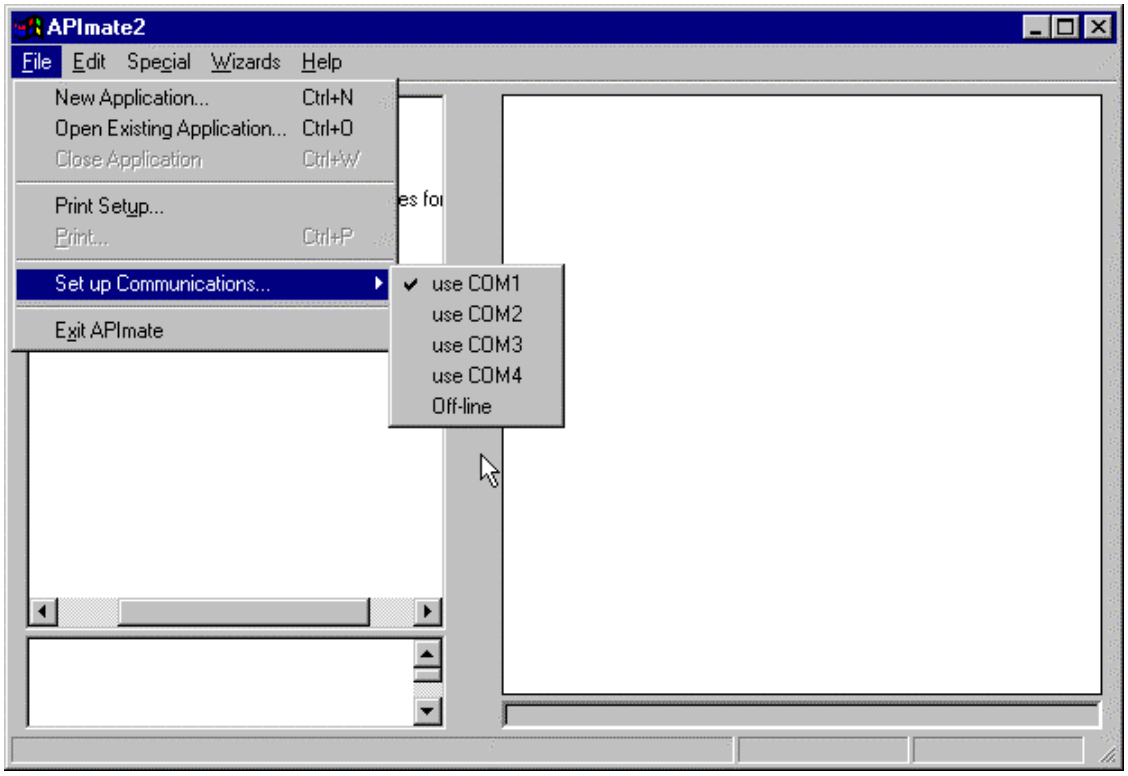
Note that extensive help menus are available with APImate to assist the user in determining the function of each command, parameter, or feature. Help screens for commands and parameters are accessed by first highlighting the item and then performing a right-mouse click.

4.3 APImate 2.0 Configuration

To take full advantage of the APImate 2.0 software features, the user must first configure the software for his computer. Launch the APImate software from your program menu. Figure 4-1 below is an example of the file functions available from the Main Screen.

The user should take this time to configure the software for the printer. The user should also confirm the communications port being utilized by the software to communicate to the amplifiers. Whenever APImate is loaded, a check is completed of the PC's ports to select the proper location of your communications port. *Shared IRQ's for the selected communications port and LAN, MODEM or MOUSE will result in erratic operation of the software.*

Figure 4-1 *APImate 2.0* ***Main Screen***

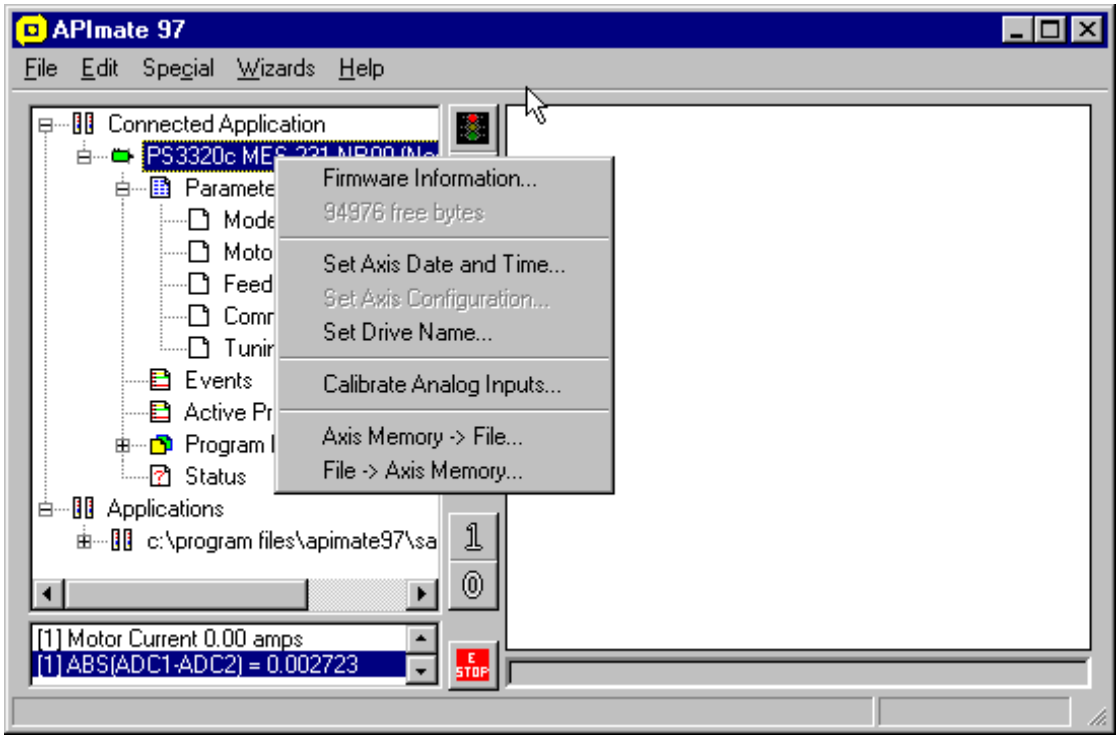


A green icon of a motor under the connected application lets you know which axes are currently connected to the PC. The Axis Menu can be accessed via a right-mouse click.

The feature **Axis Memory-> File** will make a snapshot or backup copy of the existing unit. This snapshot is saved as a file type SNA and includes all the information necessary to completely duplicate the function of an amplifier.

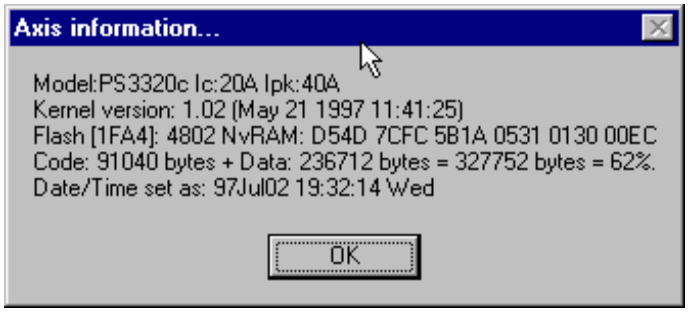
When requesting applications assistance, this file may be sent via e-mail to assist in prompt response to your application needs. Call our toll-free customer service number described in Section 1.4 to obtain our current e-mail address. Be sure to supply additional application information that may be useful in determining your application configuration and desired function.

Figure 4-2 *APImate 2.0* ***Axis Menu***



The firmware information presented here must be available when calling for applications assistance. This information will provide you with the Model and Kernel Version of the firmware currently installed in flash.

Figure 4-3 *APImate 2.0* ***Firmware Information***



You are now ready to proceed with the configuration of the amplifier.

	WARNING
	Before proceeding, make sure that the ENABLE input is INACTIVE to prevent accidental motion during the amplifier configuration process.

5. System Startup

After the system has been installed and wired, it is ready for startup. This section will detail the startup procedure of the servo system and verify proper wiring and operation. Parameter settings and tuning adjustments to the amplifier will be accomplished for your particular application.

To assist you in starting up the servo system, a step-by-step Startup procedure has been included. This procedure should always be followed to ensure proper operation of the servo system. This procedure assumes that the correct interconnect diagrams have been followed and International, National and Local electrical wiring codes have been carefully adhered to.

5.1 Preparation for Startup

5.1.1 Selecting Operation Mode

Before the Startup procedure can proceed, the system integrator must determine the motor parameters and type of motor being used.

The **PS-33xxd** and **PS-33xxi** amplifiers can only operate Brushless DC servomotors. The **PS-33xxc** Centennial units can operate three different motor types: Brushless DC servomotor, Induction motor vector control, Induction motor variable frequency control, and Brush DC servomotor.

All models of the PS-33xx series are easily configured as a servo amplifier in a current reference mode (for direct input to the current loop) or as a velocity (speed) controller. All modes of operation offer a PID-loop tuning feature to properly control API Controls Brushless DC servomotors.

5.1.2 Modes of Operation

This section is to briefly describe possible modes of operation that the user may adopt for their application. For additional information on parameters and function, please refer to Figure 5-6 Function Block Diagram and Figure 5-13 **APImate 2.0** Drive Mode (DM).

Analog Current Mode

In analog current mode, the amplifier will accept a current reference command on the analog input ADC1. This analog input is ±10 VDC, where a +10 volt command results in the maximum peak current of the selected model, (the PS-3310 has a peak rating of 20 amps RMS, thus a +10 volt command results in 20 amps RMS output). **This is the primary or inner current loop of the amplifier and is the most common mode of commanding motion with an external motion controller.**

Analog Velocity Mode

In analog velocity mode, the amplifier will accept a velocity reference command on the analog input ADC1. This analog input is ±10 VDC, where a +10 volt command results in the maximum velocity being commanded to the motor. This maximum velocity is controlled via parameter **FSV**, the maximum acceleration and deceleration rates are limited via parameters **ACC** and **DEC** respectively. In this mode of operation the position loop is closed within an external motion controller and the PS-33xx controls the inner velocity and current loops.

	NOTE
	*When the amplifier is shipped from the factory, the parameters are set for velocity mode control.*

When operating in analog velocity mode it is the users responsibility to verify the application's System Gain and amplifier's analog resolution, (10 bit for the PS-33xxd/I and 14 bit for the PS-33xxc) to determine if a condition of dead-band velocity exists. If applications assistance is required, please contact the applications department at API Controls.

Stand-Alone Position Mode

The **PS-33xxi** and **PS-33xxc** Series amplifiers are computers dedicated to motion control. Like all computers, each has its own operating system, data storage capabilities, data manipulation capabilities, and an interface for data communications. In addition, its built-in inputs/outputs allow for hard-wired connections for motor feedback and to sensor switches to ensure motion that is "in sync" with the user's environment.

In Position Mode the amplifier will execute stored motion program(s) in response to external inputs.

Step & Dir Command Mode

In Step & Dir command mode, the amplifiers High Speed Inputs***** HSI1 and HSI2 are utilized to accept direction and step signals respectively. The amplifier utilizes the parameters similar to position mode in addition to the Command parameter *Step Pulse Count* **SPPR**. The **SPPR** parameter controls the number of Step signals equivalent to one revolution of the motor shaft.

Step Up/Down Command Mode

In Step Up/Down command mode, the amplifiers High Speed Inputs***** HSI1 and HSI2 are utilized to accept Step- and Step+ signals respectively. The amplifier utilizes the parameters similar to position mode in addition to the Command parameter *Step Pulse Count* **SPPR**. The **SPPR** parameter controls the number of Step signals equivalent to one revolution of the motor shaft.

Quad Encoder Command Mode

In Quad Encoder command mode, the amplifiers High Speed Inputs***** HSI1 and HSI2 are utilized to accept encoder quadrature A and B channels respectively. The amplifier utilizes the parameters similar to position mode in addition to the Command parameter *Step Pulse Count* **SPPR**. The **SPPR** parameter controls the number of encoder quadrature signals equivalent to one revolution of the motor shaft.

	CAUTION
	**The High Speed Inputs (HSI) require a signal level of 3.5-7VDC. Exceeding this voltage will result in damage to the equipment.* **The preferred interface is a differential output for improved noise immunity.**

CAN Command Mode

The CAN command mode is only available on the **PS-33xxi** series with the *optional* CAN interface. The amplifier can be issued digital commands in a current, velocity or position mode. This mode of operation is not currently supported.

Digital Command Source

With a digital command source, the amplifier must be configured to either CURRENT or VELOCITY Mode. The amplifier will interactively and continuously accept commands for new digital currents or digital velocities, parameters **DCC** and **DCV** respectively. *These digital commands may be generated internally to the amplifier via a program or externally via an ASCII command generated via the user's interface.*

The **ISP.DOC** and **IML.DOC** files located on the APImate 2.0 distribution disk document the *Intelligent-Servo-Protocol* and *Intelligent-Motion-Language* utilized for ASCII communicating to the PS-33xx Series Digital Servo Amplifiers. This information is required for users creating a multi-axes master motion control program.

.

5.2 Applying Power

	WARNING
	*Before proceeding, make sure that the ENABLE input is INACTIVE to prevent accidental motion during the amplifier configuration process.*

5.2.1 Theory of Operation

The PS-33xx is a digital motion controller that will process commands within the hardware and software limits dictated by the user (wiring, configuration, parameters, events, etc.). The output of the system is the motion(s) created in response to the command(s) input.

	NOTE
	***Flowchart your axis application so that you can determine the function of inputs and outputs, configuration, operating mode, etc. This will save time and assist in the startup of a new application. The importance of this cannot be over emphasized.***

5.2.2 Summary of Functions

5.2.2.1 Enable Input

The ENABLE input commands the drive to provide power to the motor, it is a dedicated input and cannot be reassigned. **For safety purposes this input is leading edge triggered.**

The PS-33xxi and PS-33xxc can also be enabled via software command. The Enable-Mode may be *and-ed* or *or-ed* with software and hardware.

5.2.2.2 Motor Over Temperature (OT) Input

Motor over-temperature inputs are provided on the feedback connector, J3 on the PS-33xx drives. This input is wired to a N.C thermal switch internal to the motor (Z < 10k means motor is OK). If a motor **OT** sensor is to be utilized in an application, then parameter **COT** must be set to **Active** for the PS-33xx to monitor this input.

5.2.2.3 Reset Input

The drive RESET input, when active, will cause the amplifier to immediately remove power from the motor and clear any re-settable fault conditions. **If the drive is being provided an ENABLE input, when the RESET input is activated, the drive will immediately re-enable and continue operation.**

	NOTE
	*The **RESET** input on the PS-33xxc Series, if active when power is applied, will cause the unit to start its Boot-Load-Manager. This will cause the unit to appear as if it has faulted, the unit will not respond to any IO and will not enable until the RESET input is in the inactive-state and then active-state again.* *Correctly configure your power up sequence(s) to prevent accidentally activating the units Boot-Load-Manager.* *See Section 5.3.7 Update New Firmware for additional information.*

5.2.2.4 Foldback Output

The FOLDBACK output is active when I^2t is actively reducing the motor output current to protect either the amplifier or the motor. This output is only available on the **PS-33xxd** and **PS-33xxi** series controllers. **This in not considered a fault condition and will not appear in the fault history. It is the responsibility of the user to properly use this output as required by the application.**

5.2.2.5 Servo-OK Output

The DRIVE-OK output is active when main power is applied and no fault conditions exist. If the drive faults the SERVO-OK output will be disabled. It is suggested that this output be wired in series with the user's E-Stop and Machine-Enable to stop machine operation.

5.2.2.6 High Speed Inputs

The HSI1 and HSI2 inputs are utilized for applications requiring following of a master signal. These inputs are configured by the software parameter Command-Mode to accept; Step/Dir, Step-Up/Down or Encoder Quadrature. The Centennial Series provides additional HSI input(s) for registration or general usage. On the **PS-33xxd** and **PS-33xxi** these inputs can also be utilized as general-purpose inputs, be sure to add the proper series resistance to prevent damage to these inputs.

5.2.2.7 Analog Inputs

The analog input ADC1 is dedicated for receiving a ±10VDC as either a Current or Velocity Command when the unit is configured for analog modes of operation. Parameter ADC1 represents the input voltage and parameter CAL1 the analog offset voltage. The **PS-33xxd** and **PS-33xxi** have a 10 bit analog input.

The PS-33xxi provides an additional analog input named ADC2 with its corresponding offset voltage of CAL2.

The PS-33xxc Centennial Series provides three 14 bit analog inputs named ADC1, ADC2 and ADC3 with corresponding offsets of CAL1, CAL2 and CAL3. These additional analog inputs can be utilized with the built-in PID-loop, to address applications such as web tensioning, pump, and motion profiling.

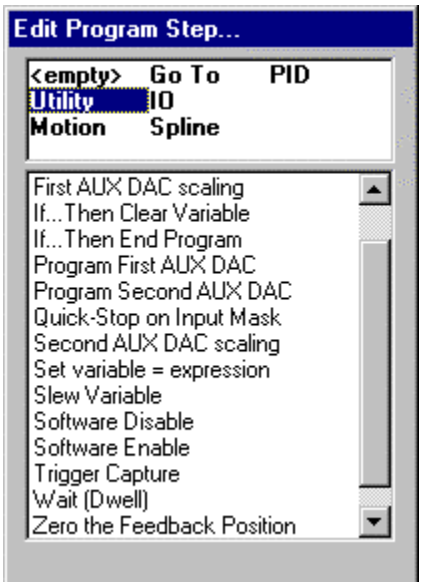
Analog inputs may be utilized to monitor additional analog signals such as pressure, temperature or load transducers. The user would create a program step to monitor the input(s) values and take appropriate action.

```
If ADC1>4.55 Then Go To SENSOR3OT
```

5.2.2.8 Analog Outputs

The PS-33xxc Centennial Series provides two analog outputs for controlling external devices or for providing information on status of the unit.

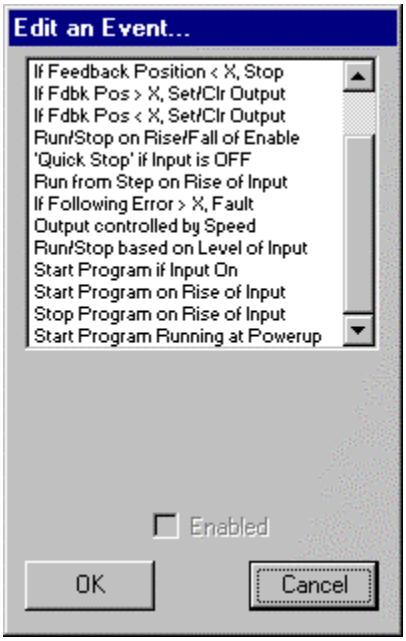
By default ANALOG OUT1 is a 0 to 10 VDC representation of velocity (VEL) and ANALOG OUT2 is 0 to 10 VDC representation of current (IREF) with respect to the amplifier's maximum rating. (A PS-3320c drive commanding full velocity with 10 amp utilization will output +10 VDC and + 2.5 VDC.)



The user may reassign the analog outputs to represent any system or user variable. The output update time is 400µs, with user scaling available. Commands for utilization are shown here.

5.2.2.9 Starting/Stopping a program

The PS-33xxi and PS-33xxc Series provide the user with the flexibility of more than thirteen conditions to begin or stop the execution of the active program. The user may also create software or variable range-checking conditions to "End Program" execution.



The user should review all his options to determine the one(s) that best meets their requirements.

One example is that the user may configure the software EVENT of *Run/Stop on Rise/Fall of Input.* To start the active program, activate the input. Likewise the program execution will stop on fall or inactive-state of the input.

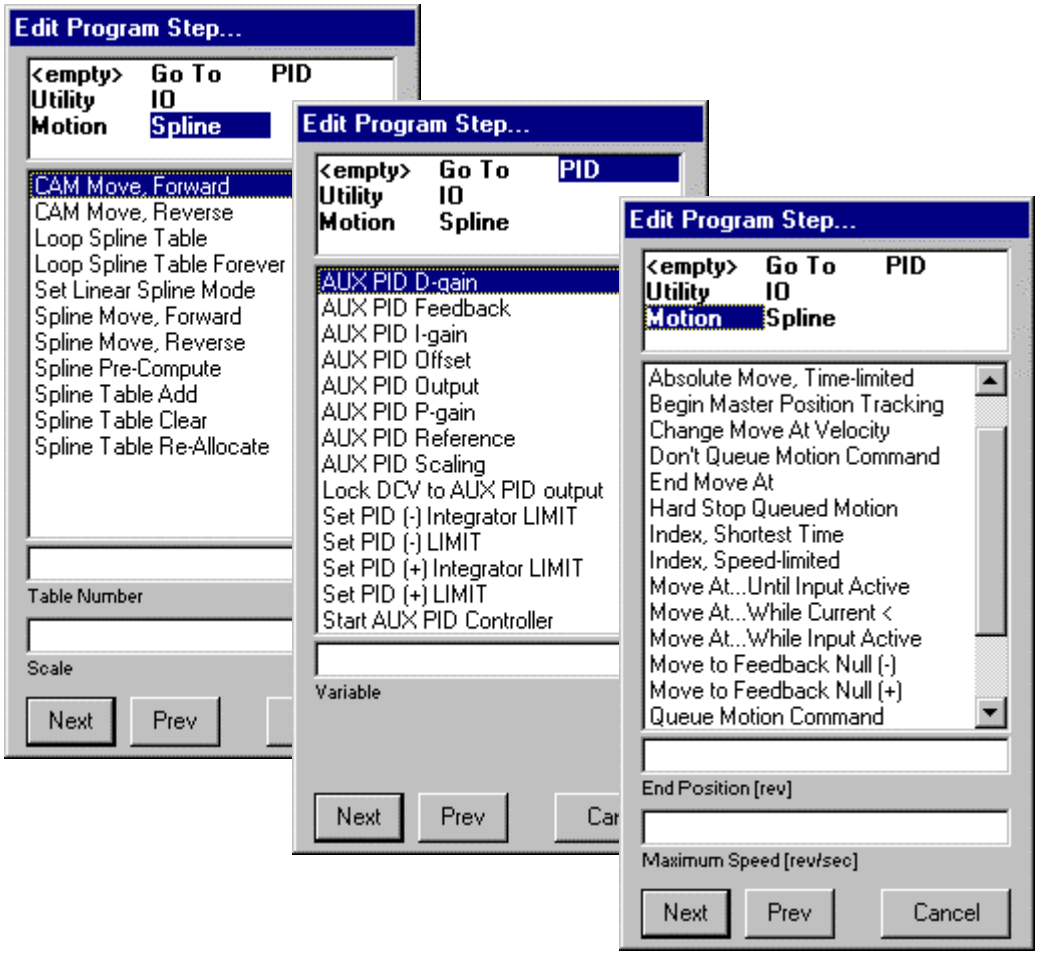
Options available in the Event Menu are shown here.

Additional methods of stopping execution of a program via a system Fault is the setting of the Command Over-Speed (OSPD) and the EVENT to fault if the following error is exceeded.

5.2.2.10 Commanding Motion

The possible methods of commanding motion are so varied that it not practical to document them all here.

All commands are documented in the APImate2 Help Menus.



5.2.3 Summary of System Parameters

Below we have listed the system parameters that may be present in the PS-33xx that you have purchased. This list of parameters is provided for advanced users that may require access to specific system parameters and variables. *Not all of the parameters may be present in the specific model purchased.*

Figure 5-1 System Logical Operators

Category Logical	Code	Description	Unit	Lower Limit	Upper Limit
	&	Logical AND			
	|	Logical OR			
	|=	NOT EQUAL			
	~	Logical NOT (this inverts all the bits) (~01010001 becomes 10101110)			
	<	LESS THAN			
	<=	LESS THAN EQUAL			
	=	EQUAL			
	>	GREATER THAN			
	>=	GREATER THAN EQUAL			

Figure 5-2 System Parameters; Analog

Category Analog inputs	Code	Description	Unit	Lower Limit	Upper Limit
	ADC1	Analog input 1	volts	-10	10
	ADC2	Analog input 2	volts	-10	10
	ADC3	Analog input 3	volts	-10	10
	CAL1	Offset for analog input 1	volts	-10	10
	CAL2	Offset for analog input 2	volts	-10	10
	CAL3	Offset for analog input 3	volts	-10	10

Figure 5-3 System Parameters; Position, Velocity, Torque

Category	Code	Description	Unit	Lower Limit	Upper Limit
Position, Velocity, Torque					
	ACC	Acceleration Rate	RPM/sec	0.001	100,000
	CPOS	CAM Position	Revolutions	Read Only	
	DCV	Digital Command Velocity	RPM	-15000	15000
	DCC	Digital Current Command	Amps	Model dependent	
	DEC	Deceleration Rate, analog velocity mode only	RPM/sec	0.001	100,000
	FPOS	Feedback Position	Revolutions	-14 bit	+14bit
	MAST	Master Position encoder	Revolutions	Read Only	
	PERR	Position Error	Revolutions	Read Only	
	PET	Position Error Tolerance	Revolutions	0	32565
	POSM	Motor Position	Revolutions	Read Only	
	POSS	Position in of Step/Dir, Step Up/Down or Quad.	Steps	Read Only	
	VEL	Velocity of feedback	RPM	Read Only	

Figure 5-4 System Parameters; Configuration

Category	Code	Description	Unit	Lower Limit	Upper Limit
Config					
	BSPD	Base Speed	RPM	0	
	CDLY	Commutation Delay		Read Only	
	CM	Command Mode; Velocity=0, Current=1, Position=2, Step & Dir=3, Step Up/Down=4, Quad=5 and CAN=6		0	6
	COFF	Commutation Offset	Degrees	-180	180
	COT	Check Motor OT Input		0	1
	DCM	Command Source	Analog/Digital	0	1
	DM	Drive Mode; Analog=0 and DCC/DCV=1		0	1

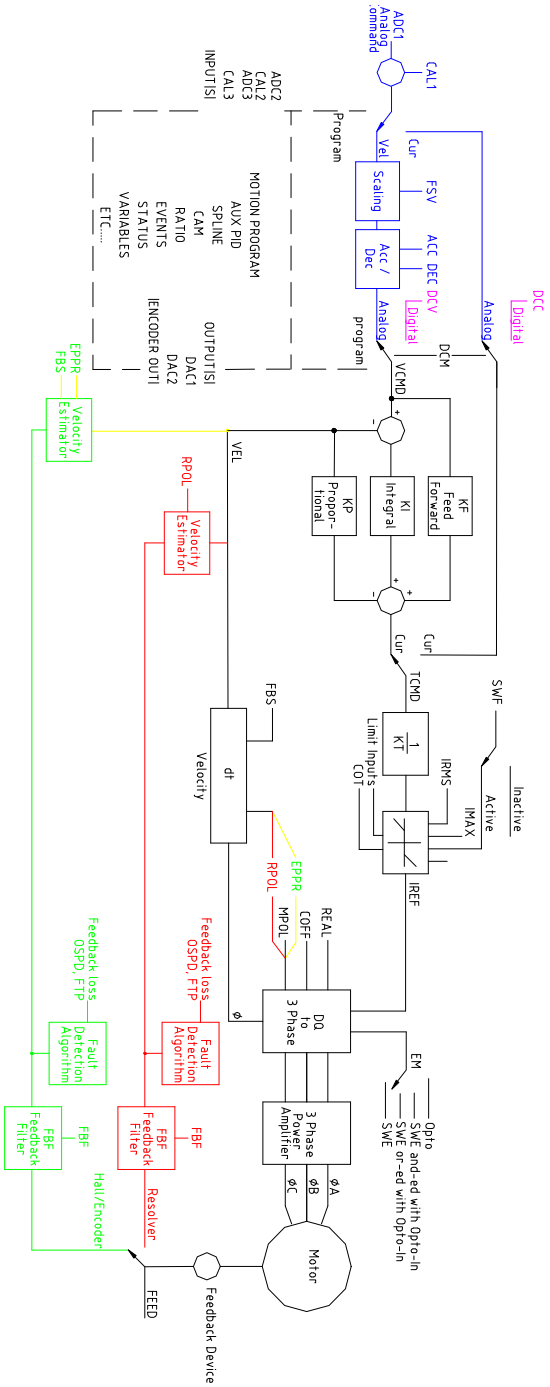
Category	Code	Description	Unit	Lower Limit	Upper Limit
Config					
	EM	Enable Source; Opto Input=0, Opto Input and-ed with SWE=1,Opto Input or-ed with SWE=2 and SWE=3		0	3
	EPPR	Feedback Encoder	pulses/rev	1	324768
	FBF	Feedback Filter (velocity)	Hz	0	10,000
	FBS	Feedback Sign and Scale	Counts	-100000	100000
	FEED	Motor Feedback device type		Model dependent	
	FSV	Velocity @ 10V Analog Cmd	RPM	0.01	100000
	HED	Displays the current status of the HED inputs		1	6
	IKPD	Current Loop D-axis gain		Read Only	
	IKPQ	Current Loop Q-axis gain		Read Only	
	IMAX	Maximum Allowed Current	Amps	Model dependent	
	INER	Motor Inertia	kg-m²	0.000001	
	IPK	Max allowable current at the moment, I2t, read only	Amps	Read Only	
	IRA	Current ref in amps	Amps	Model dependent	
	IRMS	Foldback RMS Current Limit	Amps	0.01	dependent
	KF	Velocity feedforward gain		0	10000
	KI	Velocity Integeral gain	Nm/RPM/sec	0	10000
	KP	Velocity proportional gain	Nm/RPM	0	10000
	KT	Motor Torque Constant	Nm/Amp	0	10000
	MFLX	Minimum Flux at Top Spd	Weber	0	15000
	MIND	Mutual Inductance	Henrys		
	MPOL	Motor Pole Count	pole	3	16
	MPOS	Marked Position, On-event such as "On Input"	Revolutions	Read Only	
	ONE	System variable == 1		Read Only	
	OSPD	Overspeed Fault Setpoint	RPM	1	100000
	PPG	Position Proportional Gain	1000/min	0	100
	REAL	Imaginary Axis Gain		-1	1
	RFLX	Rated Flux at Base Spd	Weber	0	15000
	RGNI	Regen Integration Increment		Read Only	
	RGNL	Limit on Integrated Regen		Read Only	
	RPOL	Feedback Resolver	pole	2	
	RRES	Rotor Resistance	Ohms	0.01	10000
	SPPR	Step Pulse Count used to set electronic gear ratio	pulses/rev	1	65536
	SWE	Software Enable; 0=Disabled, 1=Enabled		0	1
	SWF	Stop Pgm on Fault		0	1

TIME	System variable	Seconds		
TR	Translation Ratio, ratio of distance to motor rev.		-16384	16384
VDC	Bus voltage present (DC)	Read Only	Model dependent	
VFF	VF Mode Frequency	Hz	-16384	16384
VFI	VF Mode Current Command	Amps	Model dependent	
ZERO	System variable == 0		Read Only	

Figure 5-5 System Parameters; IO

Category	Code	Description	Unit	Lower Limit	Upper Limit
IO					
	IN	Bit representation of inputs that are active		Read Only	
	IN#	Force input bits "#" on			
	OFF	Function call, represents input bits that are inactive		Read Only	
	ON	Function call, represents input bits that are active		Read Only	
	ON(#)	Function call, represents input bits that are active		Read Only	

Figure 5-6 Function Block Diagram



5.2.4 General Description

APImate 2.0 supplies the tools necessary to configure the amplifier to your application. The screen images and descriptions provided in this section are intended to highlight some of the major features available within the software.

Wizards for **Setup** and **Tuning** are provided to step the user through the basic configuration of the system.

APIscope is provided to allow the user to capture data on the commanded and actual motor motion.

APImate2 provides **HELP** on commands, parameters, features and functions available within the PS-33xx Series product line.

Review this section to familiarize yourself with the features available prior to programming the unit. This will save time in the startup of a new application.

5.3 Amplifier Configuration

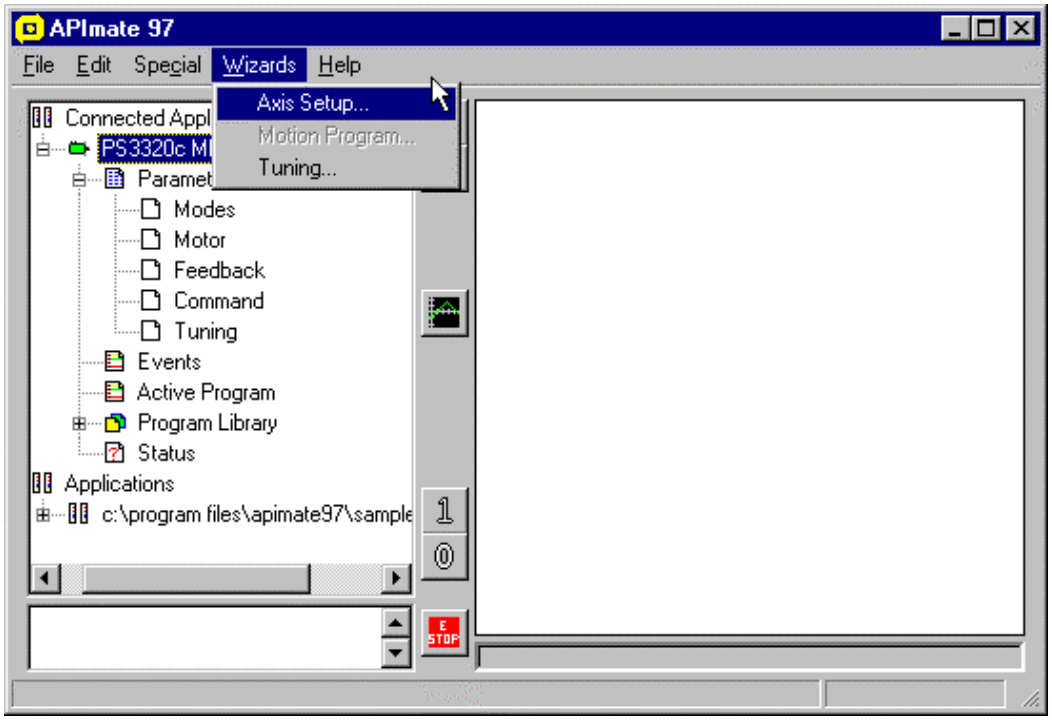
5.3.1 Wizard: Axis Setup

The amplifier configuration is done primarily via the Axis Setup Wizard. The Setup Wizard will configure all of the system parameters necessary to allow you to generate motion within your selected application. **The Setup Wizard should be the first screen accessed when configuring a new amplifier.** This wizard will utilize the information provided to create stable tuning parameters Kf, Kp, Ki and PPG.

	NOTE
	*Each time the Axis Setup Wizard is accessed, the software will automatically disable the amplifier and change the ENABLE Mode (EM) to Opto-In. This is done to protect the user and the application. If you are utilizing the Software-Enable (SWE) command, the ENABLE Mode (EM) must be changed after visiting the Axis Setup Wizard.*

The customer is required to have the minimal information about the motor type: Kt, Jmotor, Icont, feedback type, etc. Examples of these screens are shown below.

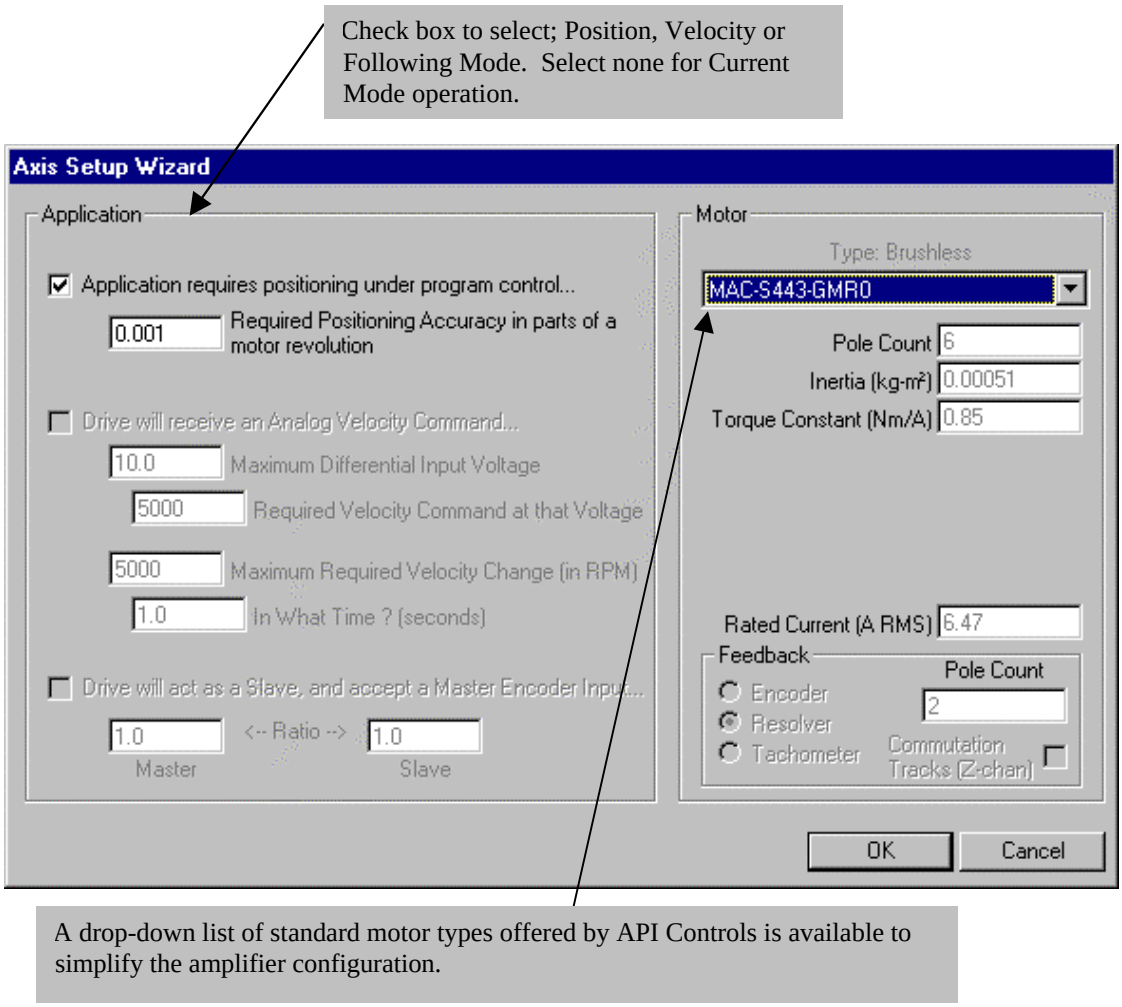
Figure 5-7 *APImate 2.0* ***Wizards***



All versions of the PS-33xx Series can be configured for a Brushless DC motor.

The user is required to provide minimal information about the motor type, the application mode, and the command source.

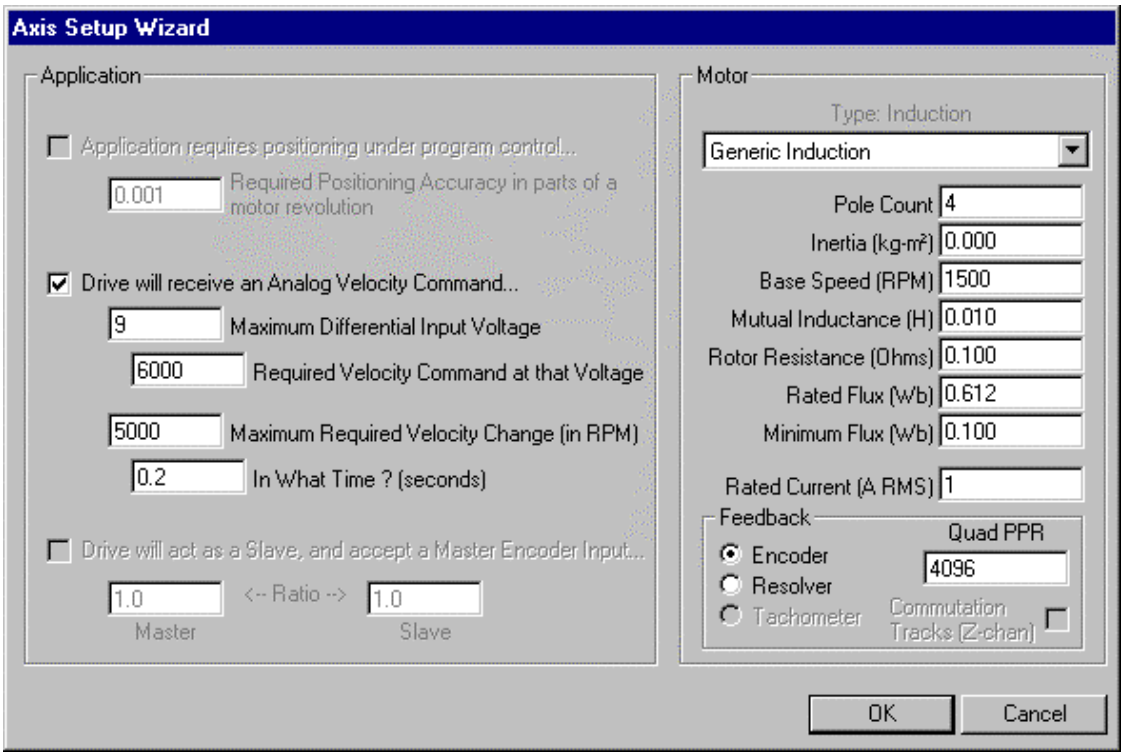
Figure 5-8 *APImate 2.0* ***Wizard - AC Brushless Motor***



Only the **PS-33xxc** Centennial series can be configured for Induction Motors.

The induction motor must be a 300 volt winding when the amplifier is operated from a 230VAC, 3∅ supply. The motor feedback may be either encoder or resolver. The motor manufacturer upon request will supply additional motor parameters.

Figure 5-9 *APImate 2.0* ***Wizard - Induction Motor***

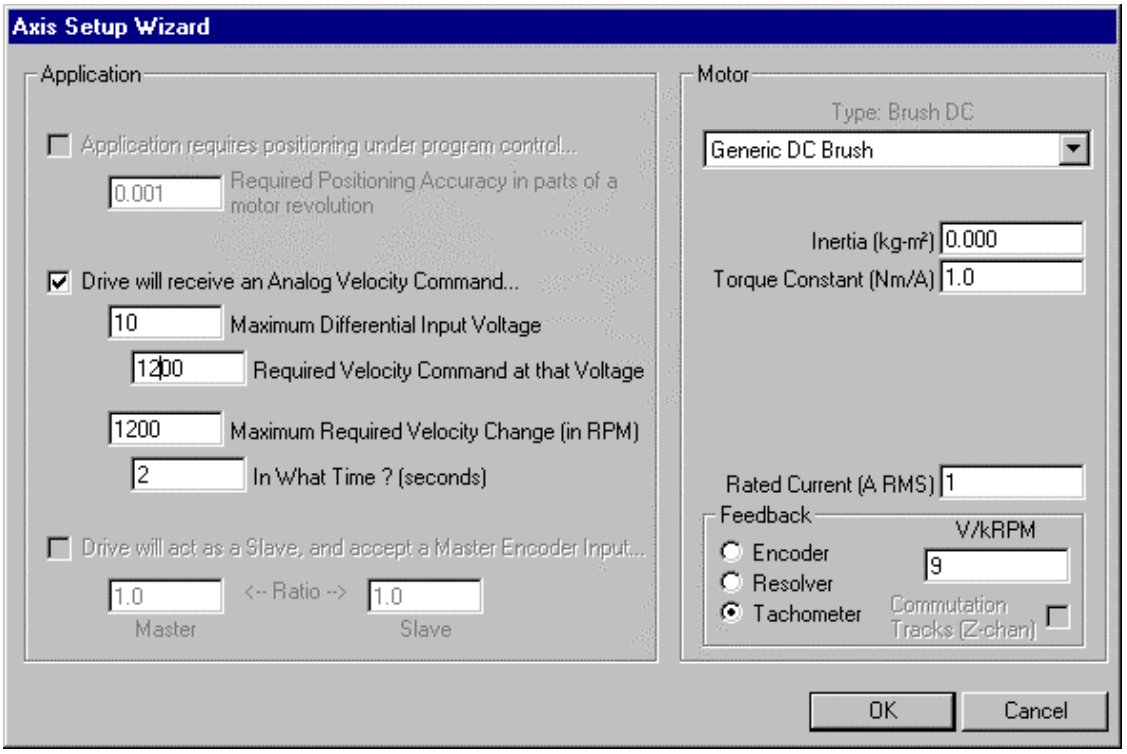


Only the **PS-33xxc** Centennial series can be configured for DC Brush Motors. Interconnect wiring for this motor type is not covered in this guide.

The Connections at TB2 motor connector will determine the maximum voltage that will be applied to the motor windings.

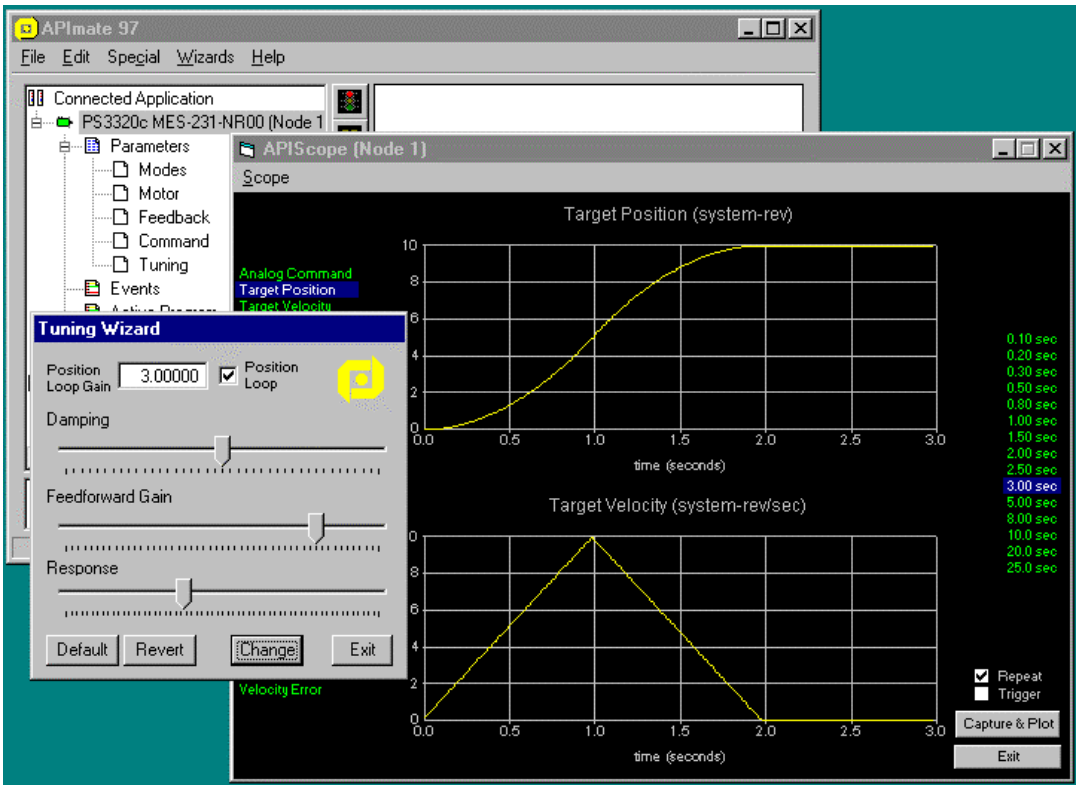
The motor feedback may be Tachometer, Encoder or Resolver depending on the application. The tachometer feedback is wired into the ADC2 input to provide the velocity feedback. The user must enter the tachometer calibration in Volts/kRPM. The motor manufacturer upon request will supply additional motor parameters.

Figure 5-10 *APImate 2.0* ***Wizard - DC Brush Motor***



The Tuning Wizard is typically utilized in conjunction with APIscope to monitor the commanded motion versus the motion output. The slider bars are provided to assist with making adjustments. The slider bars are arranged in the order of importance, the most important is displayed at the top of this Tuning Wizard screen. During the adjustment process the software will automatically adjust the Kp, Ki, and Kf parameters. If the system becomes unstable during this process, select DEFAULT or REVERT, then select CHANGE.

Figure 5-11 *APImate 2.0* ***Wizard - Tuning***



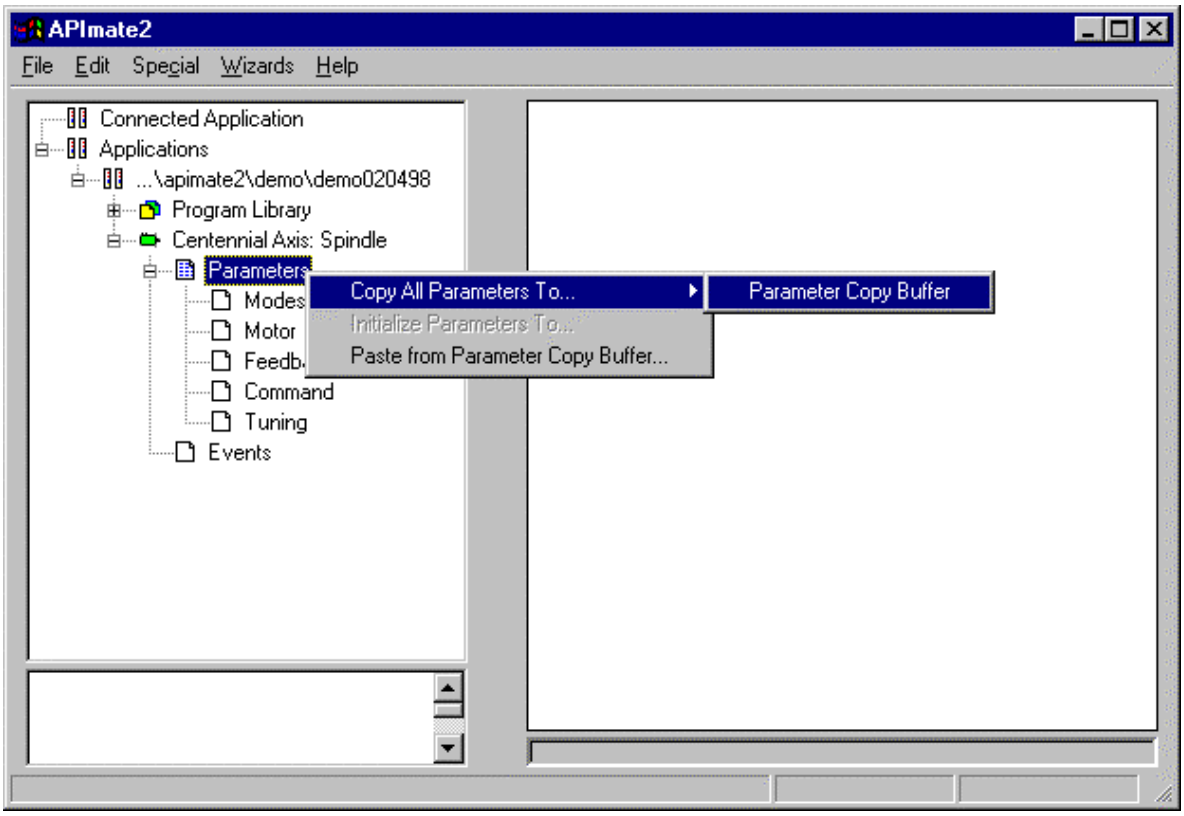
5.3.2 Parameters

For ease of identification and function, system parameters are grouped into; **Modes**, **Motor**, **Feedback**, **Command**, and **Tuning** parameters.

When positioned on the Parameters icon in APImate the user may use a right-mouse click to *Copy Parameters to Buffer* and paste to a new motor application in the off-line applications folder.

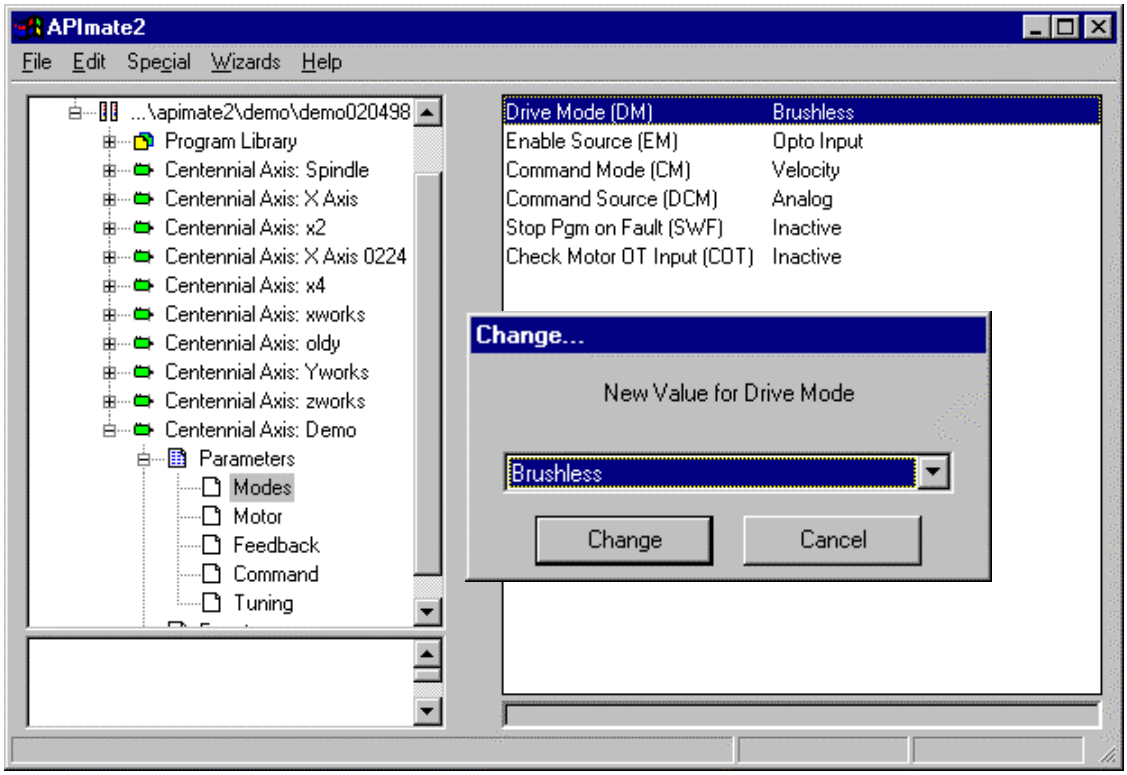
When positioned on the Parameters icon in a Connected Application the user has an additional option to *Initialize Parameters* to factory default settings.

Figure 5-12 *APImate 2.0* ***Drive Parameters***



The Drive mode is typically set through the Setup Wizard and should not be changed by an inexperienced user. If system parameters become corrupted, return to the Setup Wizard to reset the system parameters.

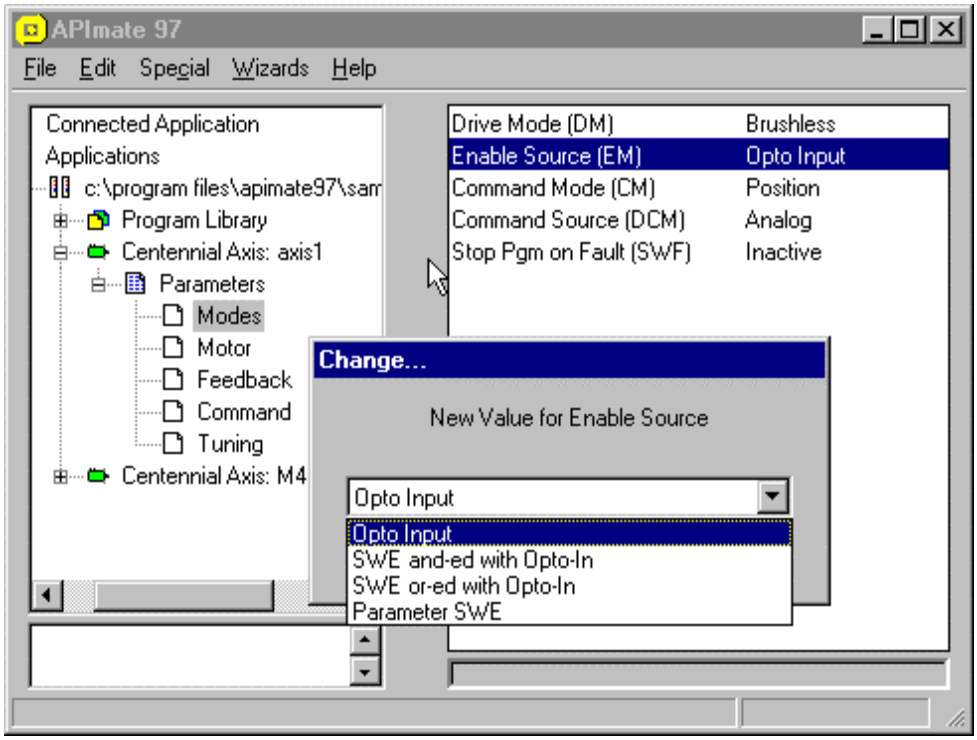
Figure 5-13 *APImate 2.0* ***Drive Mode (DM)***



The user must select the amplifiers ENABLE Mode (EM). When enabled the amplifier power output stage becomes active. Opto Input refers to the hardware enable input and Parameter SWE refers to Software Enable whereby the unit is enabled via a software command. To provide the user with the most versatility possible, the two enable sources can be "and-ed" or "or-ed" together.

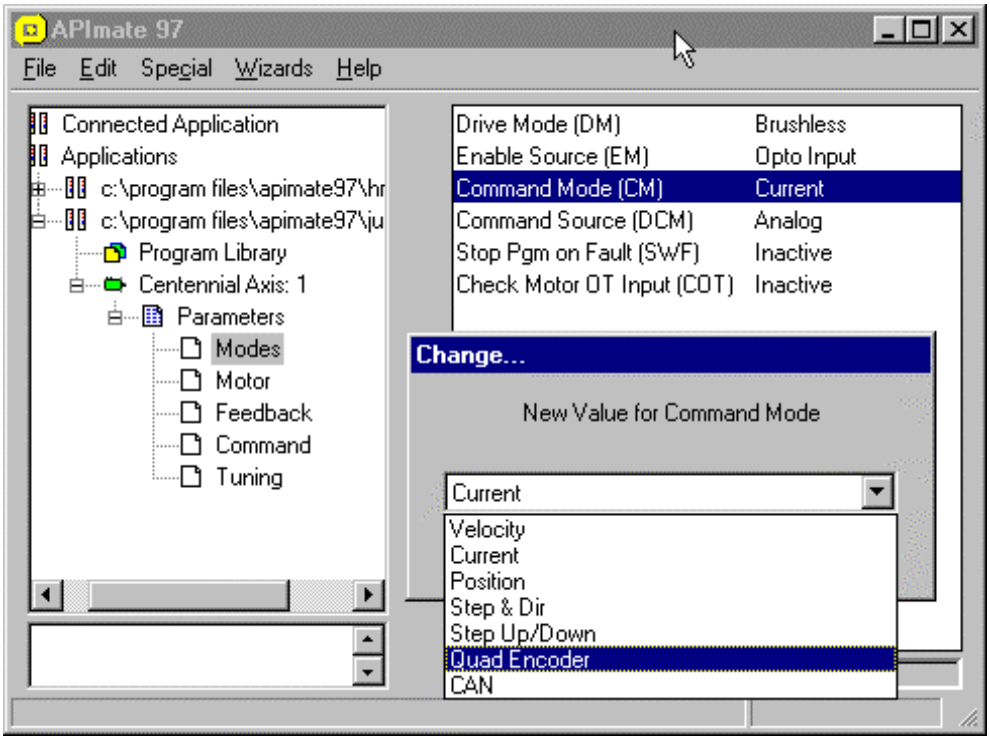
	NOTE
	*Each time the Axis Setup Wizard is accessed, the software will automatically disable the amplifier and change the ENABLE Mode (EM) to Opto-In. This is done to protect the user and the application. If you are utilizing the Software-Enable (SWE) command, the ENABLE Mode (EM) must be changed after visiting the Axis Setup Wizard.*

Figure 5-14 *APImate 2.0* ***Enable Source (EM)***



The Command Mode (CM) can also be accessed to allow the configuration of the unit. The CM parameter is normally set through the Setup Wizard. The amplifier must be disabled to allow changes to this parameter. An example of the screen is shown below.

Figure 5-15 *APImate 2.0* ***Command Mode (CM)***

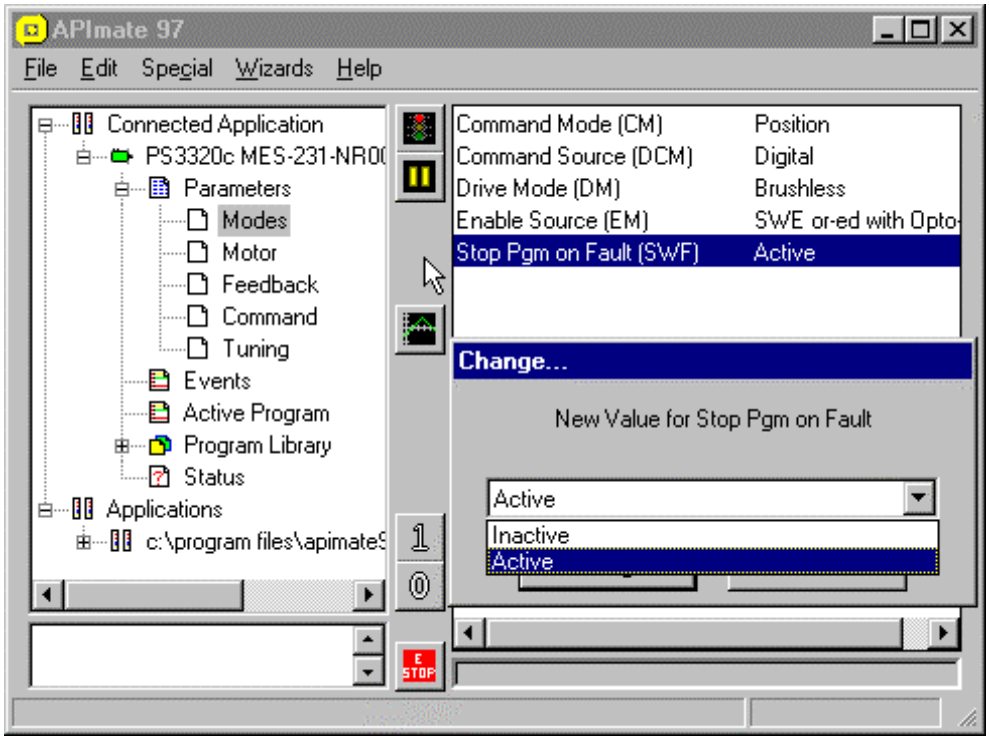


A parameter (Software Fault, or SWF) has been provided that will allow the user to terminate program execution on a software fault.

The application may require the program to continue execution after the external RESET input is activated. This is extremely useful in applications where the user cannot allow interruptions of the process or motion program such as in web handling applications. The default configuration for parameter SWF is "inactive".

The user may toggle this parameter to "active" to allow the program to abort and disable the amplifier. This is extremely useful in applications where the controller is programmed to range check values of entered variables or data.

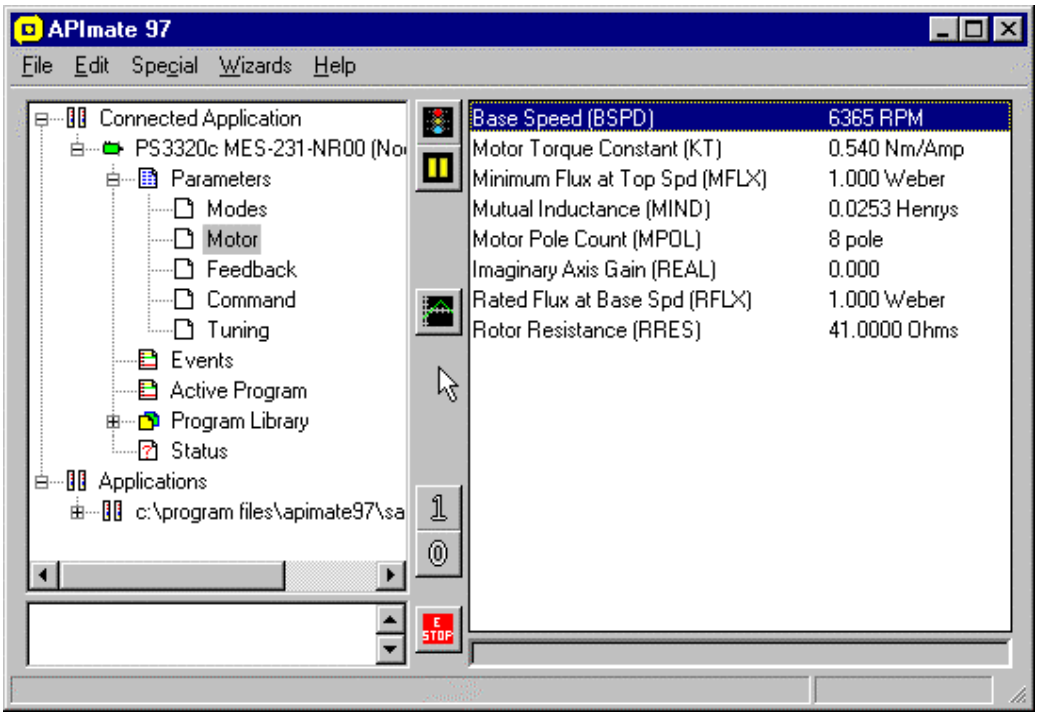
Figure 5-16 *APImate 2.0* ***Modes - Stop Program on Fault (SWF)***



The next group of parameter's deal with the motor configuration and is provided for informational purposes only. These parameters are defined by the Setup Wizard and should not be changed by the user. Some of the parameters shown may not apply for the specific motor being driven in your application.

Improper configuration of these parameters may result in an unstable system configuration or damage to the motor.

Figure 5-17 *APImate 2.0* ***Motor Parameters***

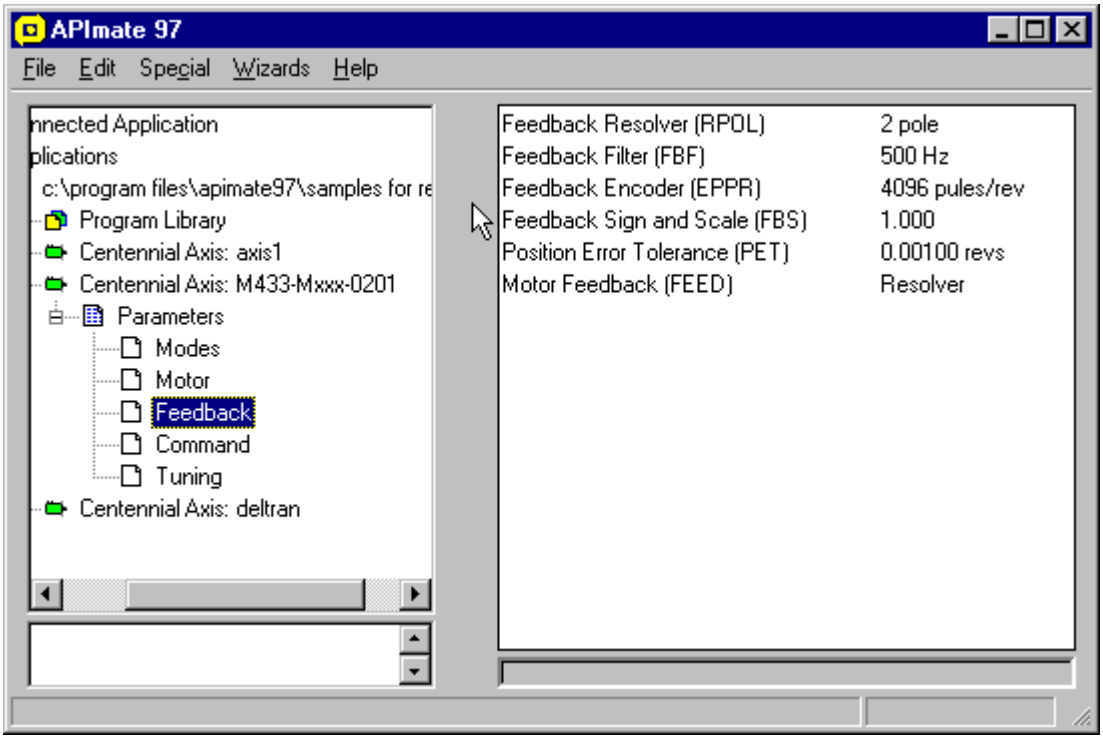


The next group of parameters deal with motor feedback. These parameters are set through the Setup Wizard and need not be changed by the user.

A Feedback Filter (FBF) parameter is provided for users with application "noise" on the feedback signal lines.

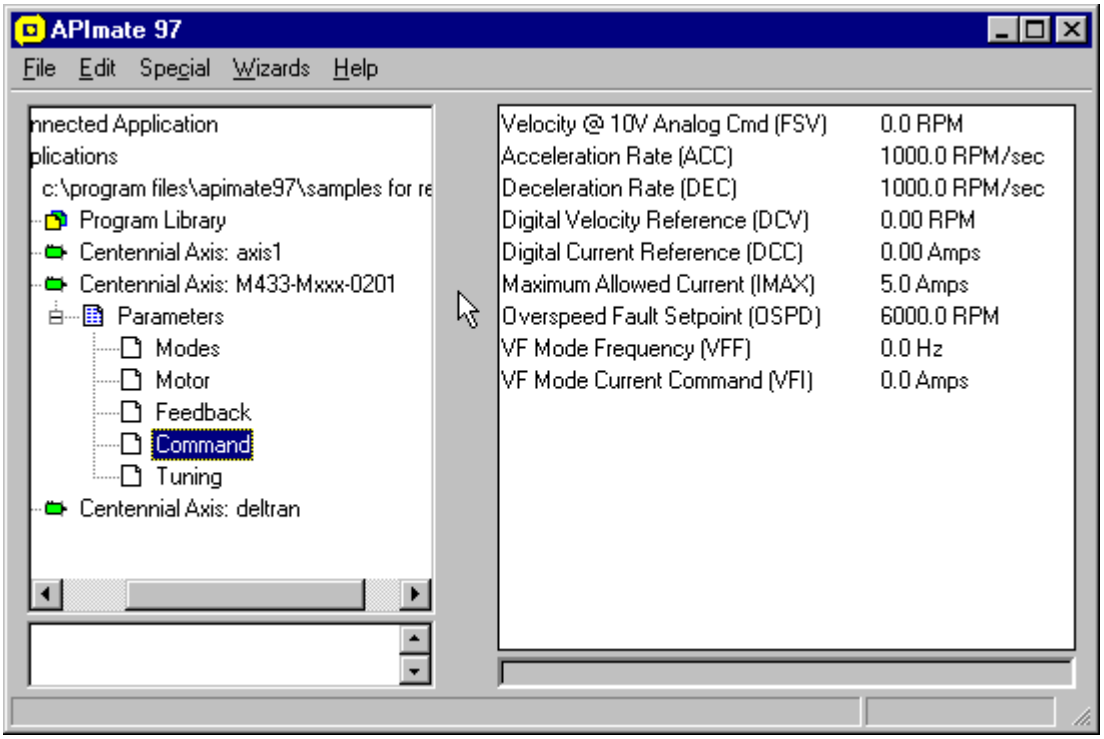
	CAUTION
	*Low values entered for the Feedback Filter (FBF) may result in an unstable situation. If FBF = 100 Hz, the feedback is sampled every .01 seconds.*

Figure 5-18 *APImate 2.0* ***Feedback Parameters***



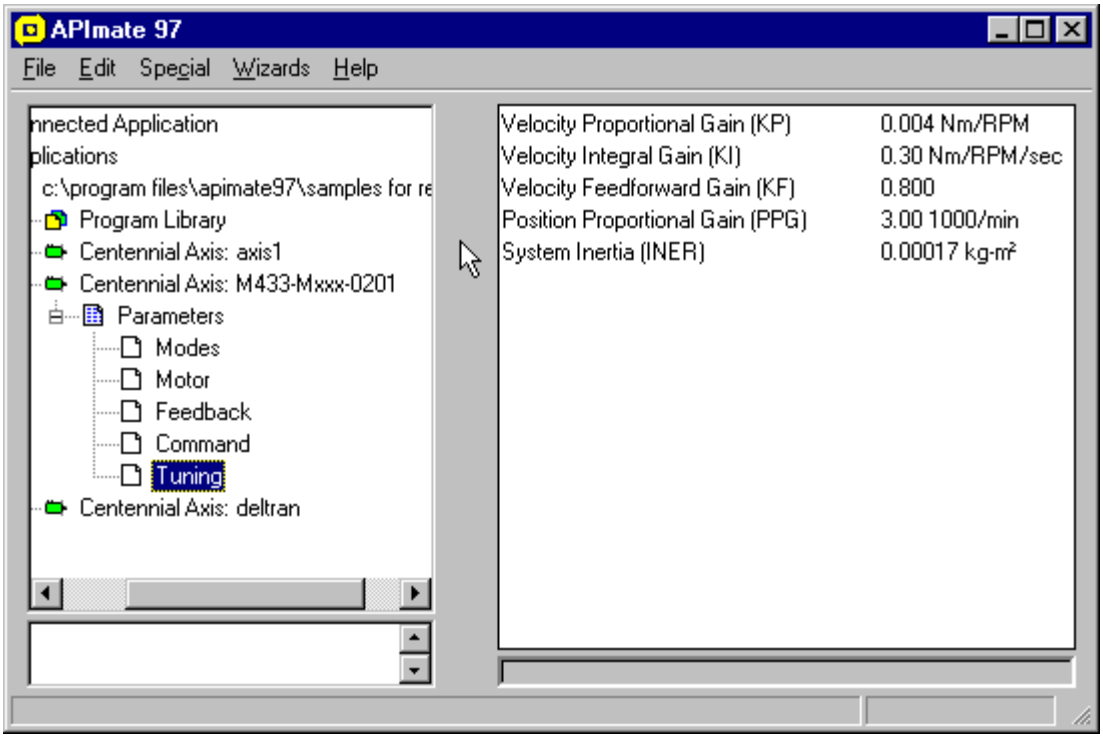
The group of command parameters are also set via the Setup Wizard. The user may wish to adjust the *Maximum Allowed Current* (IMAX) and *Foldback RMS Current Limit* (IRMS) to prevent over-energizing the motor or limit excessive torque in the system.

Figure 5-19 *APImate 2.0* ***Command Parameters***



The last group of parameters is the tuning parameters. These parameters are configured through the Setup Wizard and can be adjusted through the Tuning Wizard.

Figure 5-20 *APImate 2.0* ***Tuning Parameters***



5.3.3 Software Events

The user has the ability to select from a group of software events. The software events are utilized to reduce programming to a minimum. Software events act similarly to interrupts in that they are continuously evaluated background events.

Removing the check mark from the Enabled box can temporarily disable an event. All events are automatically re-enabled upon a RESET command or power cycle. This is done as a safety measure to prevent the limit inputs or other features from becoming accidentally disabled during the machine integration process.

Examples of some of these events are shown on Figure 5-21 through Figure 5-23.

Figure 5-21 *APImate 2.0* ***Events - Menu***

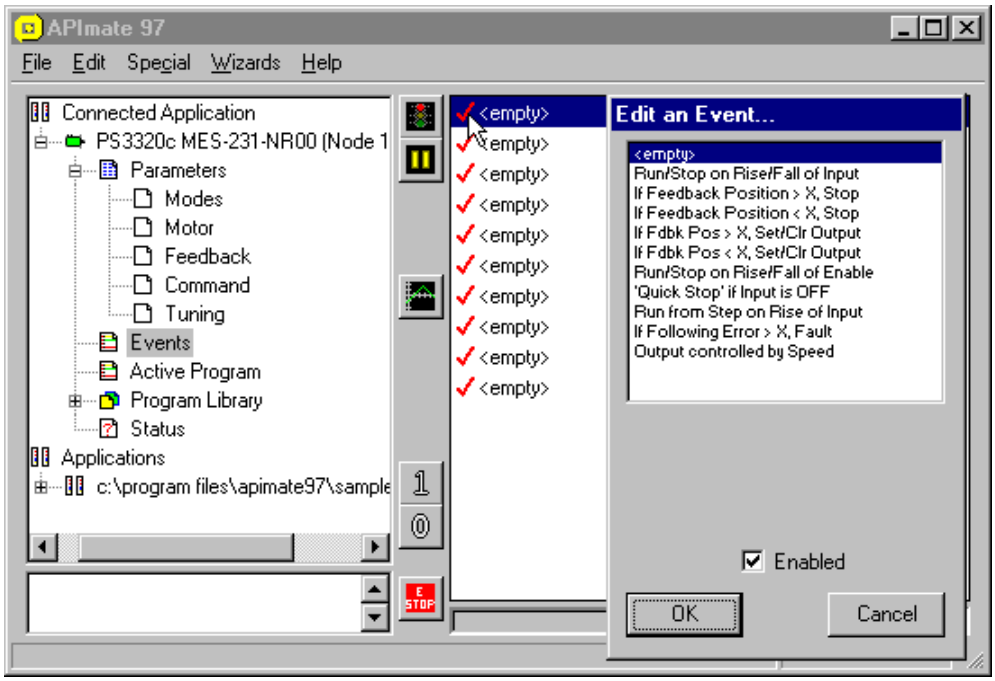


Figure 5-22 *APImate 2.0* ***Events - Run From Label on Active Input***

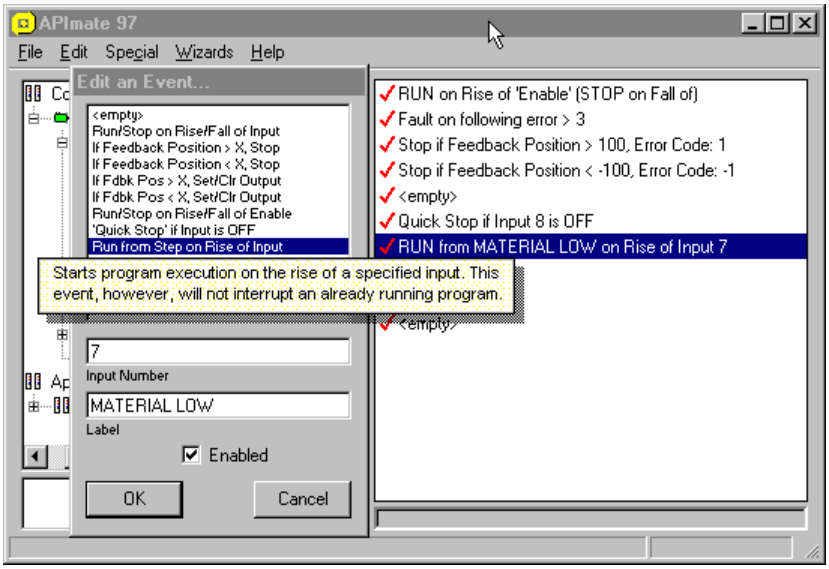
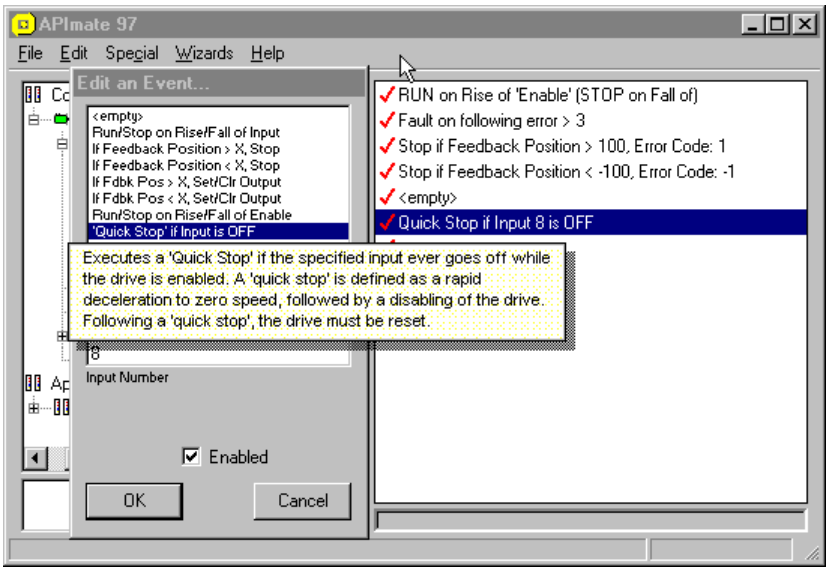


Figure 5-23 *APImate 2.0* ***Events - Quick Stop if Input is Off***

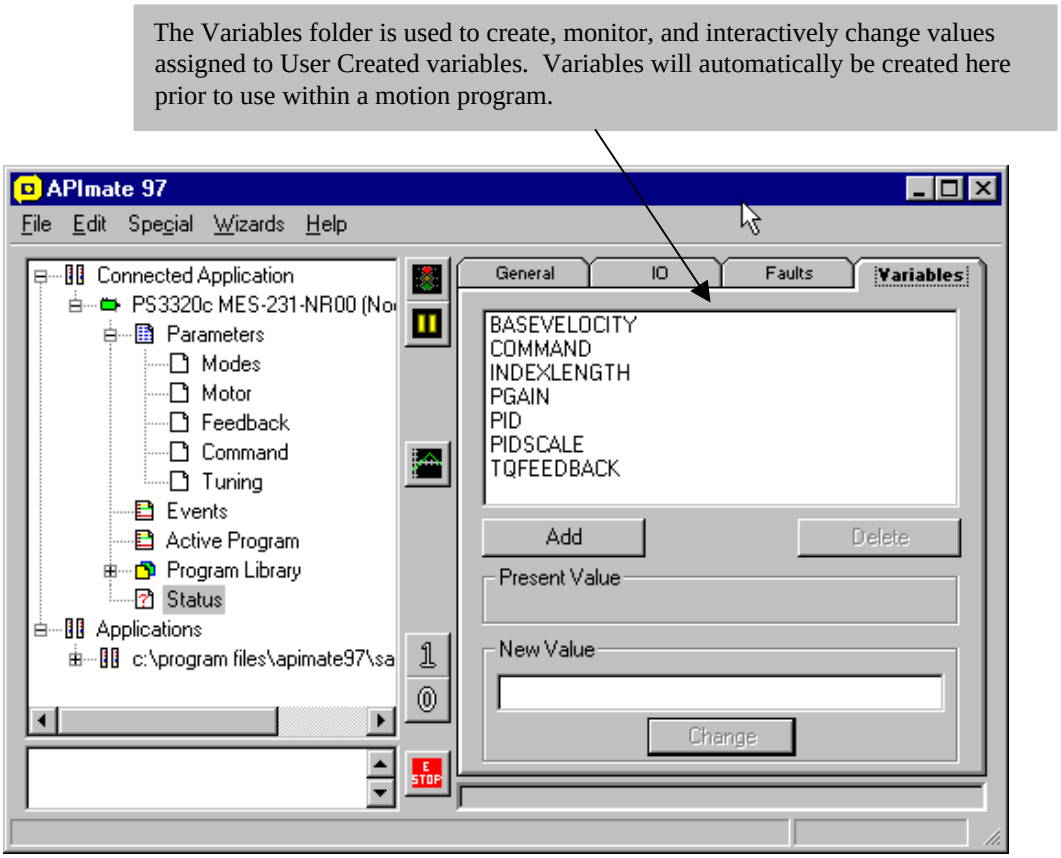


5.3.4 Amplifier Status

The amplifier Status Icon provides access to four folders that show the current status of the *Connected Application*.

Good programming practice is to create your motion program utilizing variable names in place of constants. This allows the user to edit the variable values without the need of editing the program. In addition, it allows the variable to be modified via the **T-330** Data Entry Terminal.

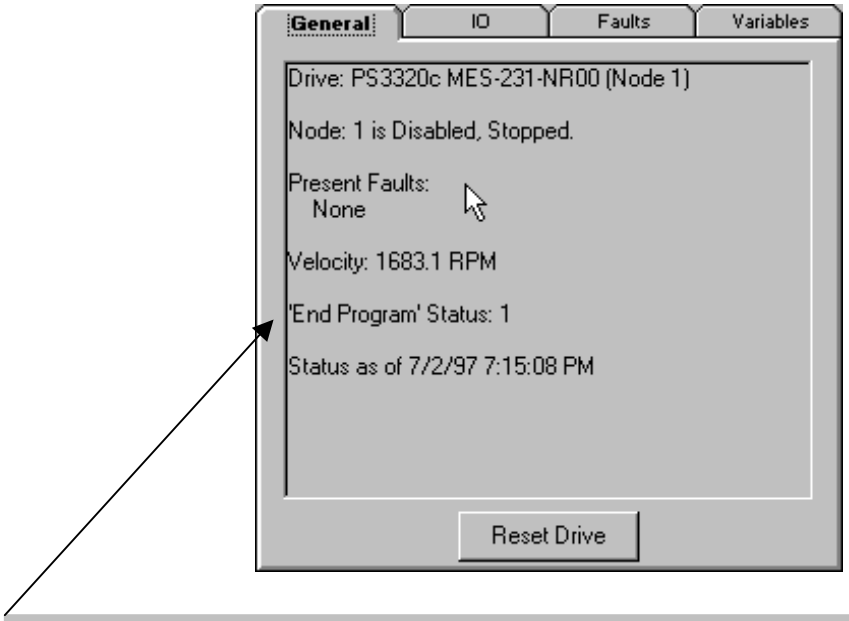
Figure 5-24 *APImate 2.0* ***Status - Folder for Variables***



The General Status folder shows the current status of the amplifier.

The amplifier can be software reset from this location without triggering the Reset Input or cycling power.

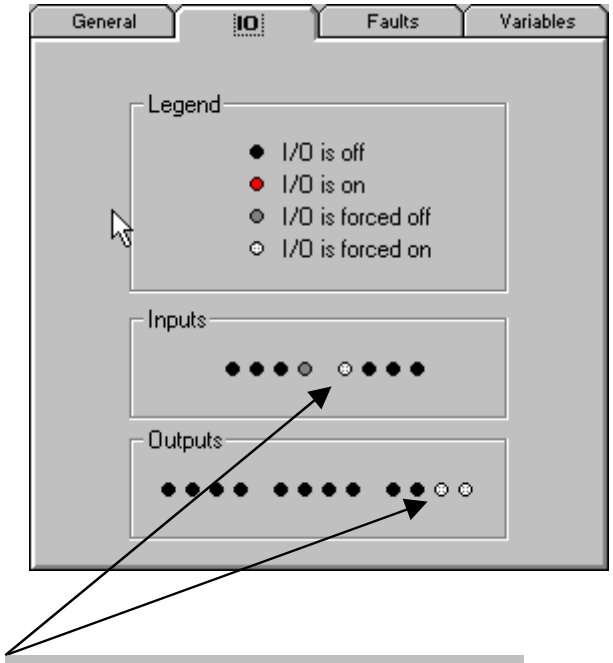
Figure 5-25 *APImate 2.0* ***Status - General***



The 'End Program' Status: shows the code returned from the current program of last fault status if non-zero. This is useful in determining the cause of program fault.

The I/O folder provides the current status of I/O points. This folder is extremely useful and allows the user to check the status of I/O points, force inputs and outputs ON and OFF to assist in system integration process.

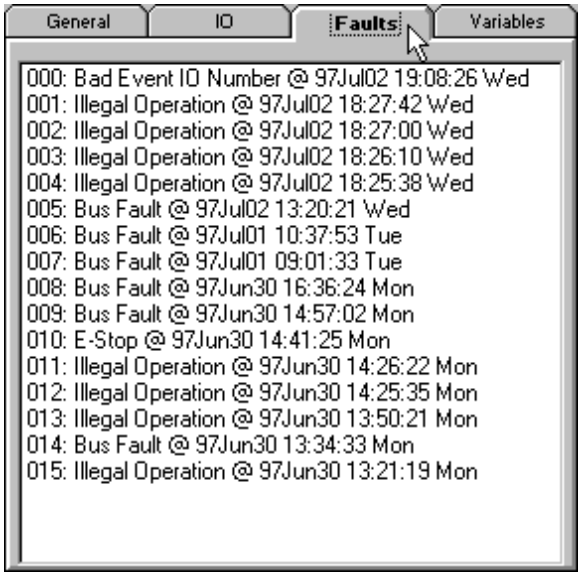
Figure 5-26 *APImate 2.0* ***Status - I/O***



To force a change in status of an input or output, click the mouse on the corresponding input or output indicator.

The Fault folder provides a history of system faults that resulted in the amplifier being disabled. Highlighting the fault and using the right-mouse key can access additional information regarding the particular fault selected.

Figure 5-27 *APImate 2.0* ***Status - Faults***

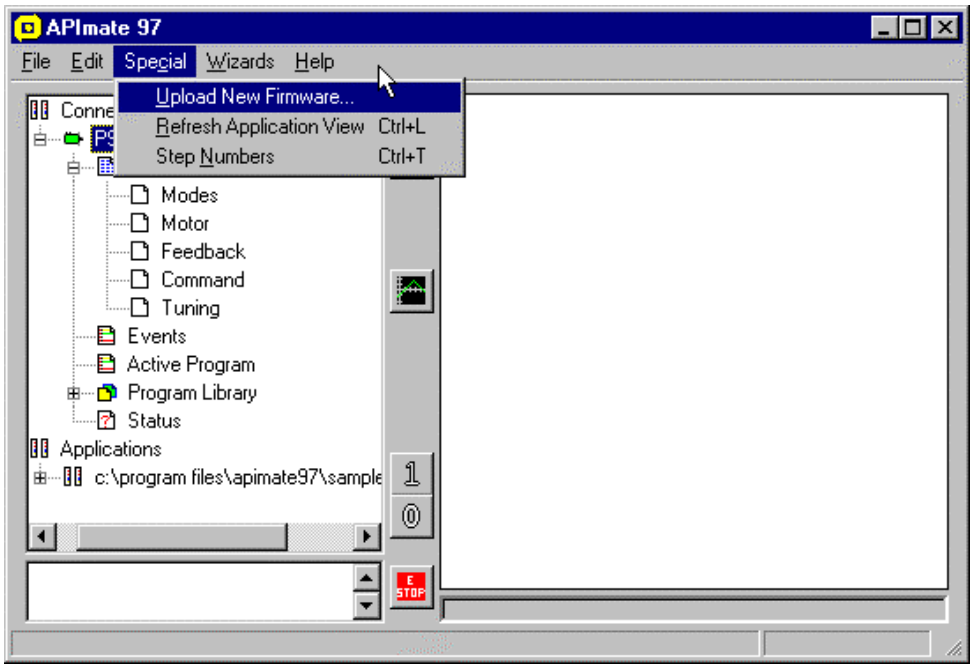


5.3.5 Special functions

Special functions are available when the mouse is placed on the green motor icon. When in the connected application view, the user may refresh the connected application view (reread the data from the connected application from the amplifier) or Upload New Firmware.

	WARNING
	***When uploading new firmware, the user is prompted to observe safety precautions to prevent accidental damage to the application. The amplifier will be disabled while the firmware is being copied into flash memory. POWER MUST NOT BE INTERUPTED DURING FIRMWARE UPLOAD!***

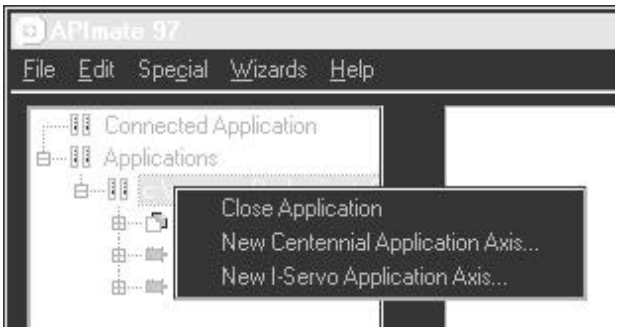
Figure 5-28 *APImate 2.0* ***Special Functions***



When positioned on the off-line Applications icon, a right-mouse click will prompt the user to create a new axis. Once created the user may utilize the Setup Wizard to configure the axis and adjust parameters to suit the new application.

We suggest that the user create an off-line application folder for each machine type. Axis created within this application folder can be utilized as a location to backup programs, parameters and events for the machine application.

Figure 5-29** APImate 2.0 **Create New Axis

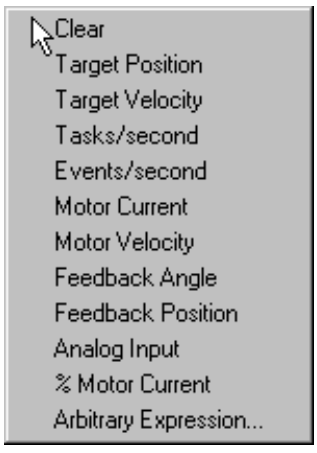


The System Monitor Window is active only when there is an amplifier in the connected application icon. The monitor window appears at the lower left-hand corner of the APImate Main-screen. The monitor window is updated approximately every one-half second.

Figure 5-30 *APImate 2.0* ***Monitor Window***

A double-left-mouse click will result in a menu of items being listed that the user may select from. The items that can be monitored are shown in the Monitor Menu below. An extremely useful tool is the ability to create Arbitrary Expressions. If the user wishes to monitor the value of analog input 1 minus the analog input 2, the arbitrary expression would be "ADC1-ADC2".

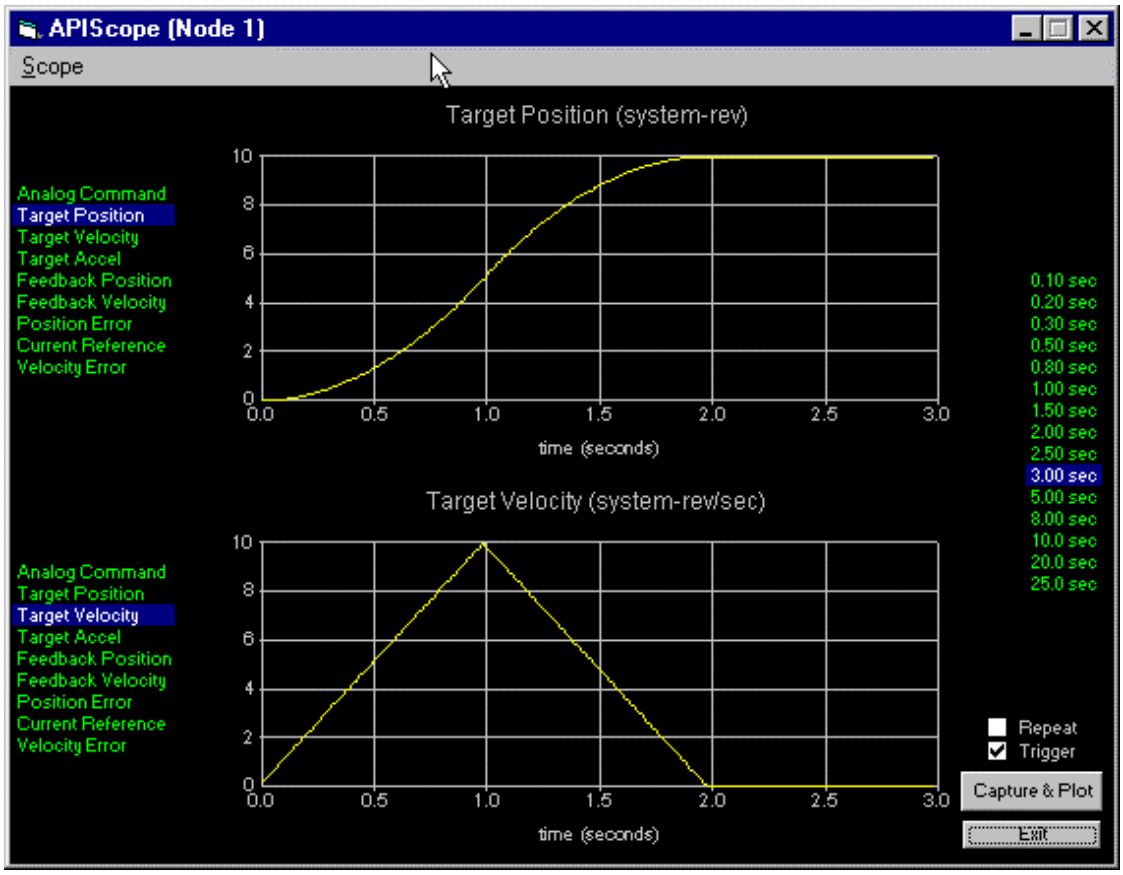
Figure 5-31 *APImate 2.0* ***Monitor Menu***



The APIscope icon is located on the center-bar and can only be accessed when in the Connected Application view. APIscope provides a graphic view of specific parameters that can be monitored as a function of time.

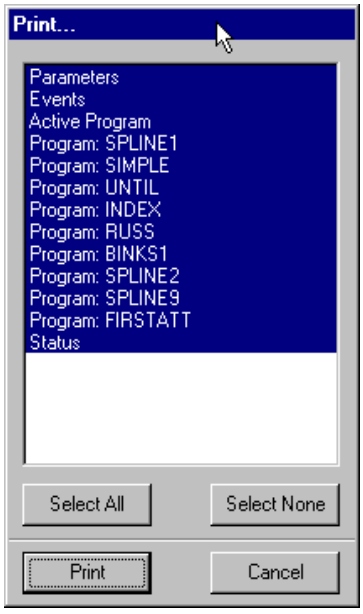
The features of Capture, Repeat, Trigger and Print are available for the collection of data. The Trigger command must be located within the motion program and can be found under the Utilities menu when creating/editing a program.

Figure 5-32 APIScope Target Position and Velocity



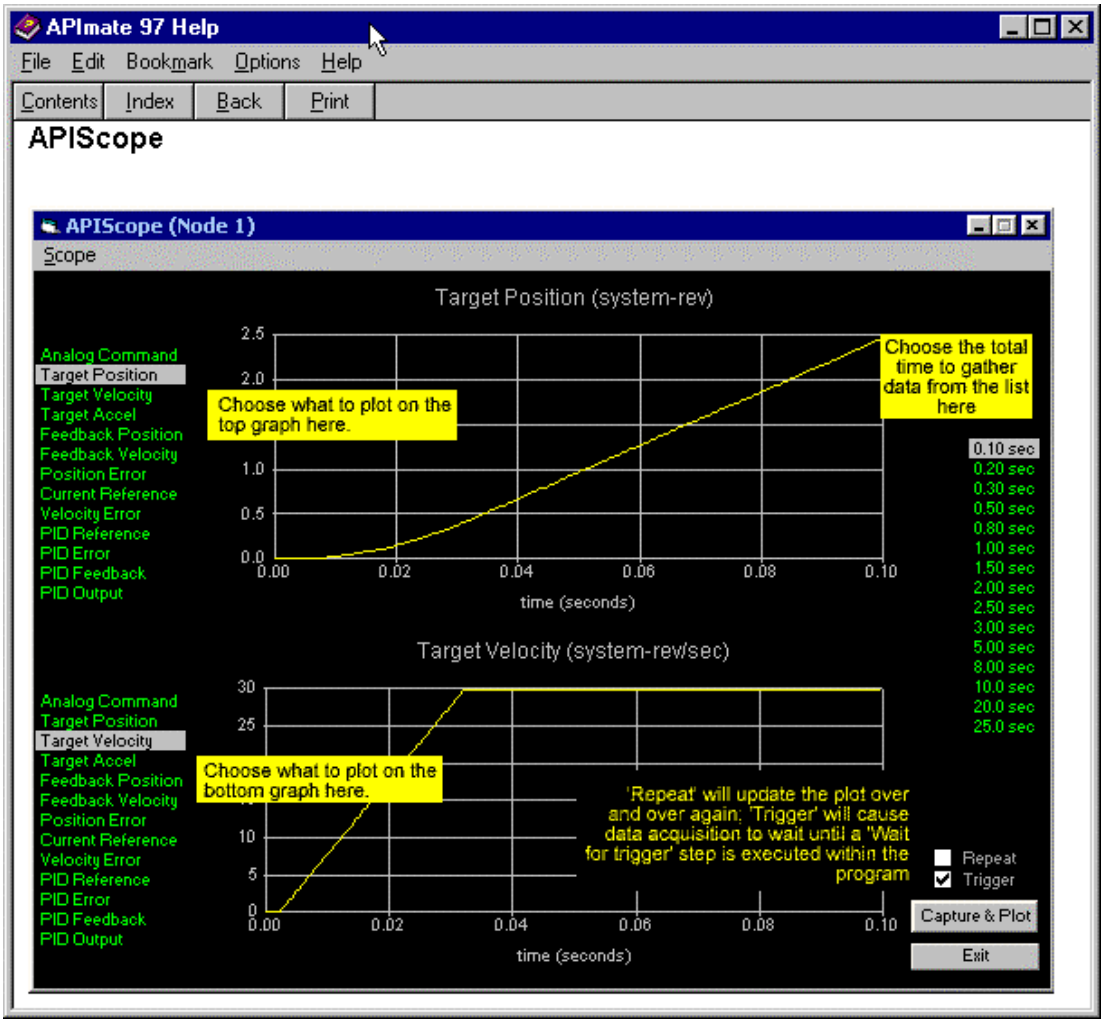
The system printer must be configured prior to printing application data. When located on an Application icon the user may access the print function via a right-mouse click. A Print Menu is displayed of all the items for a selected application. After selecting the items to be printed the print key is selected.

Figure 5-33 *APImate 2.0* ***File - Print***



APImate provides the user with complete online help to provide examples and descriptions of specific commands and functions. Where possible we have included graphic examples of features and functions.

Figure 5-34 *APImate 2.0* ***Help Screens***

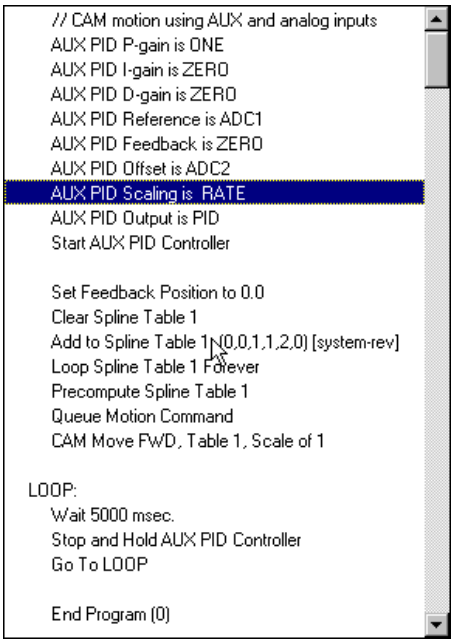


5.3.6 Active Program

The user must select the Active Program icon to view the currently active program. If a program exists then it will be displayed in the right window. If a program is not shown, the user can create a program by simply making a double left-mouse click in the right window. A menu of program commands will become available to assist in writing the program. Additional help screens are available via the right-mouse key.

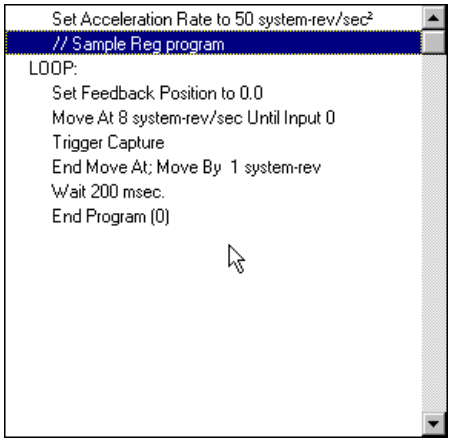
Below is an example of a CAM type motion being controlled through the two analog inputs and the Aux PID Loop.

Figure 5-35 *APImate 2.0* ***Program CAM-AUX-Analog***



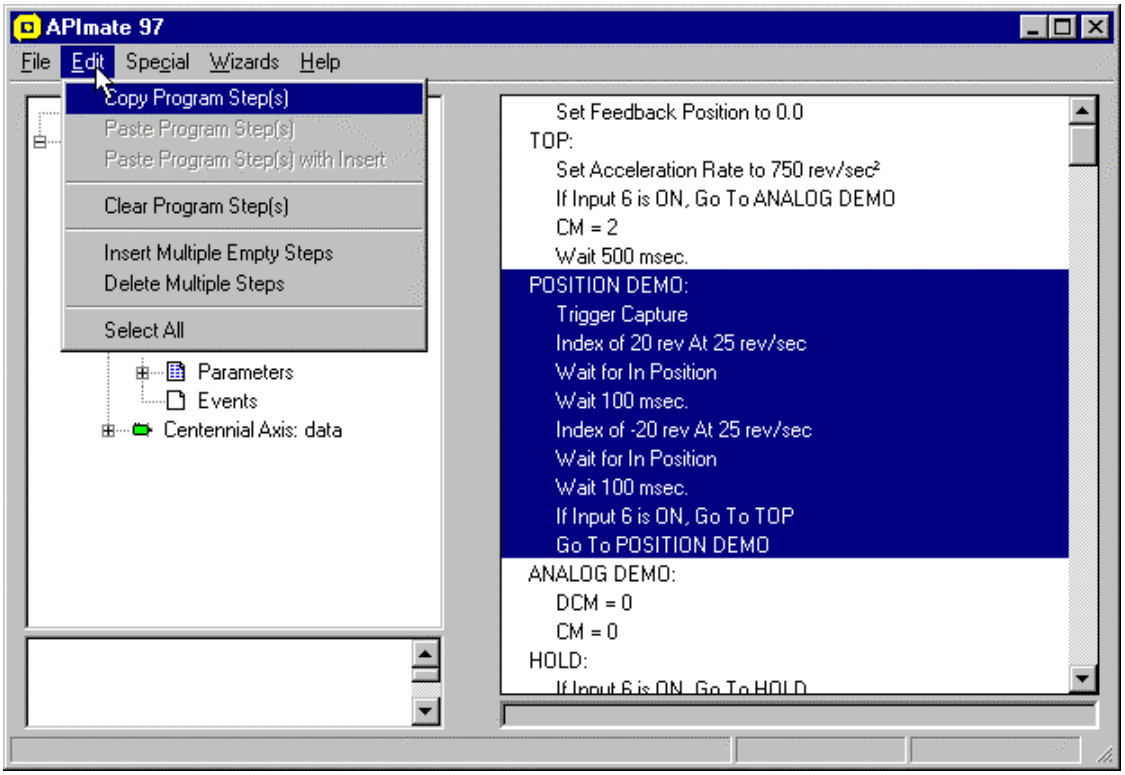
Below is an example of a program that may be used for Form Registration. The system moves continuously until an input is active, then moves an offset distance of one revolution, waits 200 ms, and stops.

Figure 5-36 *APImate 2.0* ***Program Reg***



APImate provides Copy, Clear, Insert and Delete functions that the user will find useful in editing programs. The ability to copy and insert program steps between application programs provides tools to create complex routines in a minimum of time.

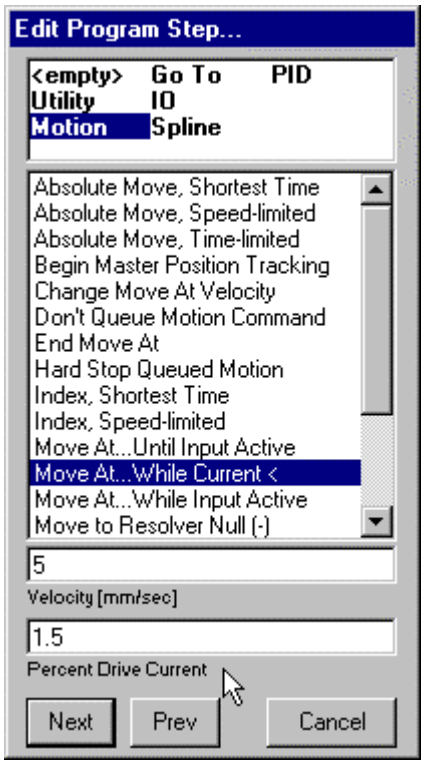
Figure 5-37 *APImate 2.0* ***Edit, Copy and Paste Functions***



APImate provides the user of the Intelligent and Centennial Controllers with menus of commands related to Utility, Motion, Logical, IO, Spline and PID functions.

A subset of the Motion commands are shown below, with an example of a Move at VELOCITY while current is less than X%. This command allows a "constant velocity move that is current limited while in a position loop". This type of motion may be used in applications where part is clamped via the motors motion.

Figure 5-38 *APImate 2.0* ***Edit Program Step***



5.3.7 Update New Firmware

A special feature of the PS-33xx series drive is the ability of the user to upgrade the FLASH Memory with new firmware. This feature is useful for performing field upgrades to units as software enhancements or custom commands are made available.

Functions are available when the mouse is placed on the green motor icon. When in the connected application view, the user may refresh the connected application view (reread the data from the connected application from the amplifier) or Upload New Firmware.

	WARNING
	***When uploading new firmware, the user is prompted to observe safety precautions to prevent accidental damage to the application. The amplifier will be disabled while the firmware is being copied into flash memory. POWER MUST NOT BE INTERUPTED DURING FIRMWARE UPLOAD!***

6. Maintenance/ Troubleshooting

This section summarizes the status and error codes that may be displayed on the PS-33xx Series Digital Servos. It also makes recommendations for troubleshooting and fault recovery procedures.

6.1 Status Display

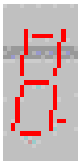
A seven segment display is located on the front of the PS-33xx Series amplifier to provide the user with information on the current status of the amplifier. If a fault condition exists that prevents the unit from performing its function, the seven-segment display will indicate the error code(s).

If multiple errors are present, the codes will scroll to allow you to determine the type of errors present.

Table 6.1 below shows the meaning of each code combination.

Table 6.1 Seven Segment Display

Display Segment	Status Description
API idnn	Logon display that occurs on power-up. The number nn indicates the unit's ID.
At	Amplifier over-temp fault, disabled. Verify condition exists, provide additional cooling, reduce motion requirements.
bF	Bus fault. The output is disabled due to an under voltage or over voltage condition.
CF	Configuration fault, disabled. Important system configuration parameters are missing.
d	Disabled, bus voltage not present. Enable input is not active.
E	Enabled, bus voltage is present.
FE	Following Error, stopped. Verify the moto'rs ability to meet the load requirements. Verify tuning parameters.
FL	Feedback Loss, disabled. Check wiring and function of feedback device.
HL	Hall Effect Loss, disabled. Check wiring and function of Hall device.
OS	Over-Speed fault, disabled. Verify control signal and load coupling.
Ot	Over-Temp motor fault, disabled. Verify condition exists, reduce motion requirements.
SF	Software Fault condition exists, disabled. Check program for errors.
SC	Short Circuit Fault. The output is disabled. Check for shorts in motor and power leads to the motor.
.	Blinking when processor is functional. If non-blinking, unit requires factory service.



6.2 Fault Recovery

Software faults are cleared when the RESET input is activated. Hardware faults are cleared ONLY after the condition has been cleared and the RESET input is activated.

Overspeed	The motor's velocity has exceeded the value in the OSPD (overspeed) parameter.
E/Quick-Stop	Either an event, communications or an input has caused a quick-stop or e-stop condition.
End Program Fault	The program has ended with a non-zero "End Program" value.
Bad Var/Label	A variable specified in an expression does not exist. A variable specified in an expression is read-only, and cannot be changed. The target label of a "Goto" does not exist. The target label of a "Call" does not exist.
Bad Expression	There was an error attempting to evaluate an expression. The usual cause is an ill-formed expression, an expression with spaces or other illegal characters, or possibly missing, illegally-specified or undefined variables.
Feedback Loss	A signal is missing for motor feedback.
Bad IO Number	An illegal value was specified for an input or an output in a command. Each drive has a specified limited number of IO points which are available for general use.
Bad Event IO Number	An illegal value was specified for an input or output in an event. Each drive has a specified limited number of IO points which are available for general use.
Invalid Argument	An expression has evaluated to a value not legal for the command or context it is used in. For example, a negative time in a command which needs a positive, non-zero time.

Spline Error

The number of points in a spline table is less than 3; at least three points make up a spline table.
The specified spline table does not exist. Depending on the drives configuration, there are a limited number of spline tables available to load data into. Typically, there are four such tables, numbered zero (0) through three (3).
The number of points specified in a "Spline Table Re-Allocate" exceeds the available memory dedicated to spline tables.
There is no space available in a spline table to add anymore data points; this error occurs in the "Add to spline table" command. Either reduce the number of points, or use the "Re-Allocate" command to increase the size of the spline table.
The "X" value in an "Add…" command is less than or equal to the last point which was added to the table. Spline table "X" values (either time or master position) must be increasing in value.

Following Error

An event which monitors following error (the difference between the target position and the feedback position) has shut down the drive because the limit specified in the event has been exceeded. Either increase the value programmed in the event, or reduce the acceleration rate, speed or time-requirement for the programmed motion.

Illegal Operation

An attempt was made to start or stop motion when the drive is not in position mode.
A specified time period is negative or zero.
A variable which was specified in a PID or "Slew Variable" command does not exist.
An attempt was made to stop motion when the drive has executing a "Move At". Such commands need to be terminated with a corresponding "End Move At" command.
An attempt was made to use a "Hard/Soft Stop Queued Motion" command when the drive was not queuing motion.
An attempt was made to enter "Master Position Tracking Mode" when the drive was not in position mode, or the drive was in a continuous move, or the drive was executing a queued motion command.
Another "Slew Variable" instruction was encountered before the first had completed. Only one such command may be active at a time.
" Wait for In Position" was executed within a "Move At" block.
An attempt was made to execute a spline or CAM command when the system was already executing one.
Arguments specified in a "Move At" or related command are not valid.
Arguments specified in a "Move" command do not make sense.
Too many Call's have occurred.
A Return has occurred without a Call.
A variable specified for DAC related commands does not exist.

Short Circuit Fault	An amplifier fault has occurred in the power transistor stage.
Bus Fault	An bus-related amplifier fault has occurred.
Amplifier Overtemp	The drive shutdown because internal thermal limits have been exceeded.
Motor Overtemp	The motor overtemperature thermal switch has been tripped. If the motor does not have such protection, change the value of the COT parameter, which controls whether or not the thermal switch input should be examined.

7. Appendices

The information contained in the following appendices is provided for reference purposes.

7.1 Product Specifications

7.1.1 Mounting Assembly Outline Dimensions

Figure 7-1 Outline Dimensions PS-3303/PS-3306d/i

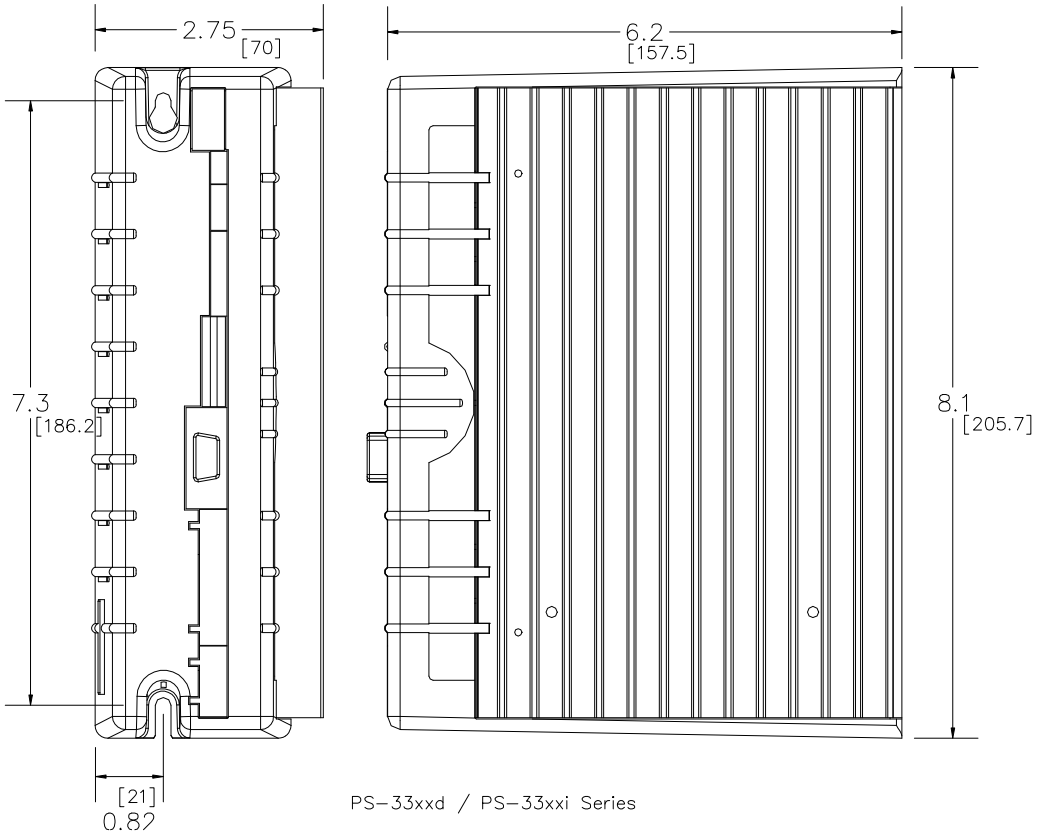


Figure 7-2 Outline Dimensions PS-3306c/PS-3310/PS-3320

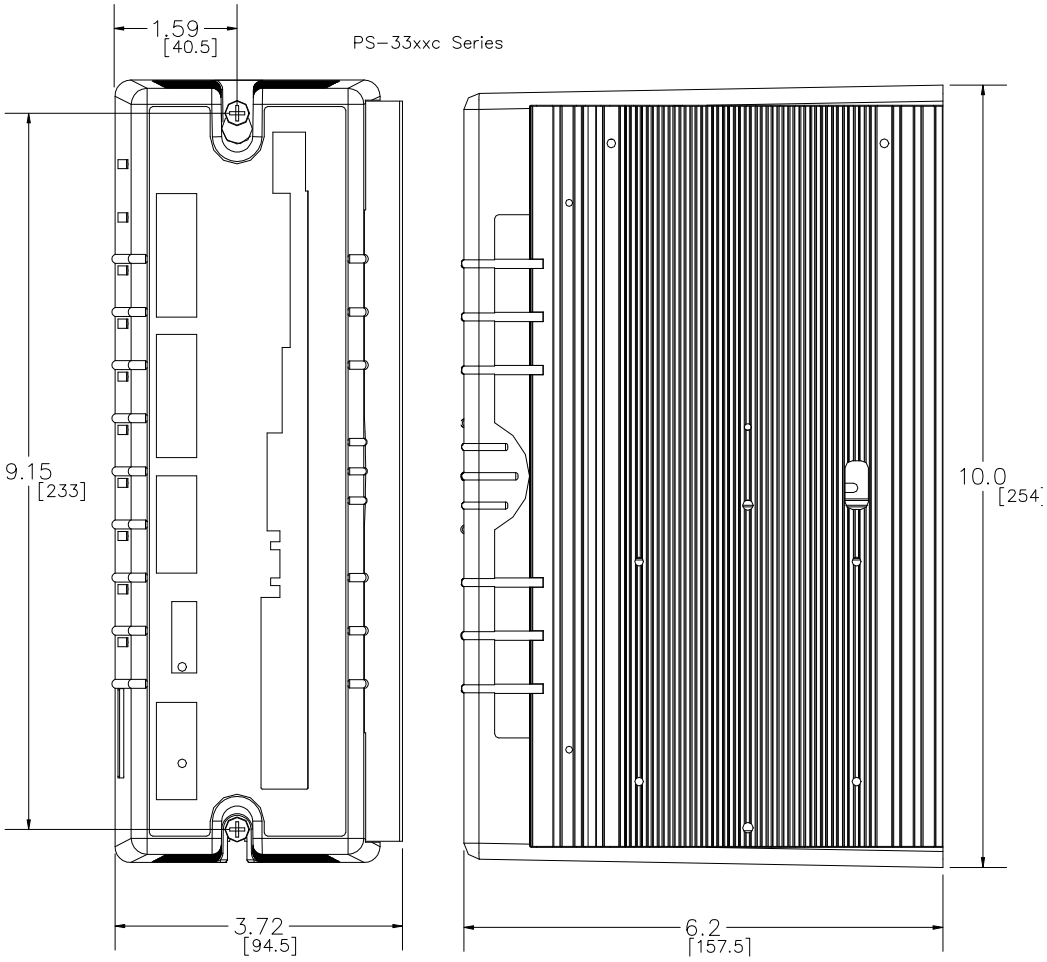


Figure 7-3 Drive Part Number Configuration

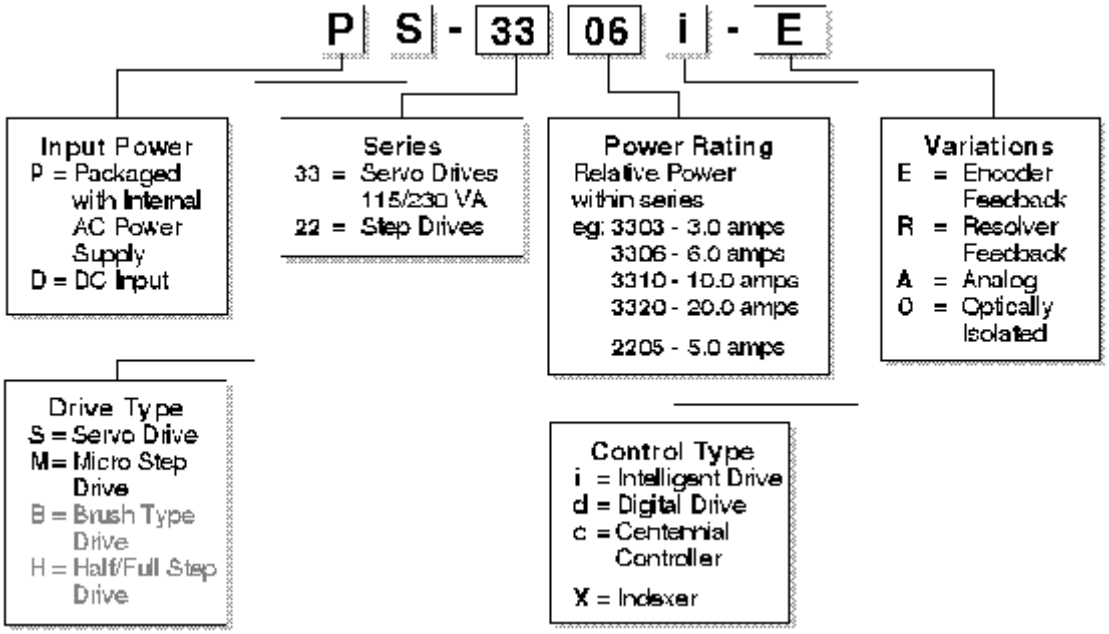
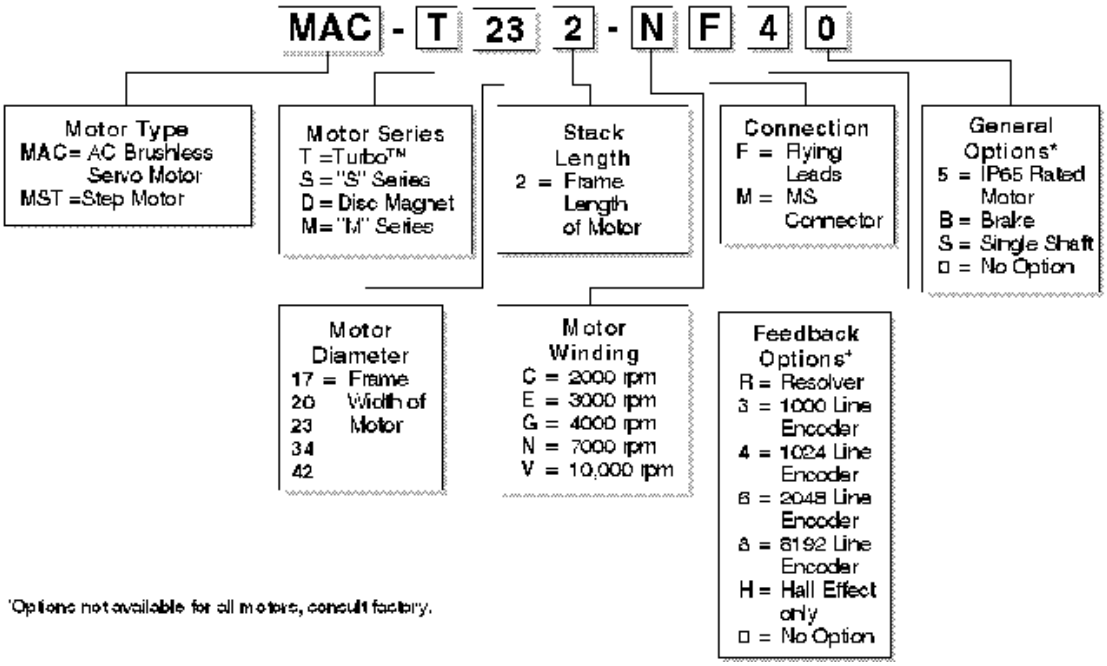


Figure 7-4 Motor Part Number Configuration



7.1.2 AC Motor Specifications

Table 7.2 M Series AC Servo Motors

"Metric" Series Servo Motors

PS-33xxd-E, PS-33xxi-E and PS-33xxc-E models only

Part Number	Torque (lb-in)	Torque (N-m)	Cont. (RPM)	Peak (RPM)	Rated Power (watt)	Feedback Device	Inertia (Kg-m2)	Kt (Nm/Amp)	Amps Cont. RMS	Amps Peak RMS
MAC-M161-HM60	2.81	0.32	3000	4500	100	2048 line encoder	0.000007	0.39	0.89	2.8
MAC-M241-HM60	5.64	0.64	3000	4500	200	2048 line encoder	0.000021	0.35	2.00	6.0
MAC-M242-HM60	11.24	1.27	3000	4500	400	2048 line encoder	0.000035	0.54	2.60	8.0
MAC-M312-HM60	21.15	2.39	3000	4500	750	2048 line encoder	0.000211	0.64	4.10	13.9
MAC-M511-EM80	48.00	5.42	1500	3000	850	8192 line encoder	0.001390	0.83	7.10	17.0
MAC-M512-EM80	74.00	8.36	1500	3000	1,310	8192 line encoder	0.002500	0.84	10.70	28.0
MAC-M711-EM80	102.00	11.52	1500	3000	1,810	8192 line encoder	0.003170	0.73	16.70	42.0
MAC-M712-EM80	165.00	18.64	1500	3000	2,930	8192 line encoder	0.004600	0.83	23.80	56.0

Motors have front shaft seal and keyed.
Class B, UL

Part Number	"U" (mm)	"AH" (mm)	"K1" (mm)	"K2" (mm)	"A" (mm)	"AK" (mm)	"BB" (mm)	"BF" (mm)	"AJ" (mm)	"AG" (mm)	Weight (kg)
MAC-M161-HM60	8	25	3	14	40	30	2.5	2-4.3	46	94.5	0.5
MAC-M241-HM60	14	30	5	20	60	50	3	5.5	70	96.5	1.1
MAC-M242-HM60	14	30	5	20	60	50	3	5.5	70	124.5	1.7
MAC-M312-HM60	16	40	5	30	80	70	3	7	90	145	3.4
MAC-M511-EM80	19	58	5	25	130	110	6	9	145	161	7.6
MAC-M512-EM80	22	58	6	25	130	110	6	9	145	185	9.6
MAC-M711-EM80	35	79	10	60	180	114.3	3.2	13.5	200	166	14
MAC-M712-EM80	35	79	10	60	180	114.3	3.2	13.5	200	192	18

Part Number	Power Con	Plug	Socket or Clamp	FB Con.	Plug	Socket or Clamp
MAC-M161-HM60	172167-1	192159-1	170361-1 (4)	172169	172163-1	170361-1 (9)
MAC-M241-HM60	172167-1	192159-1	170361-1 (4)	172169	172163-1	170361-1 (9)
MAC-M242-HM60	172167-1	192159-1	170361-1 (4)	172169	172163-1	170361-1 (9)
MAC-M312-HM60	172167-1	192159-1	170361-1 (4)	172169	172163-1	170361-1 (9)
MAC-M511-EM80	MS3102A18-10P	MS3106B18-10S	MS3057-10A	MS3102A20-29P	MS3106B20-29S	MS3057-12A
MAC-M512-EM80	MS3102A18-10P	MS3106B18-10S	MS3057-10A	MS3102A20-29P	MS3106B20-29S	MS3057-12A
MAC-M711-EM80	MS3102A22-22P	MS3106B22-22S	MS3057-12A	MS3102A20-29P	MS3106B20-29S	MS3057-12A
MAC-M712-EM80	MS3102A22-22P	MS3106B22-22S	MS3057-12A	MS3102A20-29P	MS3106B20-29S	MS3057-12A

Figure 7-5 Drawing MAC-M Series

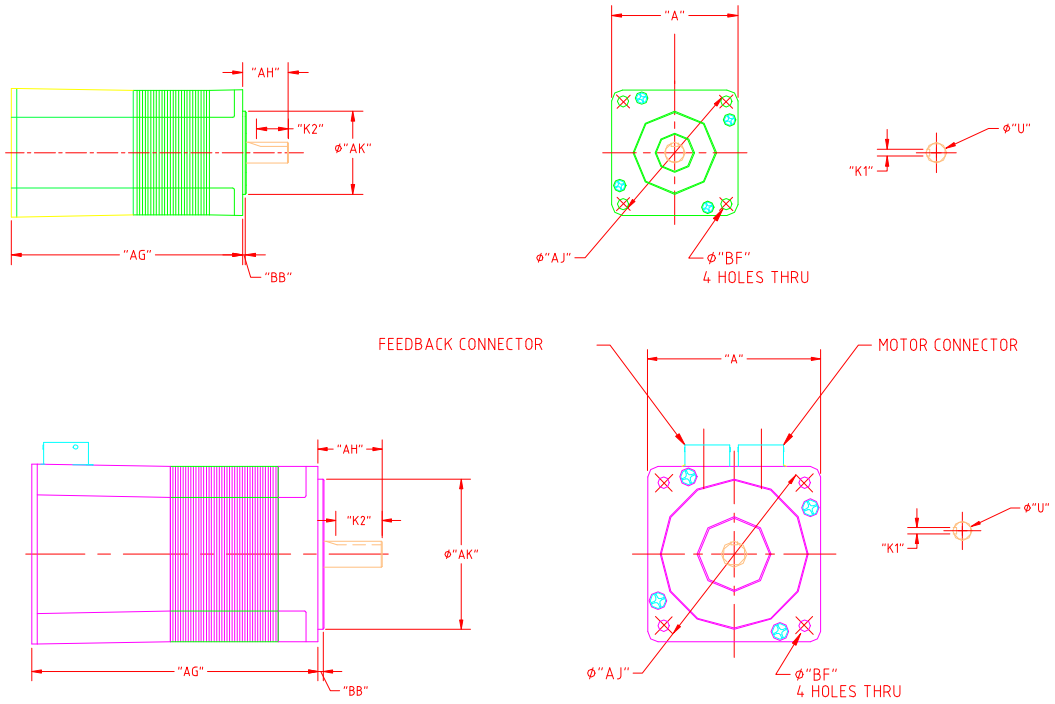


Table 7.3 S Series AC Servo Motors

"S" or M400 Series Servo Motors

PS-33xxi-R and PS-33xxc-R models only

						40C Ambient Ratings		
Part Number	**Torque (lb-in)**	**Torque (N m)**	**Cont. (RPM)**	**Peak (RPM)**	**Rated Power (watt)**	**Feedback Device**	**Inertia (Kg-m2)**	**Kt (Nm/Amp)**
MAC-S431-NMR0	12.20	1.38	5500	7000	790	2 Pole Resolver	0.00007	0.45
MAC-S432-NMR0	24.40	2.76	5500	7000	1,590	2 Pole Resolver	0.00012	0.48
MAC-S442-GMR0	36.70	4.15	3000	4000	1,300	2 Pole Resolver	0.00041	0.79
MAC-S443-GMR0	48.90	5.52	3000	4000	1,740	2 Pole Resolver	0.00051	0.85
MAC-S444-GMR0	68.60	7.75	3000	4000	2,430	2 Pole Resolver	0.00063	0.82
MAC-S462-GMR0	108.00	12.20	3000	4000	3,830	2 Pole Resolver	0.00203	0.82
MAC-S463-EMR0	154.00	17.40	2500	3600	4,560	2 Pole Resolver	0.00282	0.96
MAC-S464-EMR0	194.00	21.92	1700	3000	3,900	2 Pole Resolver	0.00361	1.04

Part Number	**"U" (mm)**	**"AH" (mm)**	**"K1" (mm)**	**"K2" (mm)**	**"A" (mm)**	**"AK" (mm)**	**"BB" (mm)**	**"BF" (mm)**	**"AJ" (mm)**	**"AG" (mm)**
MAC-S431-NMR0	14	30	5	20	86	80	3	7	100	250
MAC-S432-NMR0	14	30	5	20	86	80	3	7	100	289
MAC-S442-GMR0	19	40	6	30	109.2	95	3	9	115	265
MAC-S443-GMR0	19	40	6	30	109.2	95	3	9	115	303
MAC-S444-GMR0	19	40	6	30	109.2	95	3	9	115	341
MAC-S462-GMR0	24	50	8	40	152.4	130	3.5	12	165	291
MAC-S463-EMR0	24	50	8	40	152.4	130	3.5	12	165	329
MAC-S464-EMR0	24	50	8	40	152.4	130	3.5	12	165	367

Part Number	**Power Con**	**Plug Kit (IP67)**	**Plug**	**FB Con.**	**Plug Kit (IP67)**	**Plug**
MAC-S431-NMR0	MS3112E14-5P	175-6F15-S01	MS3116F-14-5S	MS3112E14-18P	175-6F15-S02	MS3116F-14-18S
MAC-S432-NMR0	MS3112E14-5P	175-6F15-S01	MS3116F-14-5S	MS3112E14-18P	175-6F15-S02	MS3116F-14-18S
MAC-S442-GMR0	MS3112E14-5P	175-6F15-S01	MS3116F-14-5S	MS3112E14-18P	175-6F15-S02	MS3116F-14-18S
MAC-S443-GMR0	MS3112E14-5P	175-6F15-S01	MS3116F-14-5S	MS3112E14-18P	175-6F15-S02	MS3116F-14-18S
MAC-S444-GMR0	MS3112E14-5P	175-6F15-S01	MS3116F-14-5S	MS3112E14-18P	175-6F15-S02	MS3116F-14-18S
MAC-S462-GMR0	MS3102E-24-22P	175-6F24-S01	MS3106F24-22S	MS31202E-24-28P	175-6F24-S02	MS3106F-24-28S
MAC-S463-EMR0	MS3102E-24-22P	175-6F24-S01	MS3106F24-22S	MS31202E-24-28P	175-6F24-S02	MS3106F-24-28S
MAC-S464-EMR0	MS3102E-24-22P	175-6F24-S01	MS3106F24-22S	MS31202E-24-28P	175-6F24-S02	MS3106F-24-28S

Figure 7-6 Drawing MAC-S Series

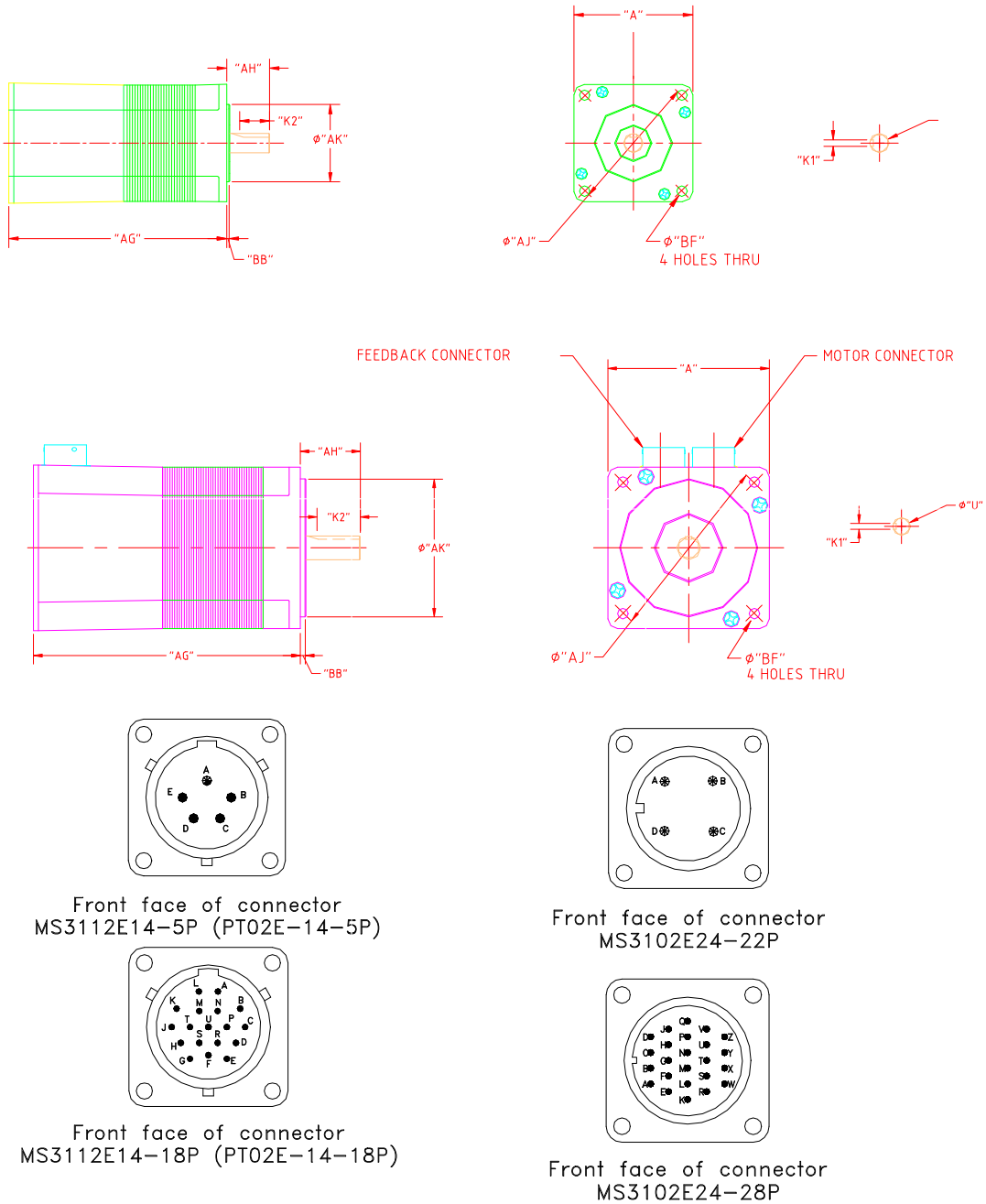


Table 7.4 T Series AC Servo Motors

Turbo Servo Motors

PS-33xxd-E, PS-33xxi-E and PS-33xxc-E models only

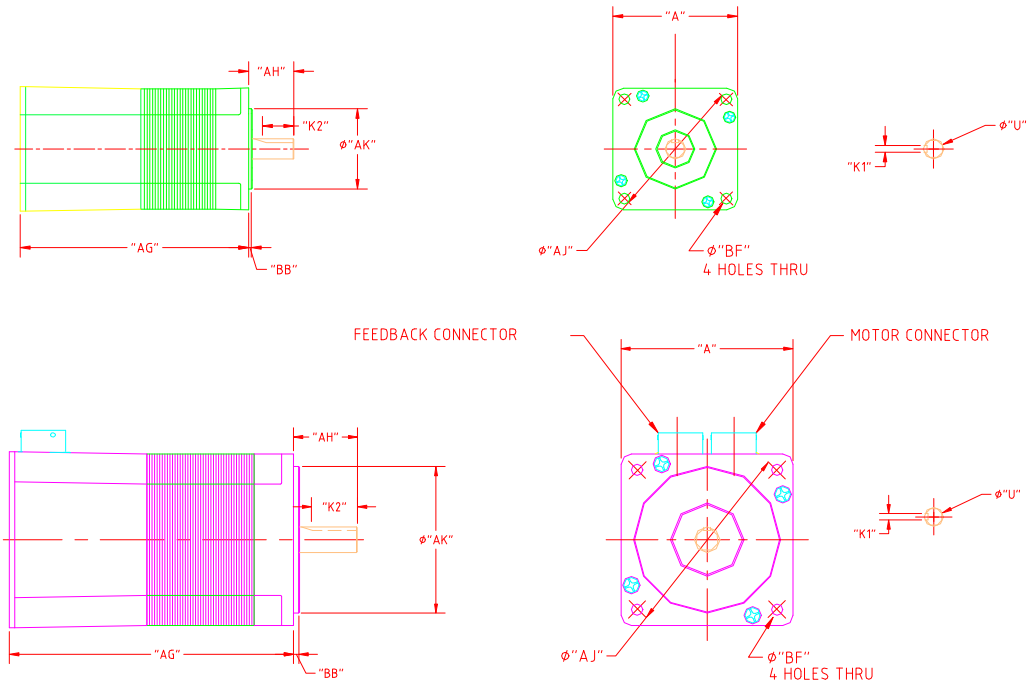
Part Number	Torque (lb-in)	Torque (N-m)	Cont. (RPM)	Peak (RPM)	Rated Power (watt)	Feedback Device	Inertia (Kg-m2)	Kt (Nm/Amp)	Amps Cont. RMS	Amps Peak RMS
MAC-T171-NF40	2.15	0.24	5500	7000	140	Halls/1024 line encoder	0.000009	0.54	0.45	1.35
MAC-T172-NF40	3.95	0.45	5500	7000	260	Halls/1024 line encoder	0.000019	0.47	0.94	2.82
MAC-T231-NF40	5.09	0.58	5500	7000	330	Halls/1024 line encoder	0.000018	0.54	1.06	3.18
MAC-T232-NF40	9.71	1.10	5500	7000	630	Halls/1024 line encoder	0.000035	0.53	2.07	6.21
MAC-T233-NF40	13.17	1.49	5500	7000	860	Halls/1024 line encoder	0.000052	0.52	2.85	8.55
MAC-T341-GM60	19.62	2.22	3250	4000	750	Halls/2048 line encoder	0.000130	0.92	2.42	7.26
MAC-T342-GM60	32.37	3.66	3250	4000	1,240	Halls/2048 line encoder	0.000250	0.90	4.09	12.27
MAC-T343-GM60	47.77	5.40	3250	4000	1,840	Halls/2048 line encoder	0.000380	1.00	5.38	16.14
MAC-T422-GM60	72.07	8.14	2500	4000	2,130	Halls/2048 line encoder	0.000770	1.00	8.18	24.54
MAC-T423-GM60	91.94	10.39	2500	4000	2,720	Halls/2048 line encoder	0.001200	0.92	11.30	33.90

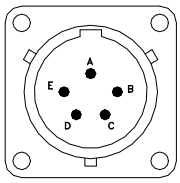
Flying Leads on size 17 and 23, MS connectors on size 34 and 42
IP55 Rating

Part Number	"U" (in)	"AH" (in)	"K1" (in)	"K2" (in)	"A" (in)	"AK" (in)	"BB" (in)	"BF" (in)	"AJ" (in)	"AG" (in)	Weight (lbs)
MAC-T171-NF40	0.250	0.75	N/A	N/A	1.69	0.875	0.06	0.149	2.000	3.69	2.0
MAC-T172-NF40	0.250	0.75	N/A	N/A	1.69	0.875	0.06	0.149	2.000	4.96	2.2
MAC-T231-NF40	0.375	0.82	0.094	0.50	2.27	1.500	0.06	0.200	2.625	4.19	2.9
MAC-T232-NF40	0.500	0.82	0.125	0.50	2.27	1.500	0.06	0.200	2.625	5.19	3.3
MAC-T233-NF40	0.500	0.82	0.125	0.50	2.27	1.500	0.06	0.200	2.625	6.19	4.0
MAC-T341-GM60	0.500	1.20	0.125	0.88	3.36	2.875	0.12	0.220	3.875	5.42	6.2
MAC-T342-GM60	0.500	1.20	0.125	0.88	3.36	2.875	0.12	0.220	3.875	6.92	10.6
MAC-T343-GM60	0.500	1.20	0.125	0.88	3.36	2.875	0.12	0.220	3.875	8.42	16.9
MAC-T422-GM60	0.625	1.30	0.1875	0.80	4.38	2.186	0.13	0.300	4.950	8.53	23.8
MAC-T423-GM60	0.625	1.30	0.1875	0.80	4.38	2.186	0.13	0.300	4.950	10.53	33.9

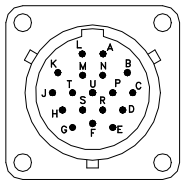
Part Number	Power Con	Plug	Sockets	FB Con.	Plug	Sockets
MAC-T171-NF40	172167-1	192159-1	170361-1 (4)	172171-1	172163-1	170361-1 (15)
MAC-T172-NF40	172167-1	192159-1	170361-1 (4)	172171-1	172163-1	170361-1 (15)
MAC-T231-NF40	172167-1	192159-1	170361-1 (4)	172171-1	172163-1	170361-1 (15)
MAC-T232-NF40	172167-1	192159-1	170361-1 (4)	172171-1	172163-1	170361-1 (15)
MAC-T233-NF40	172167-1	192159-1	170361-1 (4)	172171-1	172163-1	170361-1 (15)
MAC-T341-GM60	MS3112E14-5P	MS3116F-14-5S		MS3112E14-18P	MS3116F-14-18S	
MAC-T342-GM60	MS3112E14-5P	MS3116F-14-5S		MS3112E14-18P	MS3116F-14-18S	
MAC-T343-GM60	MS3112E14-5P	MS3116F-14-5S		MS3112E14-18P	MS3116F-14-18S	
MAC-T422-GM60	MS3112E14-5P	MS3116F-14-5S		MS3112E14-18P	MS3116F-14-18S	
MAC-T423-GM60	MS3112E14-5P	MS3116F-14-5S		MS3112E14-18P	MS3116F-14-18S	

7- Drawing MAC-T Series





Front face of connector
MS3112E14–5P (PT02E–14–5P)



Front face of connector
MS3112E14–18P (PT02E–14–18P)

7.2 Motor Feedback Specification

If the customer is utilizing a motor not supplied by API Controls then specific care must be taken to ensure that the motor feedback is compatible and able to interface to the PS-33xx series controllers.

It is the responsibility of the user to ensure compatibility.

7.2.1 Standard Resolver Specification

Resolver		
	Value	**Units**
Input Voltage	7.5	volts
Input Current (max)	58	mamp
Input Power	0.26	watts
Impedance Z-r0	75+j150	ohm
Impedance Z Sine	600+j985	ohm
Impedance Z-Cos	560+j870	ohm
Transformation Ratio	1.000	-----
Output Voltage	7.5	volts
D.C. Rotor Resistance	25	ohm
D.C. Stator Resistance	360	ohm
Sensitivity	262	mv/degree
Phase Shift (open circuit)	6	degree
Null Voltage (total)	30	RMS mv
Phase shift with Temp Drift	0.4	%/C

7.2.2 Commutating Encoder Specification

Encoder/Hall	Value	Units
Encoder		
Input Voltage	5	volts
Input Current (max)	135	mamp
Operating Frequency	200	kHz max
Output Device	26LS31	
Sink/Source, (nominal)	20	mamp
Suggested Interface	26LS32	
Alignment (Z-Channel)	See Note 1	
HALL		
Input Voltage	5	volts
Input Current (max)	80	mamp
Output Device	LM339	
Sink (max)	16	mamp
Alignment (HALL1)	See Note 2	

[1] Low-to-High transition of Z-Channel aligns with positive going zero-crossing of motor Phase-A to neutral back-emf waveform.

[2] Low-to-High transition of HALL1 aligns with positive going zero-crossing of motor Phase-A to Phase-C back-emf waveform.

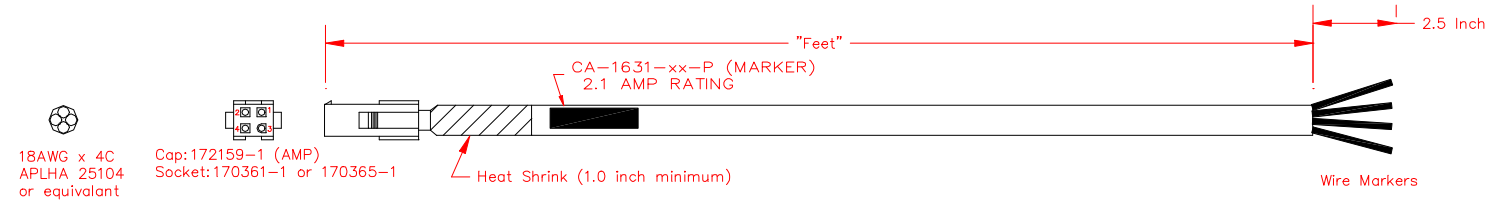
7.2.3 Motor Connector Wiring

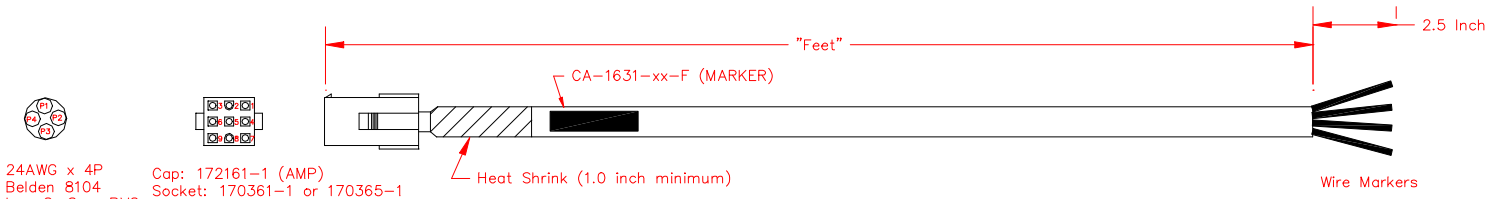
Motor Cable Selection Table		
Purpose	**Description**	**Motor Series**
CS-1723-010	CABLE SET, PWR/FB, T17,T23, 10 FT	MAC-T17x/MAC-T23x
CS-1723-025	CABLE SET, PWR/FB, T17,T23, 25 FT	MAC-T17x/MAC-T23x
CS-3442-010	CABLE SET, PWR/FB, T34,T42, 10 FT	MAC-T34x/MAC-T42x
CS-3442-025	CABLE SET, PWR/FB, T34,T42, 25 FT	MAC-T34x/MAC-T42x
CS-5666-010	CABLE SET, PWR/FB, T56,T66, 10 FT	MAC-T56x/MAC-T66x
CS-5666-025	CABLE SET, PWR/FB, T56,T66, 25 FT	MAC-T56x/MAC-T66x
CS-1631-10	CABLE SET, PWR/FB, M16, M24,M31, 10 FT	MAC-M16x/M24x/M31x
CS-1631-25	CABLE SET, PWR/FB, M16, M24,M31, 25 FT	MAC-M16x/M24x/M31x
CS-5100-010	CABLE SET, PWR/FB, M51, 10 FT	MAC-M51x
CS-5100-025	CABLE SET, PWR/FB, M51, 25 FT	MAC-M51x
CS-7100-010	CABLE SET, PWR/FB, M71, 10 FT	MAC-M71x
CS-7100-025	CABLE SET, PWR/FB, M71, 25 FT	MAC-M71x

PART NUMBER	NEXT ASSY.
CS-1631-xx	None

REVISIONS				
REV	ECO	DESCRIPTION	DATE	BY
B	ECO257	Change vendor, wire spec and marker	4/19/98	RMF

Motor	Marker	Color
1	U	Black
2	V	Red
3	W	White
4	GND	Green





Feedback	Marker	Conductor Pair
1	A+	P1
2	A-	P1
3	B+	P2
4	B-	P2
5	Z+	P3
6	Z-	P3
7	+5 Ret	P4
8	+5 Vdc	P4
9	SHIELD	Shield

CS-1631-xx (xx = feet, +1.5/-0.0 inch)

Cable Set includes one each of the above cables packaged in a plastic bag.
Plastic bag is marked with the cable set CS-1631-xx part number.

API Controls
45 Hazelwood Dr.
Amherst, New York 14228
Phone: (716) 691-9100 Fax: (716) 691-9181

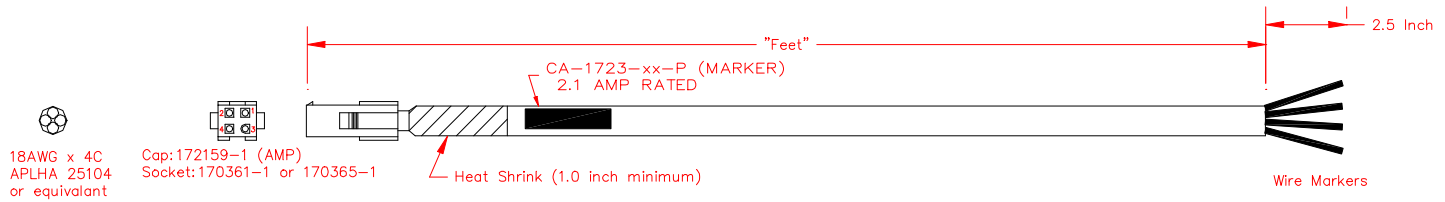
ASSY:	Cable Assy CS-1631-xx		
SCALE: CAD	DWG. NO. 1		REV. B
CHECK	DRAWN: RMF	DATE: 1-29-98	SHEET 1 OF 1

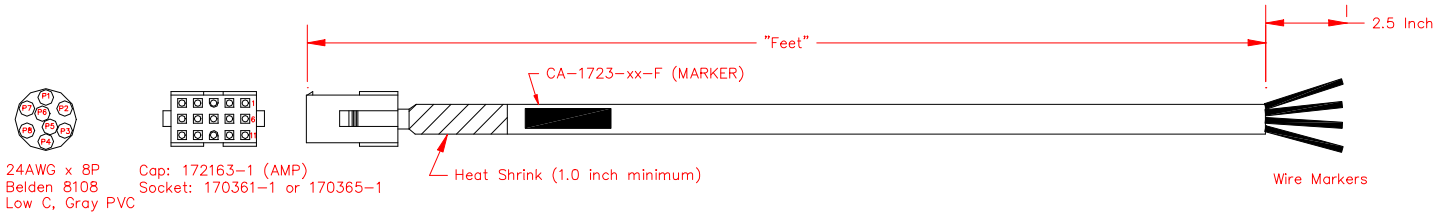
CS-1631

PART NUMBER	NEXT ASSY.
CS-1723-xx	None

REVISIONS				
REV	ECO	DESCRIPTION	DATE	BY
B	EC0257	Change vendor, wire spec and marker	4/19/98	RMF

Motor	Marker	Color
1	U	Black
2	V	Red
3	W	White
4	GND	Green





Feedback	Marker	Conductor Pair
1	A+/SIN+	P1
2	A-/SIN-	P1
3	B+/COS+	P2
4	B-/COS-	P2
5	Z+/REF+	P3
6	Z-/REF-	P3
7	+5 Ret	P4
8	+5 Vdc	P4
9	SHIELD	Shield
10	n/c	
11	n/c	
12	n/c	
13	HALL 1	P6
14	HALL 2	P7
15	HALL 3	P8

CS-1723-xx (xx = feet, +1.5/-0.0 inch)

Cable Set includes one each of the above cables packaged in a plastic bag.
Plastic bag is marked with the cable set CS-1723-xx part number.

API Controls
45 Hazelwood Dr.
Amherst, New York 14228
Phone: (716) 691-0100 Fax: (716) 691-9181

ASSY:	Cable Assy CS-1723-xx	
SCALE: CAD	DWG. NO. 1	REV. B
CHECK	DRAWN: RMF	DATE: 1-29-98
		SHEET 1 OF 1

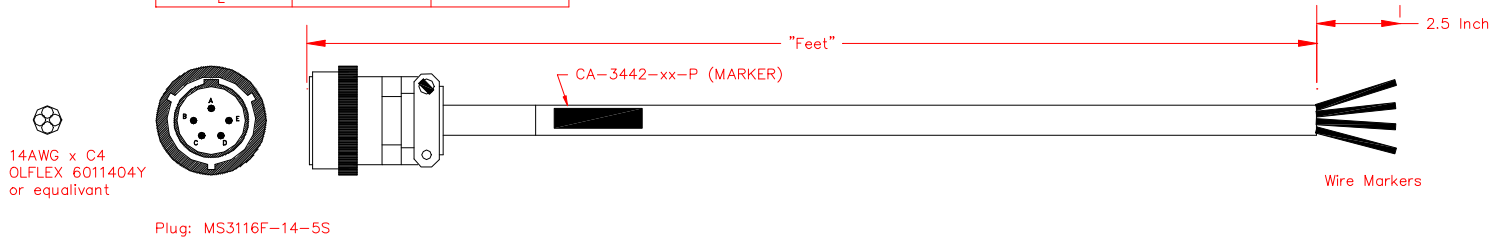
CS-1723

PART NUMBER	NEXT ASSY.
CS-3442-xx	None

REVISIONS

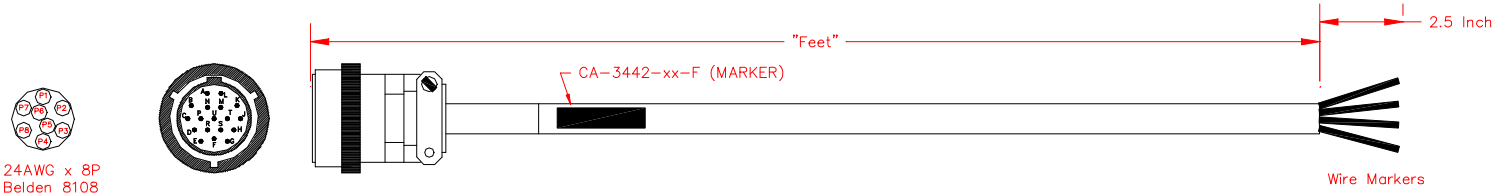
REV	ECO	DESCRIPTION	DATE	BY
B	EC0257	Change vendor, wire spec and marker	4/19/98	RMF

Motor	Marker	Color
A	U	Black
B	V	Red
C	W	White
D	GND	Green
E		



14AWG x C4
OLFLEX 6011404Y
or equalivant

Plug: MS3116F-14-5S



24AWG x 8P
Belden 8108
Low C, Gray PVC

Plug: MS3116F-14-18S

Feedback	Marker	Conductor Pair
A	Z+/REF+	P3
B	Z-/REF-	P3
C	B+/COS+	P2
D	B-/COS-	P2
E	OT+	P5
F	OT-	P5
G	BRK-	P6
H	BRK+	P6
J	+5VDC	P4
K	+5 Ret.	P4
N	A+/SIN+	P1
P	A-/SIN-	P1
R	SHIELD	SHIELD
S	HALL 1	P7
T	HALL 2	P7
U	HALL 3	P8

CS-3442-xx (xx = feet, +1.5/-0.0 inch)

Cable Set includes one each of the above cables packaged in a plastic bag.
Plastic bag is marked with the cable set CS-3442-xx part number.

API Controls
45 Hazelwood Dr.
Amherst, New York 14228
Phone: (716) 691-9100 Fax: (716) 691-9181

ASSY:	Cable Assy CS-3442-xx		
SCALE: CAD	DWG. NO. 1		REV. B
CHECK	DRAWN: RMF	DATE: 1-29-98	SHEET 1 OF 1

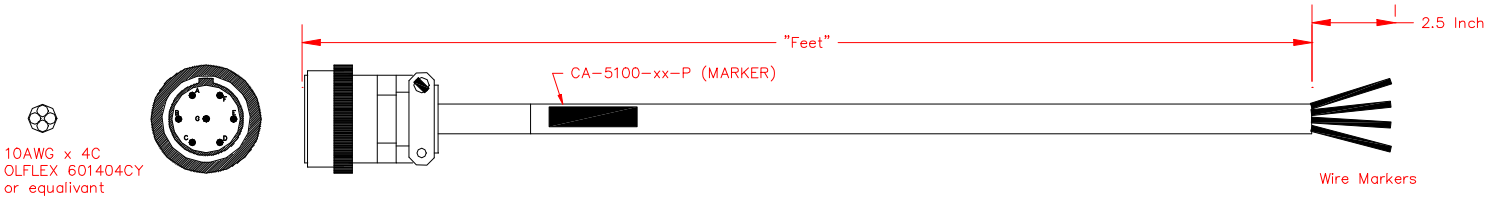
CS-3442

PART NUMBER	NEXT ASSY.
CS-5100-xx	None

REVISIONS

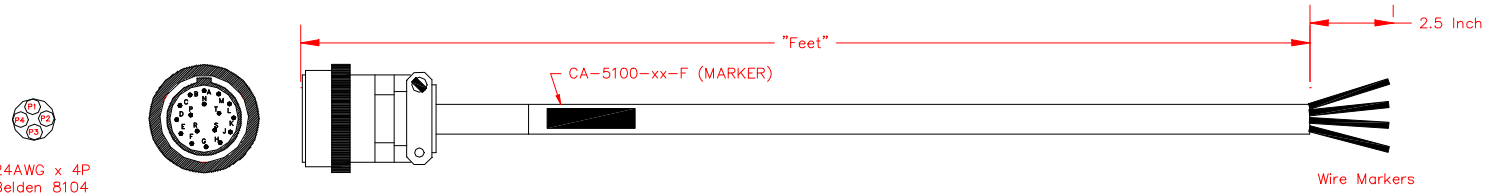
REV	ECO	DESCRIPTION	DATE	BY
B	EC0257	Change vendor, wire spec and marker	4/19/98	RMF

Motor	Marker	Color
A	U	Black
B	V	Red
C	W	White
D	GND	Green



10AWG x 4C
OLFLEX 601404CY
or equalivant

Plug: MS3106B18-10S Clamp: MS3057-10A



24AWG x 4P
Belden 8104
Low C, Gray PVC

Plug: MS3106B20-29S Clamp: MS3057-12A

Feedback	Marker	Conductor Pair
A	A+	P1
B	A-	P1
C	B+	P2
D	B-	P2
E	Z+	P3
F	Z-	P3
G	+5 Ret.	P4
H	+5 VDC	P4
J	SHIELD	SHIELD

CS-5100-xx (xx = feet, +1.5/-0.0 inch)

Cable Set includes one each of the above cables packaged in a plastic bag.
Plastic bag is marked with the cable set CS-5100-xx part number.

API Controls
45 Hazelwood Dr.
Amherst, New York 14228
Phone: (716) 691-5100 Fax: (716) 691-9181

ASSY:	Cable Assy CS-5100-xx	
SCALE: CAD	DWG. NO. 1	REV. B
CHECK	DRAWN: RMF	DATE: 1-29-98
		SHEET 1 OF 1

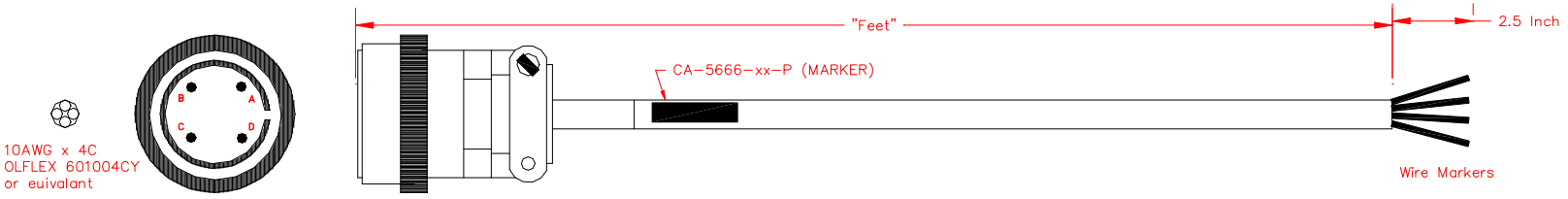
CS-5100

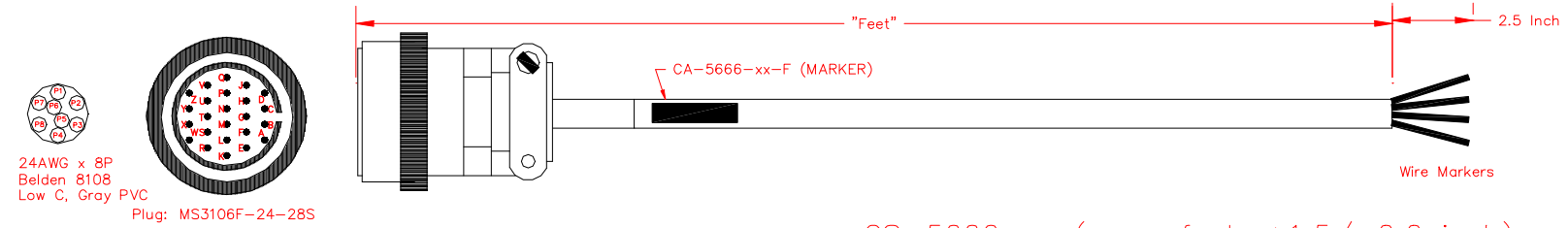
PART NUMBER	NEXT ASSY.
CS-5666-xx	None

REVISIONS

REV	ECO	DESCRIPTION	DATE	BY
B	EC0257	Change vendor, wire spec and marker	4/19/98	RMF

Motor	Marker	Color
A	U	Black
B	V	Red
C	W	White
D	GND	Green





CS-5666-xx (xx = feet, +1.5/-0.0 inch)

Cable Set includes one each of the above cables packaged in a plastic bag.
Plastic bag is marked with the cable set CS-5666-xx part number.

Feedback	Marker	Conductor Pair
A	Z+/REF+	P3
B	Z-/REF-	P3
E	B+/COS+	P2
F	B-/COS-	P2
G	SHIELD	SHIELD
H	+5VDC	P4
J	+5 Ret.	P4
K	A+/SIN+	P1
L	A-/SIN-	P1
R	OT+	P5
S	OT-	P5
T	HALL 1	P7
U	HALL 2	P7
V	HALL 3	P8
W	BRK+	P6
X	BRK-	P6

API Controls
45 Hazelwood Dr.
Amherst, New York 14228
Phone: (716) 691-9100 Fax: (716) 691-9181

ASSY:	Cable Assy CS-5666-xx	
SCALE: CAD	DWG. NO. 1	REV. B
CHECK	DRAWN: RMF	DATE: 1-29-98
		SHEET 1 OF 1

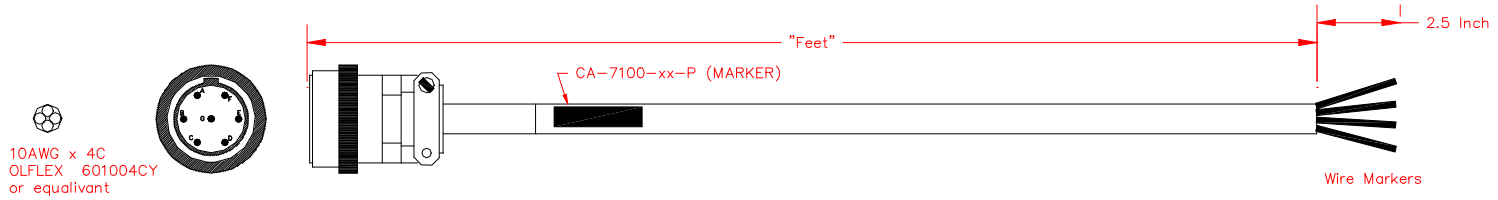
CS-5666

PART NUMBER	NEXT ASSY.
CS-7100-xx	None

REVISIONS

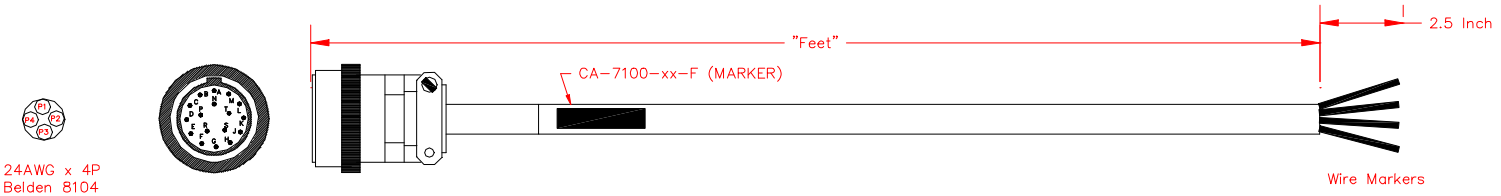
REV	ECO	DESCRIPTION	DATE	BY
B	ECO257	Change vendor, wire spec and marker	4/19/98	RMF

Motor	Marker	Color
A	U	Black
B	V	Red
C	W	White
D	GND	Green



10AWG x 4C
OLFLEX 601004CY
or equalivant

Plug: MS3106B22-22S Clamp: MS3057-12A



24AWG x 4P
Belden 8104
Low C, Gray PVC

Plug: MS3106B20-29S Clamp: MS3057-12A

Feedback	Marker	Conductor Pair
A	A+	P1
B	A-	P1
C	B+	P2
D	B-	P2
E	Z+	P3
F	Z-	P3
G	+5 Ret.	P4
H	+5 VDC	P4
J	SHIELD	SHIELD

CS-7100-xx (xx = feet, +1.5/-0.0 inch)

Cable Set includes one each of the above cables packaged in a plastic bag.
Plastic bag is marked with the cable set CS-7100-xx part number.

API Controls
45 Hazelwood Dr.
Amherst, New York 14228
Phone: (716) 691-9100 Fax: (716) 691-9181

ASSY:	Cable Assy CS-7100-xx	
SCALE: CAD	DWG. NO. 1	REV. B
CHECK	DRAWN: RMF	DATE: 1-29-98

SHEET 1 OF 1

CS-7100

7.2.4 Suggested Contactors DIN Mount

Table 7.5 Suggested Contactors DIN Mount

Suggested Contactor with MOL Mounting		
Rating (A)	**Description**	**MOL Relay Square D**
9	3 N.O., aux: 3 N.O. 2 N.C., 120 V coil	LC1D0910F7 & LA1DN22
12	3 N.O., aux: 3 N.O. 2 N.C., 120 V coil	LC1D1210F7 & LA1DN22
25	3 N.O., aux: 3 N.O. 2 N.C., 120 V coil	LC1D2510F7 & LA1DN22
32	3 N.O., aux: 3 N.O. 2 N.C., 120 V coil	LC1D3210F7 & LA1DN22
50	3 N.O., aux: 3 N.O. 2 N.C., 120 V coil	LC1D5010F7 & LA1DN22
80	3 N.O., aux: 3 N.O. 2 N.C., 120 V coil	LC1D8010F7 & LA1DN22

Use arc suppressor for relay coil (Square D LA4DA1U)

The contactor is a "BREAK-BEFORE-MAKE" type to prevent damaging the amplifiers power section. During an e-stop the bus is shunted, via the N.C. contact, through the external regen resistor.

7.3 Options and Accessories

Table 7.6 AC Fuse Selection

AC Fuse Selection Table		
Drive Model	**Fuse Rating**	**Fuse**
PS-3303	5 A RMS, 250V	Bussman ABC-5
PS-3306	10 A RMS, 250V	Bussman ABC-10
PS-3310	15 A RMS, 500V	Bussman FNQ-15
PS-3320	30 A RMS, 500V	Bussman FNQ-30

The preferred AC line over-current protective device, one for each unit, is a three-phase magnetic circuit breaker with a 5-8x instantaneous trip point.

The listed AC line fuses are recommendations only. It is the user's responsibility to ensure compliance with applicable electrical safety codes.

Table 7.7 External Regen Fuse Selection

Regen Fuse Selection Table		
Drive Model	**Fuse Rating**	**Fuse**
PS-3303	4.0 A RMS, 500VDC	Bussman KLM-4
PS-3306	4.0 A RMS, 500VDC	Bussman KLM-4
PS-3310	10.0 A RMS, 500VDC	Bussman KLM-10
PS-3320	10.0 A RMS, 500VDC	Bussman KLM-10

Table 7.8 PS-33xx d/i Cable Assemblies

CA-F6-2	CABLE ASSEMBLY, ANALOG, FLYING LEADS, 2 FT
CA-F14-2	CABLE ASSEMBLY, FEEDBACK, FLYING LEADS, 2 FT
CA-F24-2	CABLE ASSEMBLY, IO, FLYING LEADS, 2 FT
CA-ID24-OPTO	CABLE ASSEMBLY, IO, FLYING LEADS, 2 FT, I-SERVO
CA-DB9-232-6	CABLE ASSEMBLY, DB9, RS-232, 6 FT

Crimping Tools can be obtained from:

USA: Schuster Electronics Tel: 1-800-521-1358. (P/N DF11-TA2428HC)
CE : Hirose (D) Tel: 07-11-456-0021, Hirose (UK) Tel: 01-90-826-0616.

Table 7.9 PS-33xxc Cable Assemblies

CA-SD26-KIT	CABLE ASSEMBLY FOR IO, 26SUB D, DIN BREAKOUT
CA-SD15-KIT	CABLE ASSEMBLY, FEEDBACK, 15SUB D, BREAKOUT
CA-SD26-OPTO	CABLE ASSEMBLY FOR OPTO22, 26SUB D-25D
CA-DB9-232-6	CABLE ASSEMBLY, DB9, RS-232, 6 FT

The PS-33xxc requires two cable assemblies, CA-SD26-KIT.

Customers wishing to manufacturer their own cable sets may purchase the mating connectors from the table of PS-33xxc connectors below.

Description	Adam Tech Part Number
DB9 (male) solder cup Aluminum Back Shell Grommet Tree	DE09PD DE09-DH-AL-TS GS-DE09-HD
SD15 (female) solder cup Aluminum Back Shell Grommet Tree	HDT15SD DE09-DH-AL-TS GS-DA15-HD
SD26 (female) solder cup Aluminum Back Shell Grommet Tree	HDT26SD DA15-HD-AL-TS GS-DA26-HD

Table 7.10 External Regeneration Resistors

Model	External Continuous	External Peak	External Regen Resistor Kit
PS-3303	47 Ohm, 150 W	3 kW	RRK-0160-47
PS-3306(d)(i)	47 Ohm, 150 W	3 kW	RRK-0160-47
PS-3306c	10 Ohm, 200 W	14 kW	RRK-0200-10
PS-3310	10 Ohm, 200 W	14 kW	RRK-0200-10
PS-3320	10 Ohm, 200 W	14 kW	RRK-0200-10

Table 7.11 Suggested Line Filters

Filter Selection Table (AC Line In)		
Part Number	**Description**	**Schaffner P/N**
LF-1-8	Line Filter, Single Phase, 8 A	FN350-8/29
LF-1-12	Line Filter, Single Phase, 12 A	FN350-12/29
LF-1-20	Line Filter, Single Phase, 20 A	FN350-20/29
LF-1-30	Line Filter, Single Phase, 30 A	FN350-30/33
LF-3-8	Line Filter, Three Phase, 8 A	FN351-8/29
LF-3-16	Line Filter, Three Phase, 16 A	FN351-16/29
LF-3-25	Line Filter, Three Phase, 25 A	FN351-25/33
LF-3-50	Line Filter, Three Phase, 50 A	FN2351-50/33
LF-3-80	Line Filter, Three Phase, 80 A	FN351-80/34
LF-3-110	Line Filter, Three Phase, 110 A	FN351-110/35

Required to comply with EC directive 89/336/EEC.
Schaffner EMC Inc. USA 201-379-7778

7.4 Recommended Spare Parts

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7.5 Relevant Engineering Prints

Figure 7-8 Bus Dynamic Braking Interconnect

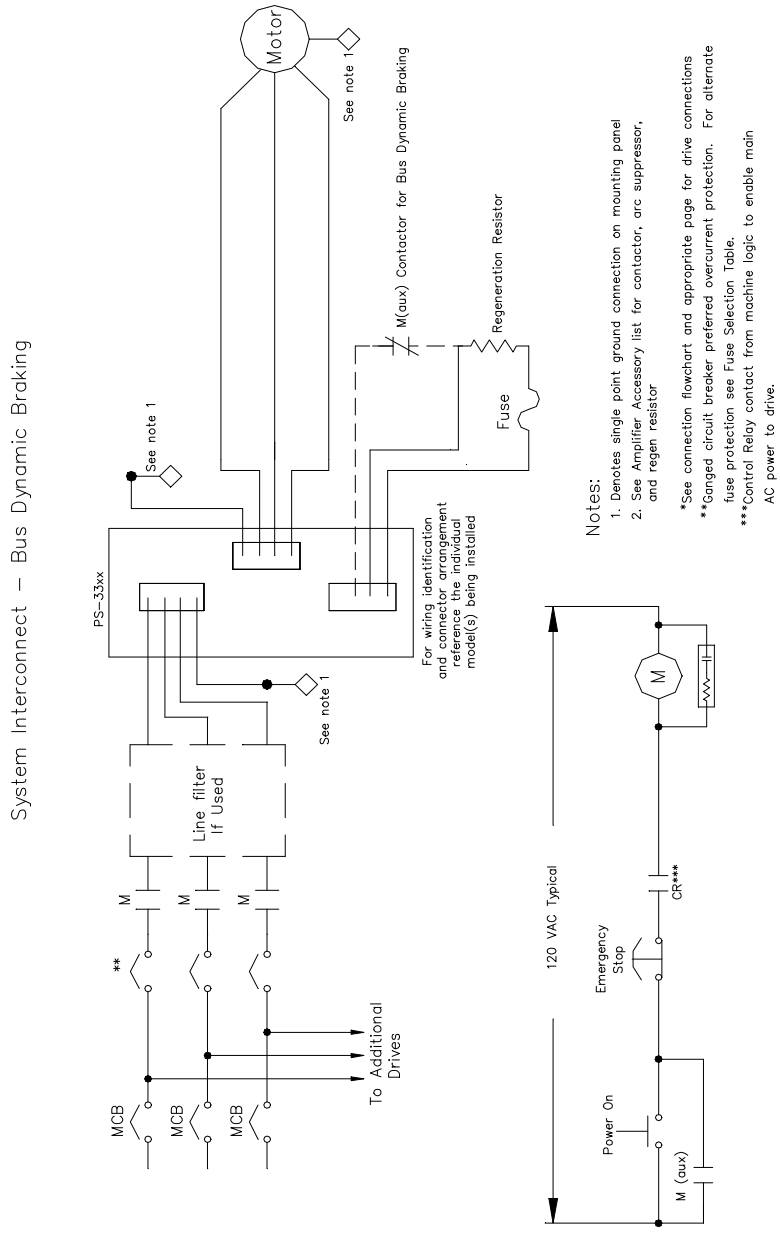
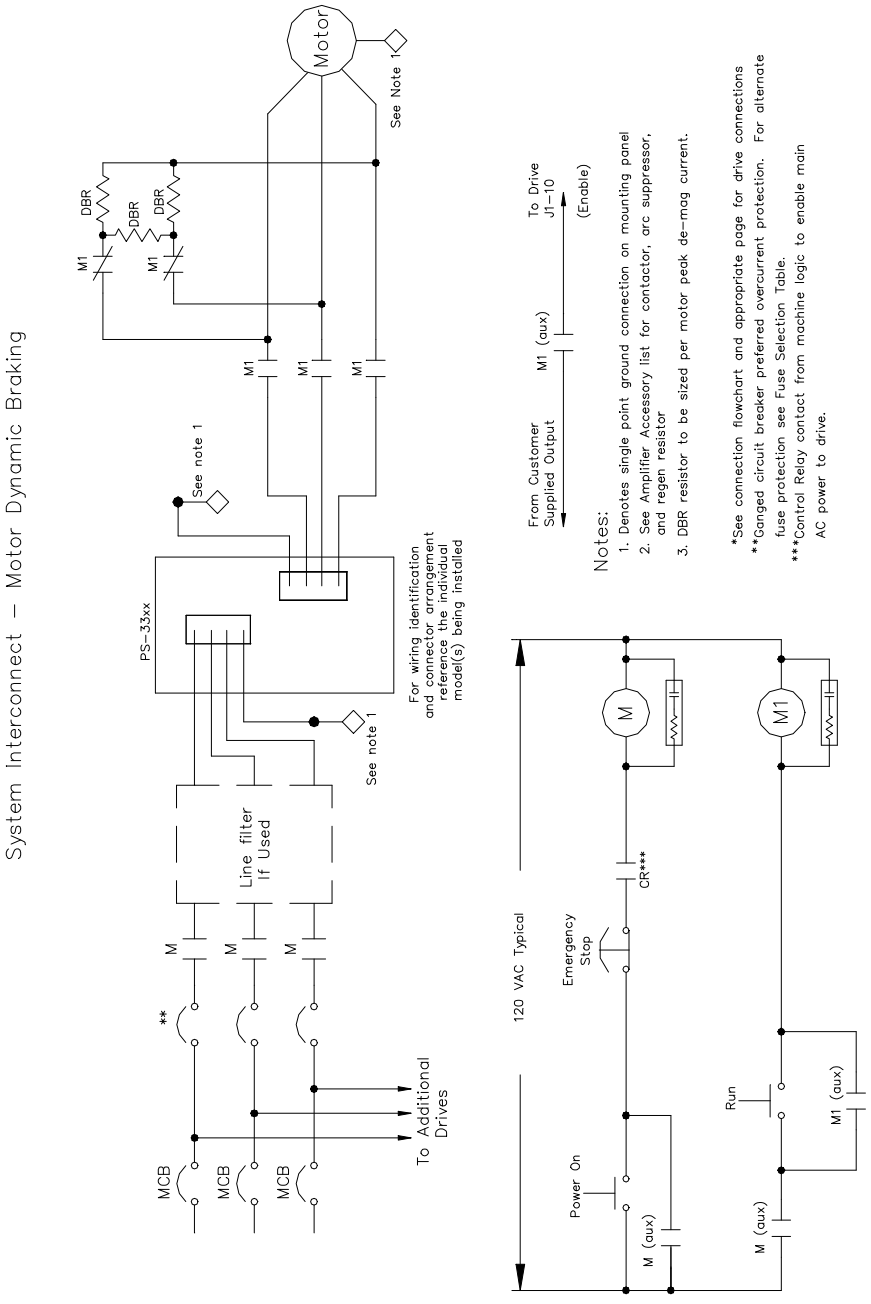


Figure 7-9 Motor Dynamic Braking Interconnect (Recommended)



7.6 PS-33xxc-R-C0

The initial release of the Centennial amplifier is designated with a "C0" in the part number. The connector layout of the C0 series is different from the production release of the Centennial unit. This section documents these variations.

Figure 7-10 PS-33xxc-C0 Digital I/O Connector (J1)

J1 Digital I/O	
Pin #	**Isolated IO**
1	Input 1
2	Input 2
3	Input 3
4	Input 4
5	Input 5
6	Input 6
7	Input 7
8	Input 8
9	Reset (9)
10	Enable (10)
11	Output Opto
12	Output COM
13	Output 1
14	Output 2
15	Output 3
16	Output 4
17	Output 5
18	Output 6
19	Output 7
20	Output 8
21	Output 9
22	Output 10
23	Output 11
24	Output 12
25	Input Opto
26	N.C., M (shell)

Figure 7-11 PS-33xxc-C0 Analog I/O Connector (J2)

J2 - Analog I/O	
Pin #	**Analog I/O**
1	+15 VDC
2	-15 VDC
3	Analog 1 in + (ADC1)
4	Analog 1 in -
5	Analog 2 in + (ADC2)
6	Analog 2 in -
7	Analog 1 Out
8	Drive OK
9	Analog 2 Out
10	Shield
11	Analog Out Common
12	Analog 3 in + (ADC3)
13	Analog 3 in -
14	HSI 2+ /B+
15	HSI 2 - /B-
16	HSI 1 + /A+
17	HSI 1 - /A-
18	Drive OK Return
19	Shield
20	Encoder Out A+
21	Encoder Out A-
22	Encoder Out B+
23	Encoder Out B-
24	Encoder Out Z+
25	Encoder Out Z-
26	N.C., M (shell)

Figure 7-12 PS-33xxc-C0 Motor Feedback Connector (J3)

J3 - Resolver Feedback	
Pin #	**Signal**
1	Sine + (S2)
2	Sine - (S4)
3	Cos + (S1)
4	Cos - (S3)
5	Ref + (R1)
6	Ref - (R2)
7	+ 5 VDC Out
8	+ 5 VDC Return
9	Spare
10	Spare
11	Motor OT +
12	Motor OT -
13	Spare
14	Spare
15	Shield
16	N.C., M (shell)

Figure 7-13 PS-33xxc-C0 Motor Feedback Connector (J5)

J5 - Comm Port		
DB9-F Pin #	**Primary RS-232**	**RS-422 RS-485**
1	NC	Tx+
2	Tx	Tx-
3	Rx	Rx+
4	NC	Rx-
5	COM	COM
6	Tx*	NC
7	Rx*	NC
8	NC	NC
9	+15VDC	+15VDC
*PS-33xxc Only (Com Port 2)		

Figure 7-14 Mounting Schematic