P41 / P42 / P51

Full/Half Step Power/Drive

Installation and User
Reference Manual

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SECTION 1

~ GETTING STARTED ***

Our goal as a supplier is to provide the user with the proper tools to get his/her application up and running as quickly as possible. This includes designing products that are easy to learn, use, install, and maintain, in addition to providing the required documentation and support to quickly answer any questions that you might have. To help you get started, this section will provide you with a roadmap through this manual. Depending on your level of expertise, you can decide how to proceed. We hope you find our recommendations helpful and we welcome any comments/suggestions that you might have in helping us achieve our goal.

The primary intention of this manual is to guide the first time user of the P41/P42/PS1 Series packages through the familiarization and installation into the chosen application. After the initial installation is accomplished it can also serve as an ongoing reference manual for installation changes or future reference needs.

While this manual is intended to include as much available information as possible, it is designed to also be easy to use for those who will not be reading the entire manual or who only want to refer to specific sections. Users should classify themselves and proceed accordingly:

First time users -
We recommend that all first time users and those basically unfamiliar with step motor drives read the entire manual before proceeding with installation.

Experienced users -
Refer to the Precautions in SECTION 2 and to the Summary in SECTION 4 before proceeding with your installation.

Current users with specific information needs -
The comprehensive Index contained in SECTION 3 will guide you to the specific location with answers to your questions.

SECTION 2

~* PRECAUTIONS AND WARNINGS *

While we have designed these drives with safety issues in mind, the user should keep the following precautions in mind:

-> Because potentially hazardous voltages can be present around this drive, only qualified service and installation personnel should install this device.

-> All connections or changes to the drive configuration should be made with any power sources turned off and disconnected from the drive.

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SECTION 3

*** CONTENTS ***

SECTION 4

*** SUMMARY OF OPERATIONS ***

This section is provided only for those who either have experience with step motor drives or wish to learn the minimum required to hook-up and run the P41/P42/P51 Series step motor drives. An assumption is made here that the user has a pulse train available to supply to the drive. If not, then other sections of the manual should be referred to as required.

The P41/P42/P51 Series are bipolar chopper step motor drives with full and half stepping capability. The P41/P42 series will drive 4-phase motors rated at up to 2.8 Amps while the P51 Series will drive motors rated at up to 5 Amps per phase (bifilar rating). The basic installation steps include:

1) Ensure that the AC power source is either 115 or 230 VAC and that it matches the drive selection (see Appendix C).
2) Plug the motor connection into the socket labeled motor.
3) Connect the required logic control lines (review SECTION 12).
4) Ensure that the drive current switch settings are set for the motor that you are running (see Appendix A and/or B).
5) P42 Series only: Verify that both Axis A and Axis B have been configured correctly and all Axis A connectors have been inserted into Axis A sockets on the drive.
6) Ensure that Steps 1, 2, and 3 have been performed correctly.
7) Plug into your power source.
8) Supply step and direction signals to the drive to move the motor.

SECTION 5

*** UNPACKING AND INSPECTION ***

Carefully remove the contents of the carton in which the driver was shipped. Inspect the carton and the drive and make note of any apparent physical damage. If severe damage is present then you should consider rejecting the shipment and making contact with the shipping company concerning in-transit damage claims. We have made every effort at the factory before shipment to fully inspect, test, and properly package this product so that it reaches you defect free and without damage.

All packaging materials should be saved and set aside in case a return shipment has to be made. The contents may include connectors, mounting screws, a motor, or other components - please compare these components to the parts list which is included on the shipper. Immediately report any discrepancies to the shipping location.

SECTION 6

*** DESCRIPTION OF OPERATION ***

Functional Overview

The P41/P42/P51 Series are semi-packaged driver and power supply units that combines bipolar chopper drive technology with an integral power section. Each model includes a motor, drive, power supply, integral heatsink, mounting brackets, power cord, connectors and a full enclosure. The P41/P42/P51 Series packages are directly compatible with the Controls Division's Indexers/Controllers for a total motion system solution.

All models contain the logic and power switching stages required to operate a large percentage of existing step motor designs. The logic section of the drive acts to direct current in and out of the motor phases in a proper sequence in order to cause the desired rotation.

The power switching stage controls the rate and amount of current flow into the motor windings as directed by the logic. In general, the faster the current is pumped through a winding during each step, the more torque and speed that will be obtained. The P41/P42/P51 Series use a sophisticated bipolar chopping method of current control which will yield the highest possible speeds and torques. This technique involves overdriving the windings with high voltages (up to 40 VDC) to decrease the current rise times, and then controlling the current level by a high frequency (20 KHz) current chopping.

The inputs to the drives have been designed to handle many configurations (see SECTION 8 for technical descriptions):

Power
The required AC power is 115 or 230 Volts, 50 or 60 Hz.
(See Appendix C for details)

Motor leads
Either 4, 6 or 8 lead hybrid motor leads can be connected to the drive.
(See SECTION 7 for details)

Pulse Source
The P41/P42/P51 Series accept pulse and direction control inputs from a wide variety of sources. The maximum rate of pulses accepted is 50 KHz, or 50,000 pulses per second. Note that the drivers have been designed to provide their own 5 volts DC for it's optical isolation circuitry. All inputs are by default optically isolated.

Other Control Features
The no-power input is used to control a power down state, disabling the motor. The low-power input is used to reduce the current to one-third full power. The current supplied to the motor is controlled by setting dip switches on the side of the drive.

SECTION 7

*** MOTOR COMPATIBILITY ***

The P41/P42/P51 Series is capable of running a wide range of step motors with their bipolar chopper switching technique. The limits of these ranges fall into several categories:

Winding Type
The motor winding type should be basically a two phase motor which is capable of bipolar operation, characterized by the need for current to flow in both directions in each coil of the motor. Most motors which fall into the "HYBRID" motor classification will work. Step angles of 0.9 and 1.8 degrees are the most common. Other step angles will also work. Appendix A lists the most common motors available through the Controls Division of API.

Number of Leads
Hybrid style motors have 4, 6, or 8 leads depending on how they are wound and connected. Diagram 7.1 shows these 3 basic configurations; note that the 4-lead motor is wound in a "UNIFILAR" fashion while the 6 and 8 lead motors are wound in a "BIFILAR" fashion. **ALL THREE OF THESE TYPES OF WINDINGS CAN BE OPERATED.**

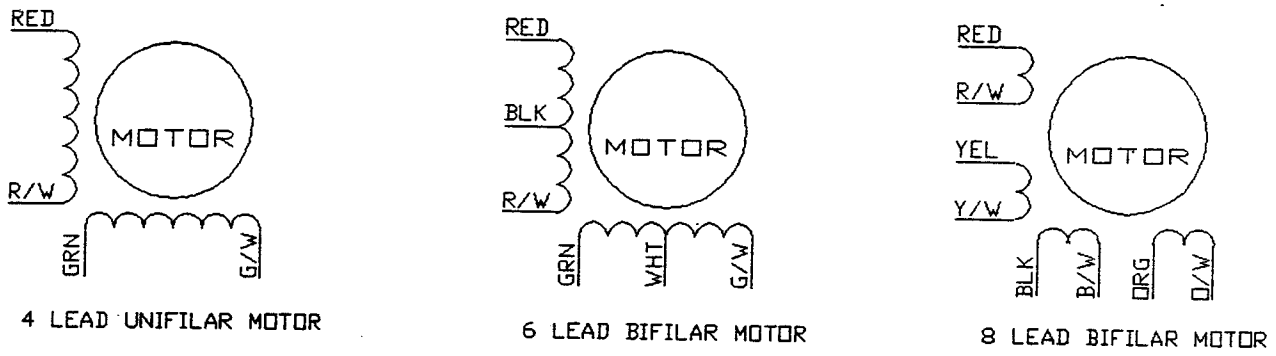


DIAGRAM 7.1

Motor Current Rating
The basic current output range is .3 to 2.0 Amps per phase for the P41/P42 Series and .3 to 3.5 Amps per phase for the P51 Series. These are the ranges for the rating per phase of a 4 lead unifilar wound motor. If a 6 or 8 lead motor is being considered then its bifilar current rating per phase should lie between .4 to 2.8 Amps for the P41/P42 and .4 to 5 Amps for the P51.

Inductance
The minimum motor inductance of .5mH unifilar is required on all models of drives for the power switching stage to be able to control currents.

Size

Recommended motor sizes for the P41/P42 Series is size 17 to size 34 single stack motors. Recommended motor size for the P51 Series is size 17 to size 34 double stack motors, (see Appendix A). Other controlling factors are the motor's current rating, inductance and winding type.

If a question remains about whether a particular motor can be operated, please contact the Controls Division for application assistance.

SECTION 8

*** DRIVE CONNECTIONS ***

This section will list and explain all the connections to the P41/P42/P51 Series drives which includes motor, logic and power connections.

Notation and Conventions

All available logic inputs have two possible input states which will be referred to as "High" and "Low". When a logic terminal is open it is in a "High" state by default since it is clamped high internally with a pull-up resistor. Any notation which uses the "bar" convention will assume that the state indicated by the bar is activated by taking that logic terminal "Low" (ie. - CW/CCW denotes CCW direction of rotation when taken "Low").

Connector Type

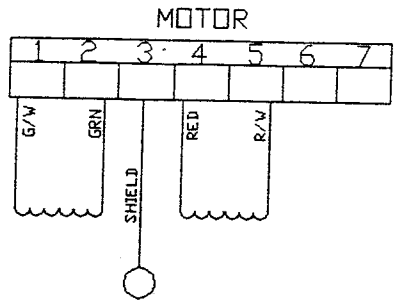
Three plug type connectors allow the user to make the necessary connections via recessed screw terminals which control a clamping action on the bare wire of each input. It is recommended that connections be made prior to plugging into the drive.

NOTE: 1.)Motor Connections are made on the 7 pin connector.
2.)Logic Connections are made on the 8 pin connector.
3.)Power Connections are made on the 3 pin connector.

Motor Connections (7 PIN CONNECTOR)

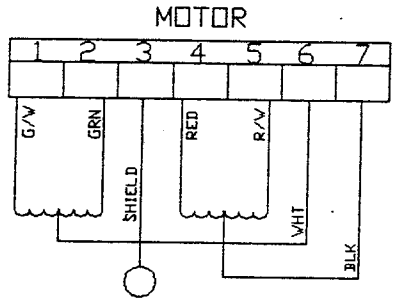
MOTOR LEAD TERMINALS (Terminal #'s 1-7)
The leads from the chosen motor will be connected at some or all of these terminals. Diagrams showing the possible connections for 4, 6 or 8 lead motors, and the benefits and trade-offs of each follows.

NOTE: Our examples use a 4, 6 or 8 lead motor rated at 1 amp per phase current (I=1), 5 ohm resistance, 10mH per phase inductance.



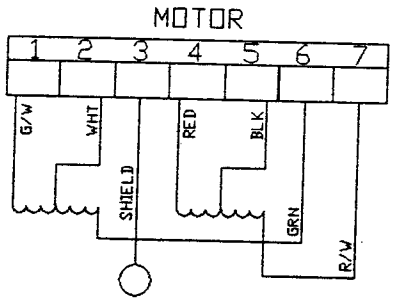
4 LEAD MOTOR

A 4 lead motor can only be hooked up in the configuration shown. The drive output current would be 1 amp (I*1). The inductance seen by the drive would be 10 mH.



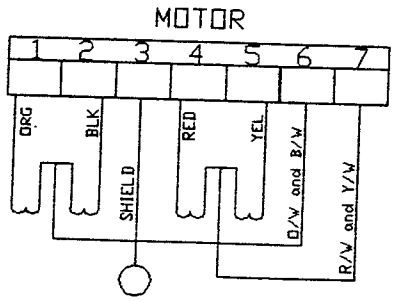
6 LEAD MOTOR

Connecting a 6 lead motor in series provides excellent low speed torque but reduced performance at higher speeds. The drive output current would be .7 amps (I*.707). The inductance seen by the drive would be 40mH.



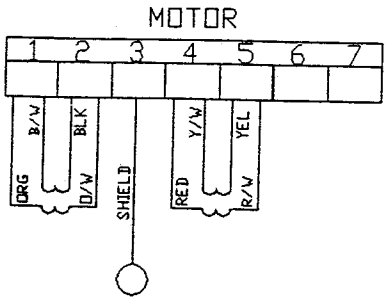
6 LEAD MOTOR
(HALF WINDING)

Connecting a 6 lead motor to utilize only half of the motor windings allows the user to achieve higher speeds but results in reduced low speed torque. The drive output current would be 1 amp (I*1). The inductance seen by the drive would be 10 mH.



8 LEAD MOTOR
(SERIES)

Connecting a 8 lead motor in series provides excellent low speed torque but reduced performance at higher speeds. The drive output current would be .7 amps (I*.707). The inductance seen by the drive would be 40mH.



8 LEAD MOTOR
(PARALLEL)

Connecting an 8 lead motor in parallel optimizes the torque and speed of the given motor due to the 100% usage of the motor windings. This configuration results in the best high speed performance with some loss of low speed performance. Note that this configuration may cause extra motor heating due to eddy current losses. The drive output current would be 1.4 amps (I.*1.414). The inductance seen by the drive would be 10 mH.

CAUTION: Do not supply power to the drive without having all of the motor leads firmly connected to their appropriate terminals.

Logic Connections (8 PIN CONNECTOR)

The logic inputs required by the P41/P42/P51 are made on the 8 pin connector and plugged into the drive section labeled "LOGIC". All Logic inputs are optically isolated and utilize the 5 VDC supplied internally by the drive.

Each of the logic inputs is clamped "High" internally with a pull-up resistor and requires the user's controller to pull them Low to "LOGIC GROUND", (Terminal 1). Each of the user's control lines should be capable of sinking at least 15 mA. The optical isolation feature electrically isolates the motor and power stages of the drive in order to protect both circuits and eliminate electrical noise problems.

GROUND (Terminal 1)
This terminal is the reference ground for the isolated 5 VDC supply and all optically isolated inputs. This reference ground should be connected to the ground of the users controller.

STEP INPUT (Terminal 2)
The motor will be instructed to step on the rising edge of each incoming pulse up to a rate of 50 KHz. The minimum input pulse width is 10 micro seconds.

DIRECTION (Terminal 3) - "CW/CCW"
A "High" or open connection on this terminal would cause a Clockwise (CW) rotation of the motor as viewed from the output shaft end. When taken "LOW", the direction will be counterclockwise (CCW). The direction input may be switched while the motor is rotating, but may cause the motor to lose synchronism if operating above it's Start/Stop capability.

LOW POWER (Terminal 4) - "HI/LO PWR"
This input allows the user to reduce the power to the motor to one-third of the high current setting. The "HIGH" or open state provides full current to the motor. When taken "LOW", the current is reduced to 33% of it's full rated power. This may be used to maintain a holding current on the motor or to help reduce motor heating.

POWER ENABLE (Terminal 5) - "ENA/NO PWR"
This input allows the user to cut off power to the motor on command. The "High" or open state allows normal stepping of the motor at it's rated current. When taken "Low", all power is cut to the motor for the duration of the "Low" state. Incoming step pulses are ignored when this line is held low. Normally this input is used to issue an emergency stop command to the motor.

RESET (Terminal 6) - "RUN/RESET"
By taking this input "Low" for a minimum of 10 micro seconds, a logic reset of the drive will be initiated. A reset takes the translator to it's initialized state. Incoming step pulses will be ignored during the time the reset line is held low. A reset is initiated automatically during the drive power-up.

NO CONNECTION (Terminal 7) - "NC"
This terminal is not connected internally.

HALF or FULL step (Terminal 8) - "HALF/FULL"
A "High" or "Open" state at this terminal will result in half stepping of the driven motor, (one phase on - two phase on - one phase on). When taken "Low", full stepping logic will be initiated ,(two phase on).

If the application requires one phase on full stepping logic, (wave drive), the following procedure should be followed: First set the drive for half step mode (terminal 8) and trigger the drive reset (terminal 6). Next command the drive to take a single step (terminal 2) and then set the drive for full step (terminal 8). The drive will now operate in the full step mode one phase on.

Power Connections (3 Pin Connector)

Ensure that the voltage selected on the drive matches the power source you are going to plug into, i.e. 115 or 230 VAC (see Appendix C).

A three prong power cord with a 3 pin plug type connector is provided with the package. Simply plug the connector into the mating socket on the drive and plug into the power source. When power is present, the green LED will be lit. Pin out list follows:

AC Input Black Wire (Line) .....Line
AC Input White Wire (Neutral).....Neutral
AC Input Green Wire (Ground).....Ground
LED indicating power on .....Power

SECTION 9

*** INSTALLATION ***

The contents of this section will guide the user through the proper steps required to safely install and hook-up the P41/P42/P51 Series drivers. This section should be read in it's entirety for first-time installers and reviewed during the installation process.

Mounting

Drives should be rigidly mounted using the supplied mounting brackets. Since the drive is convection cooled, it is recommended that you allow a minimum of one inch on all sides for air flow. The drive(s) may be mounted in a closed cabinet depending on other application considerations (see Cooling).

Cooling

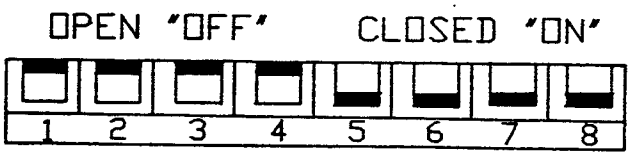
The most fundamental rule to follow concerning proper cooling of the drives is to keep the enclosure surface temperature less than 65°C. Operating in an enclosed area may require external cooling in order to keep the enclosure temperature less than 65°C (ie. - forced air fan). For a rule of thumb if you are not able to measure the case temperature, the heat sink temperature is within limits if you can comfortably hold your finger on it more than 3 seconds.

Current Switch Settings

If your drive and motor were purchased together as a package, then the current settings should have been previously made by your supplier. It is still advisable to verify that the settings are correct prior to applying power to the drive.

If you have a P42 Series dual axis drive, you must also ensure that the current setting for Axis A matches Motor A, and the current setting for Axis B matches Motor B.

Before making connections to the drive, the current setting for the motor's rated current per phase should be determined and set at the 8 position DIP switch located on the side of the drive. Diagram 9.1 shows the DIP switch and the possible open and closed (on/off) position of each of the 8 switches.



CURRENT SWITCH SETTINGS

DIAGRAM 9.1

If not known the user should determine the current per phase rating of the motor to be used and whether or not the rating is a unifilar rating or bifilar rating. In general, if the motor has four leads the rating will be unifilar; if the motor has six or eight leads the given rating will be a bifilar rating.

Once the motor part number and current rating is known, refer to Appendix A or B to determine the closest listed current setting based on the style of winding. If the closest current is within 10% of the rated current, it will probably suffice for most applications. Current settings greater than 10% more than the rated value should not be used unless special cooling precautions are taken or intermittent operation allows for liberal use of the Low Power state. These precautions should preclude motor temperatures greater than the maximums specified by the manufacturer. By using a ball point pen or pointed object, duplicate the switch settings given in the Appendix at the DIP switch on the drive. **DO NOT** switch the settings with power applied to the motor.

Motor Connections

Motor connections are made on the 7 pin pluggable connector provided with the drive. If you purchased the drive with a motor, then the motor connections and current switch settings will already have been made. If not, then refer to Sections 8.2 and Appendix B for the proper drive settings.

Please note that the P42 Series is a dual axis drive and therefore will have connections for two motors. Please be sure that the switch settings for current on each axis matches the current of the motor connected to that axis.

Logic Input Connections

The minimum logic connection required to operate the P41/P42/P51 Series is the pulse input. All other inputs will default to their "High" states during operation. If other states are required then the ability to take them "Low" should be available. Refer to the terminal descriptions in SECTION 8 to determine the required inputs.

Logic input connections are made through use of an 8 pin pluggable connector. The connector may be pulled out by applying a force straight away from the drive. Connect each input by inserting 1/4 inch of stripped bare wire into the socket and tighten the pressure screw until the wire is firmly secured.

Please note that the P42 Series is a dual axis drive and therefore will have logic connections for both axis. Please be sure that the logic connections are matched correctly to the respective motor i.e. Motor A - Logic Connections A; Motor B - Logic Connections B.

Power Connections

Ensure that the drive is configured for 115 VAC or 230 VAC as desired. (See Appendix C).

Applying Power to the Drive

Once the drive is properly mounted and all of the required connections have been made, the drive may be powered up. Plug the power cord into it's selected 115 or 230 VAC source and the 3 pin mating plug into the drive, (ensure that the drive is configured for 115 VAC or 230 VAC as desired, see Appendix C). Initial power should be applied with no pulses being fed to the drive. The motor will lock into position at it's rated static torque. Once the pulse input rate begins, the motor should begin to step in the set direction. At this point, if the motor does not have any torque or will not properly rotate, refer to SECTION 13 for possible remedies.

*** PERFORMANCE EXPECTATIONS ***

Step motors are quite unique in many aspects of their design, performance and control. Many attributes of a step motor can be attractive to the application designer; such as their simplicity, digital nature, and inherent open loop capability. Other attributes have to be overcome to allow a step motor to perform the best in an application; such as resonant instability and loss of torque as a function of speed. It turns out that a step motor's driving electronics play just as important a role in performance as the motor itself. Since a motor's inductance acts to inhibit current buildup and decay, the faster that current can be moved, the more that torque producing current will be pumped through the windings.

A chopper drive, such as the P41/P42/P51 Series, is designed to minimize the current rise times by it's bipolar, high voltage chopping action. The user can expect to achieve relatively fast stepping rates with these drives running in an open loop capacity; in general, the lower the inductance of the driven motor (also, the higher the current rating), the faster the drive will be able to step the motor.

Since all step motors exhibit resonant instability at lower speeds, the user should try to minimize their effect. The unstable areas of a full or half stepped motor are characterized by erratic motion and a severe loss of torque. A half stepped motor will exhibit less resonance than a full stepped motor. The primary resonant band usually occurs somewhere between 50-200 full steps per second with less severe occurrences at multiples of the primary frequency. The best treatment against resonant areas is to accelerate through them to higher operating frequencies. If an application requires operating speeds in a naturally occurring resonance band, then either damping techniques can be used or the band moved elsewhere by adjusting the systems friction and/or it's inertia.

If the driven step motor does lose operating synchronism between the rotor and stator (ie. - stops running), the pulse rate must be reduced to the point that synchronism is regained and then accelerated to the operating speeds. The most efficient point-to-point moves with a step motor are made by initially starting the motor and load at the highest start/stop speed possible and then accelerating to the operating speed and reversing the sequence to stop.

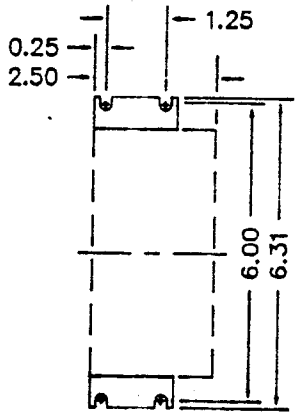
Sample performance curves are provided in Appendix D for your reference.

SECTION 11

*** OUTLINE DIMENSIONS ***

Dimensions are in inches.

Rear and Front



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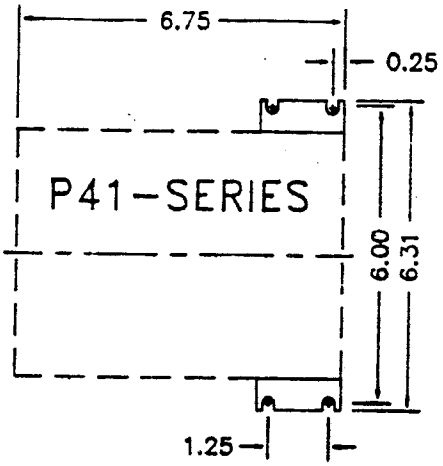

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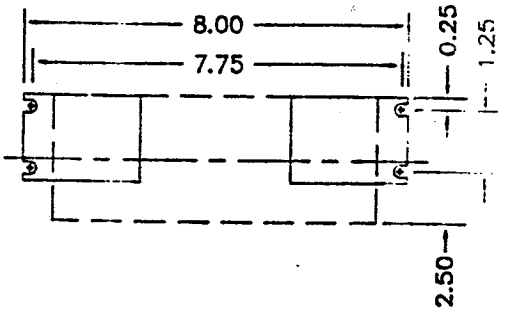

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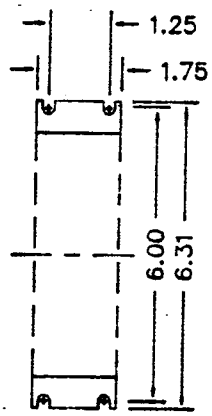

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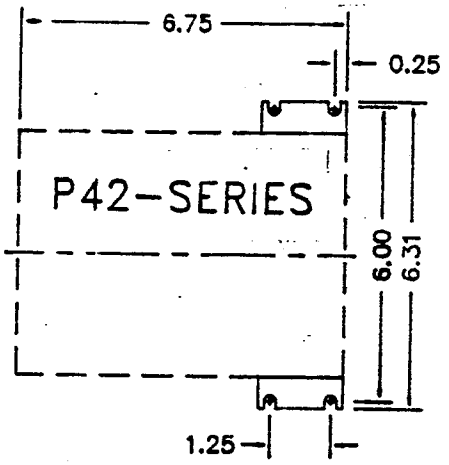
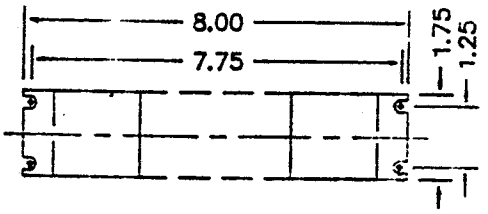


Top and Bottom



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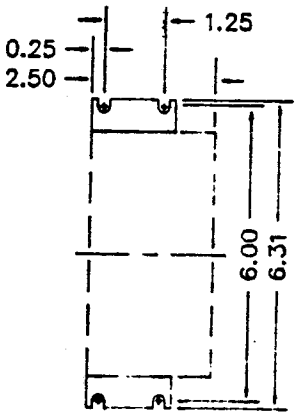

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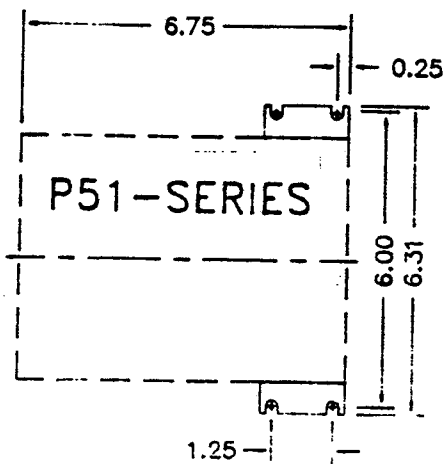
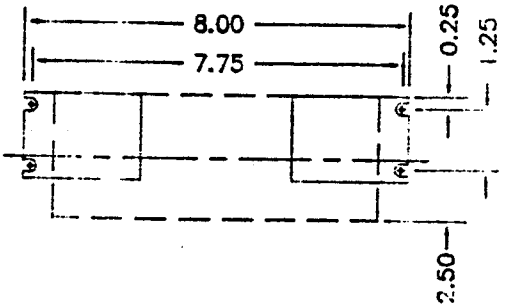


Top and Bottom



SECTION 12

*** SPECIFICATIONS ***

General:

Drive Type	2 Phase, bipolar, constant current, chopper drive
Chopping Frequency	Greater than 20 KHz.
Stepping Modes	"HALF/$\overline{\text{FULL}}$" step modes
Short Circuit Protection...	Phase to phase, phase to ground

Power Requirements:

Input	100-122 or 210-250 VAC. 50/60Hz
Output Rating	P41/P42 .3 to 2 Amps per phase P51 .3 to 3.5 Amps per phase Dip Switch Selectable

Physical:

Dimensions	P41 (Drive with connectors) 5.0"W x 1.75"H x 7.00"L P42/P51 (Drive with connectors) 5.0"W x 2.5"H x 7.00"L
Weight	P41 - 3 lbs. P42 - 6 lbs. P51 - 5 lbs.

Temperature:

Storage	-40° F to $+185^{\circ}$ F (-40° C to $+85^{\circ}$ C)
Operating	150°F (65°C) maximum enclosure temperature

Logic Inputs:

Type	Optical Isolated with a separate built-in 5 VDC supply
Level	Logic '1' (HIGH) = 2.0 to 5.0 VDC Logic '0' (LOW) = 0 to 0.8 VDC
Pulse	Step on trailing edge of a square wave signal, 10 microseconds minimum width at a maximum rate of 50 KHz.

Direction ..... "CW/$\overline{\text{CCW}}$"

Low Power ..... "HI/$\overline{\text{LO PWR}}$"
Reduces motor current to 30% of full power.

Power Enable ..... "ENABLE/$\overline{\text{NO POWER}}$"
Reduces current to motor to zero.

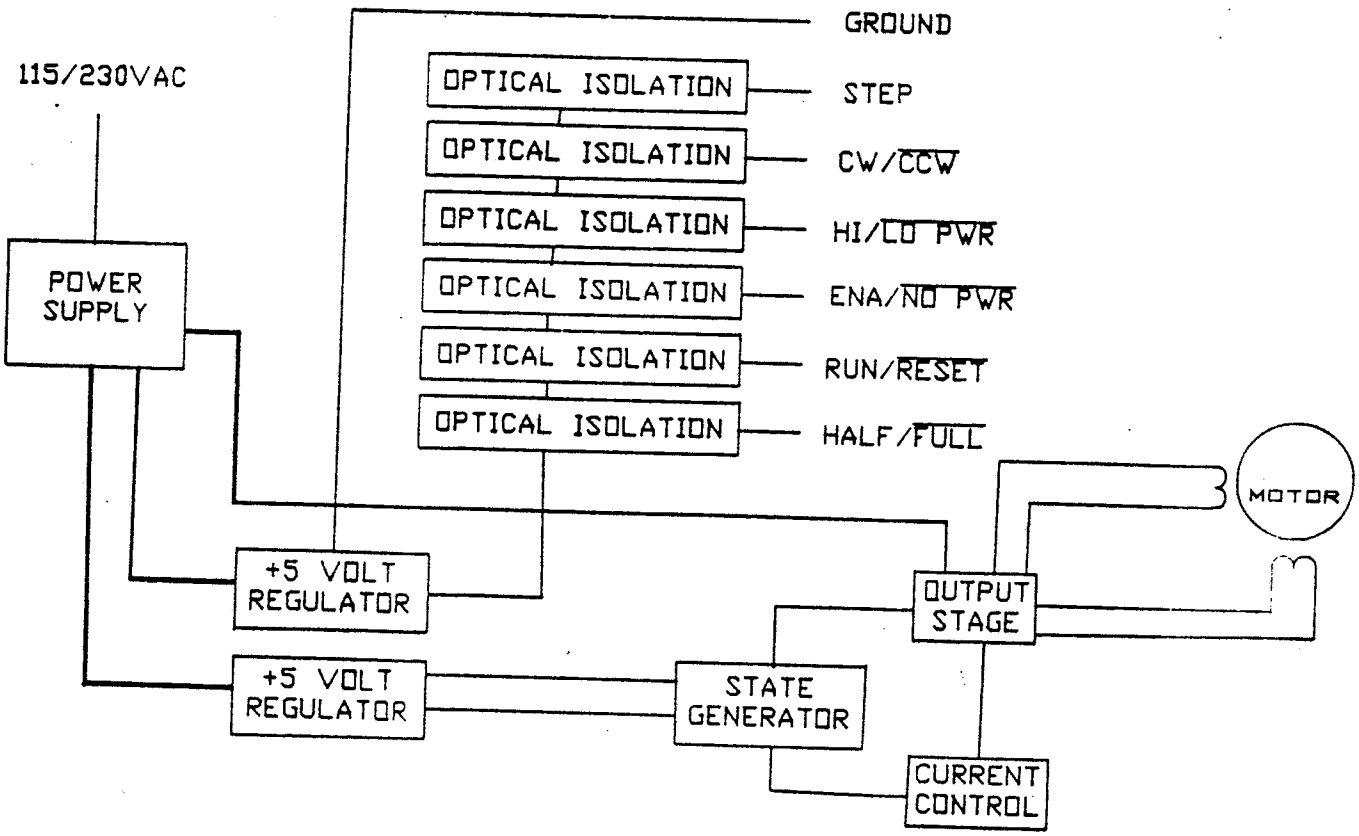
Reset ..... "NORMAL/$\overline{\text{RESET}}$"
Resets translator to initialized state.

Step Size ..... HALF/$\overline{\text{FULL}}$

Motor:

Motor Connections ..... Connections for 4, 6, or 8 lead hybrid motors.

Block Schematic .....



SECTION 13

*** TROUBLESHOOTING ***

If a problem occurs the operator should immediately turn off and disconnect all power to the drive before attempting any troubleshooting or repair. Initial troubleshooting of the drive should be done with the load disconnected to isolate the drive from possible load related problems. The following list of symptoms, causes, and corrections may help to guide the user through a problem solving session.

MOTOR SHAFT FAILS TO TURN -

No power to drive - check if AC voltage is present by checking if the green LED indicator on the drive is illuminated.

Open motor windings - check that each motor winding phase has the appropriate resistance with no open coils.

No incoming pulse - check for proper level and width of pulse at Logic Pin #2 (Step).

No power logic - be sure that Logic Pin #5,(ENA/NO PWR) is "high" or open.

Reset line held low - check to see that the reset line Logic Pin #6(RUN/RESET) is not held in a low state.

Fixed load - check to see that driven load is not jammed or too large a load for the chosen motor size.

MOTOR MOTION IS ERRATIC -

Improper lead connections - confirm that the leads of the motor are connected with the proper sequence.

Winding continuity - check to see that each phase of the motor has the appropriate resistance with no shorts between windings or to the housing.

Incoming pulse integrity - confirm that the pulses being supplied to the driver are the proper level and width and that the rates are not too fast for the motor to maintain synchronism.

Resonant instability - confirm that the motor is not operating in a resonance range by adjusting the pulse rate.

MOTOR RUNS VERY HOT -

Normal operating mode - it is normal for step motors, when run at their rated current, to be hot to the touch when operating. In general, if the motor case temperature is less that 85° C., their is no cause for concern.

Current set too high - check to see that the current is set at the appropriate level for the motor being operated.

MOTOR FAILS DURING ACCELERATION OR WHILE RUNNING -

Improper acceleration rate - check that the increasing rate of pulses feed to the drive is not too fast for the motor to maintain synchronism with the driven load.

Erratic loading - if the driven load dramatically changes while motor is driving, it could overcome the speed/torque capability of system - try to run motor while load disconnected.

No power logic - be sure that Logic Pin #5 (ENA/$\overline{\text{NO PWR}}$) is "High".

If all of the above remedies are attempted and the problem still remains, you may have to return the drive for service.

For assistance contact -

Your local API representative.

Your local Distributor.

or

CONTROLS DIVISION
45 Hazelwood Drive
Amherst, New York 14228-2278
716-691-9100
FAX 716-691-9181

To return a drive for service -
Please call the number above to receive a Return Material Authorization number. You will be instructed at that time where to return the drive for the most expeditious service.

APPENDIX A

*** STANDARD PACKAGED MOTOR LISTINGS ***

*** P41/P42 Series Packages ***

P41/P42 PACKAGES	STATIC TORQUE (Oz.In.)	WIDTH/ LENGTH (Inch.)	Bifilar(1) RATED CURRENT (Amps/ph)	DIP SWITCH SETTINGS [12345678](2)	CONTROLS DIV. MOTOR Basic Models
P4x-A231A	***(3)	2.3/2.0	1.0	01011010	23A-6102A
P4x-M171	15	1.7/1.3	1.7	10011001	M171-03
P4x-M172	20	1.7/1.5	2.1	00000011	M172-04
P4x-M173	25	1.7/1.8	2.8	11111111	M173-06
P4x-M231	60	2.3/2.0	1.0	01011010	23D-6102A
P4x-M232	100	2.3/3.3	1.8	01100101	23D-6204A
P4x-M233	150	2.3/4.0	2.9	01100111	23D-6306A
P4x-M341	150	3.4/2.5	3.0	01100111	34D-9106A

NOTES:

(1)- See Section 8 for an explanation of motor connections. Current switch settings for all the P41/P42 packages listed above are for a series winding connection.

(2)- A "0" indicates that the switch is off and a "1" indicates the switch is on (see Diagram 9.1).

(3)- Linear Actuator Model. Force is 100 lbs. for the packaged model that includes a .050 inch lead screw (20 pitch). Other lead screw pitches are available upon request.

Basic Models:

Motors supplied with these packages come with 12 inch leads. Size 17 motors are an 8 lead configuration with a single ended shaft. Size 23 and 34 motors are a 6 lead configuration with a single ended shaft.

Complete Models:

If you desire, Size 23 and 34 motors may be supplied with the following features at an additional cost:

-> Dual-shafted with a flat on the front shaft extension for positive load coupling.
-> Designed to accept a 1000 line Dual Channel Incremental Optical Encoder feature with Z channel home reference.
-> With 8 leads in twisted pairs in a six (6) foot shielded cable.

*** P51 Series Packages ***

P51 PACKAGES	STATIC TORQUE (Oz.In.)	WIDTH/ LENGTH (Inch)	Bifilar(1) RATED CURRENT (Amps/ph)	DIP SWITCH SETTINGS [12345678](2)	CONTROLS DIV. MOTOR Basic Model
P51-A231A	***(3)	2.3/2.0	3.8	00100011	23A-6108A
P51-M171	15	1.7/1.3	1.7	00001101	M171-03(See *)
P51-M172	20	1.7/1.5	2.1	00101011	M172-04(See *)
P51-M173	25	1.7/1.8	2.8	11111111	M173-06(See *)
P51-M231	60	2.3/2.0	3.8	00100011	23D-6108A
P51-M232	100	2.3/3.3	4.7	10001111	23D-6209A
P51-M233	150	2.3/4.0	4.6	01010111	23D-6309A
P51-M341	150	3.4/2.5	4.8	00011111	34D-9109A
P51-M342	300	3.4/3.7	4.6	01010111	34D-9209A

NOTES:

(1)- See Section 8 for an explanation of motor connections. Switch settings for all the motors are for a series winding connection except for P51-M171, P51-M172, and P51-M173 which are set for a parallel winding connection.

(2)- A "0" indicates that the switch is off and a "1" indicates the switch is on (see Diagram 9.1).

(3)- Linear Actuator Model. Force is 100 lbs. for the packaged model that includes a .050 inch lead screw (20 pitch). Other lead screw pitches are available upon request.

Basic Models:

Motors supplied with these packages come with 12 inch leads. Size 17 motors are an 8 lead configuration with a single ended shaft. Size 23 and 34 motors are a 6 lead configuration with a single ended shaft.

Complete Models:

If you desire, Size 23 and 34 motors may be supplied with the following features at an additional cost:

-> Dual-shafted with a flat on the front shaft extension for positive load coupling.
-> Designed to accept a 1000 line Dual Channel Incremental Optical Encoder feature with Z channel home reference.
-> With 8 leads in twisted pairs in a six (6) foot shielded cable.

APPENDIX B

*** DRIVE CURRENT SETTINGS ***

*** P41/P42 Series ***

BIFILAR MOTOR(1) (6 or 8 lead) Rated Current Per Phase	UNIFILAR MOTOR(2) (4 lead) Rated Current Per Phase	DIP SWITCH SETTING (Off/Open=0) (On/Closed=1) [12345678]
1.00	0.70	01011010
1.14	0.80	01100110
1.28	0.90	11001110
1.42	1.00	00000001
1.56	1.10	00110001
1.70	1.20	10011001
1.84	1.30	01100101
1.98	1.40	11001101
2.12	1.50	00000011
2.26	1.60	00110011
2.40	1.70	10011011
2.54	1.80	01100111
2.68	1.90	11001111
2.82	2.00	11111111

NOTES:

(1) - Bifilar Motors have two windings per stator pole. These windings can be connected differently to provide different results (see Section 8).

(2) - Unifilar Motors have one winding per stator pole and can only be connected one way.

APPENDIX B (continued)

*** P51 Series ***

BIFILAR MOTOR(1) (6 or 8 lead) Rated Current Per Phase	UNIFILAR MOTOR(2) (4 lead) Rated Current Per Phase	DIP SWITCH SETTING (Off/Open=0) (On/Closed=1) [12345678]
1.00	0.70	11001100
1.14	0.80	01011100
1.28	0.90	01000010
1.42	1.00	10010010
1.56	1.10	00001010
1.70	1.20	00011010
1.84	1.30	11111010
1.98	1.40	11100110
2.12	1.50	01110110
2.26	1.60	10101110
2.40	1.70	00111110
2.54	1.80	00000001
2.68	1.90	11010001
2.82	2.00	01001001
2.98	2.10	01011001
3.12	2.20	10000101
3.26	2.30	00010101
3.40	2.40	00001101
3.54	2.50	11101101
3.68	2.60	01111101

*** P51 Series (continued) ***

BIFILAR MOTOR(1) (6 or 8 lead) Rated Current Per Phase	UNIFILAR MOTOR(2) (4 lead) Rated Current Per Phase	DIP SWITCH SETTING (Off/Open=0) (On/Closed=1) [12345678]
3.82	2.70	10100011
3.96	2.80	10110011
4.10	2.90	00101011
4.24	3.00	11011011
4.38	3.10	11000111
4.52	3.20	01010111
4.66	3.30	10001111
4.80	3.40	00011111
4.96	3.50	11111111

NOTES:

(1) - Bifilar Motors have two windings per stator pole. These windings can be connected differently to provide different results (see Section 8).

(2) - Unifilar Motors have one winding per stator pole and can only be connected one way.

APPENDIX C

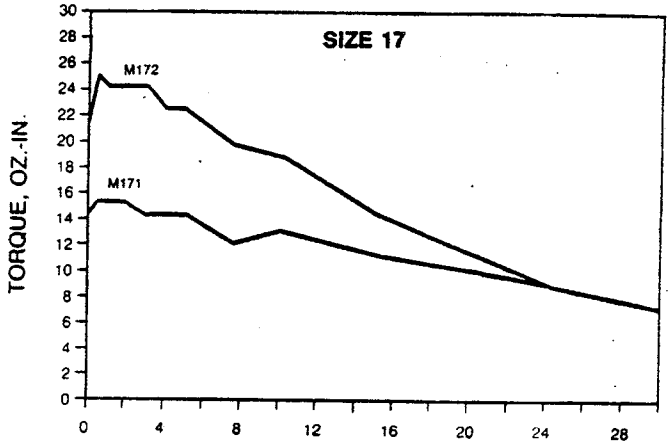
*** DRIVE VOLTAGE SET-UP ***

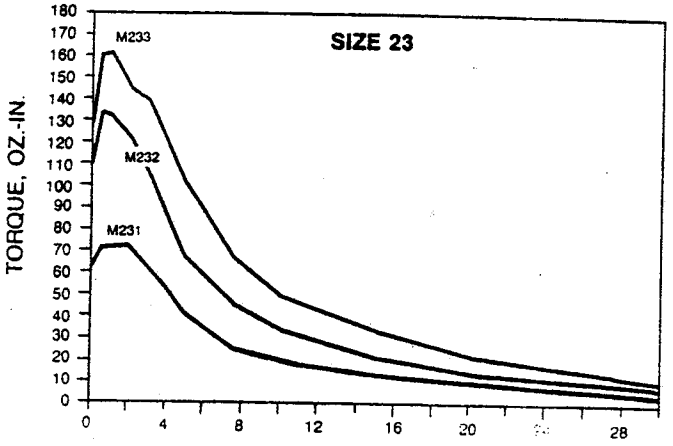
The P41/42/51 series drives are configured at the factory for 115 VAC input. If the customer requires 230 VAC input then the enclosure must be removed and the rotary selector switched to the 230 VAC setting. Reassemble the drive enclosure and label the drive as configured for 230 VAC to prevent damage in future applications.

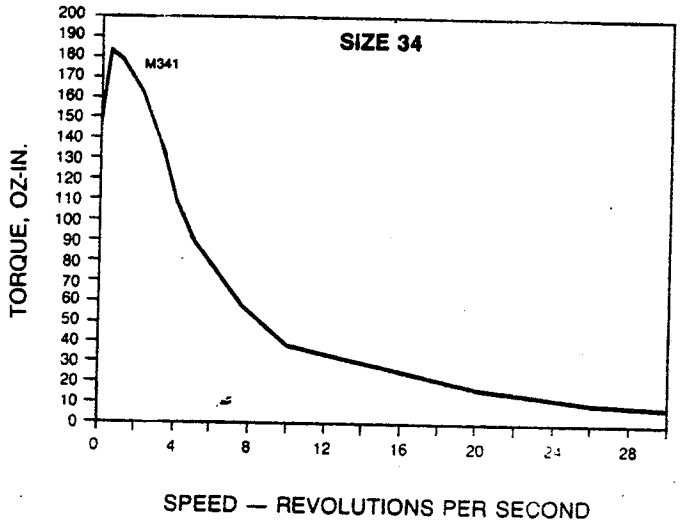
All connections or changes to the drive configuration should be made with any power sources turned off and disconnected from the drive.

APPENDIX D

*** P41 Performance Curves ***







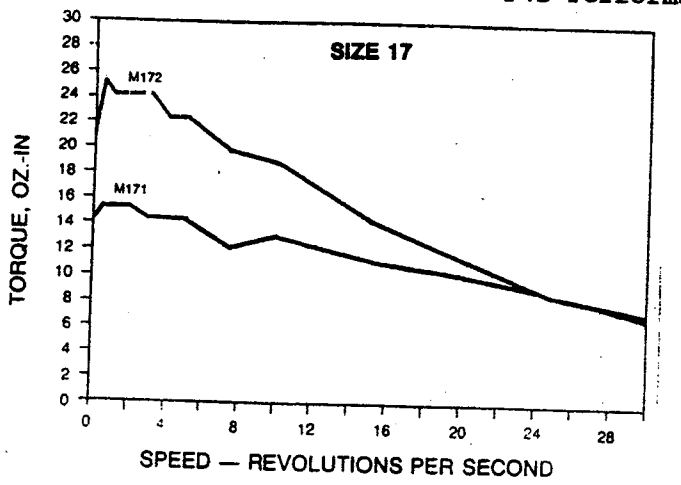
Pullout curves generated utilizing 115VAC input, 200 steps per revolution, and the SAC-560 Smart Axis Controller to provide ramping routines and step pulses.

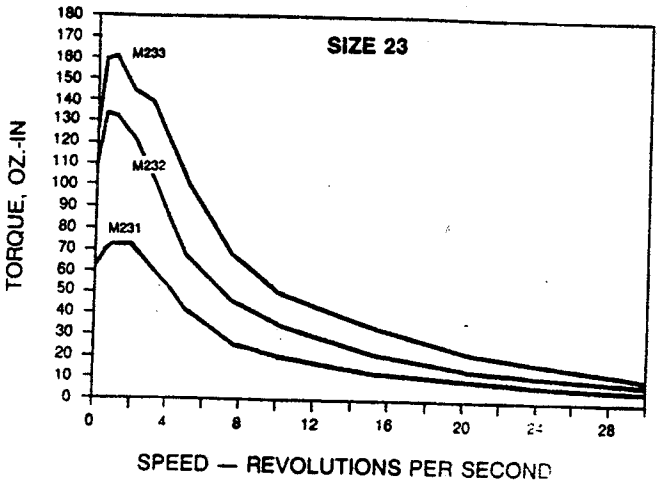
SYSTEM SELECTIONS/MOTOR DIMENSIONS

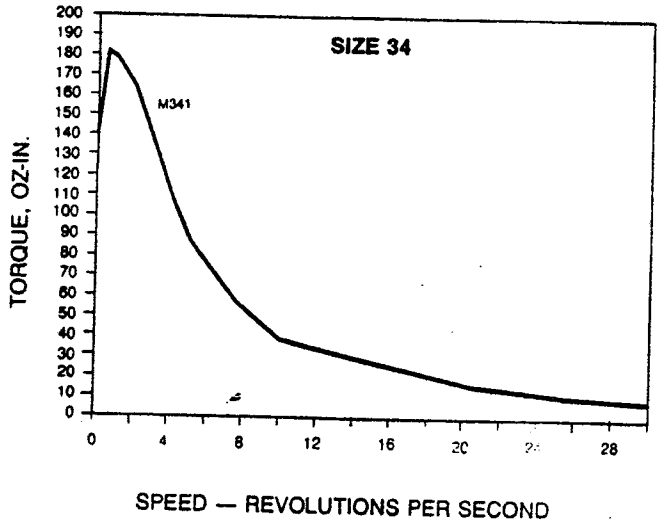
Part #	Static Torque (Oz. In.)	Width	Length
P41-A231	**	2.23" (57mm)	2.00" (51mm)
P41-M171	15	1.70" (42mm)	1.34" (34mm)
P41-M172	20	1.70" (42mm)	1.54" (39mm)
P41-M173	30	1.70" (42mm)	1.84" (47mm)
P41-M231	60	2.23" (57mm)	2.00" (51mm)
P41-M232	100	2.23" (57mm)	3.25" (83mm)
P41-M233	150	2.23" (57mm)	4.00" (102mm)
P41-M341	150	3.35" (85mm)	2.45" (62mm)

** — Linear Actuator model. Force is 40-100 lbs.

*** P42 Performance Curves ***







Pullout curves generated utilizing 115VAC input, 200 steps per revolution, and the SAC-560 Smart Axis Controller to provide ramping routines and step pulses.

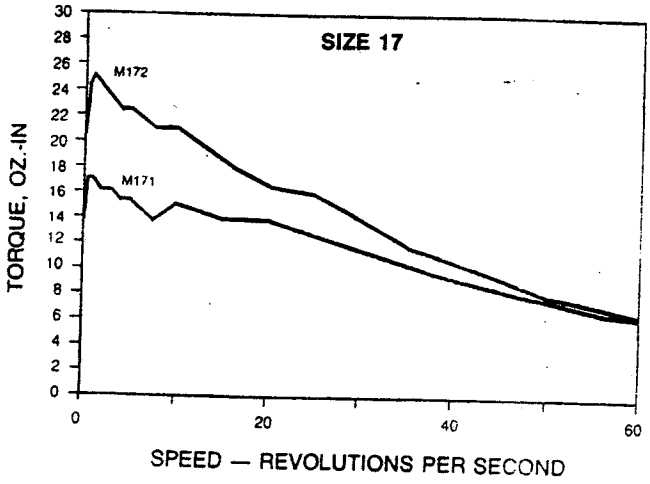
SYSTEM SELECTIONS/MOTOR DIMENSIONS

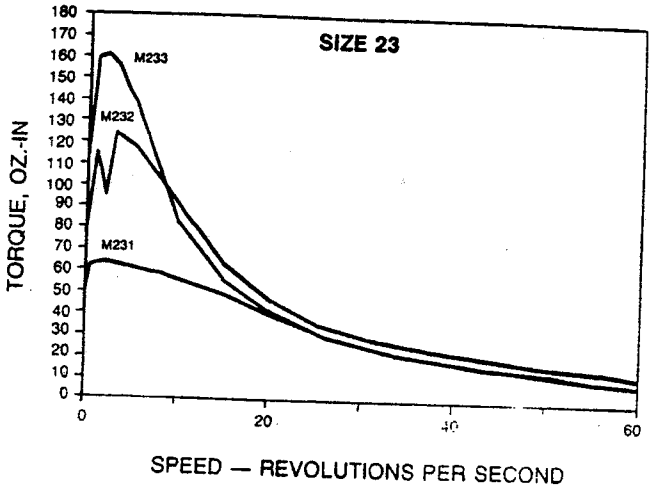
Part #	Static Torque (Oz. In.)	Width	Length
A231	**	2.23" (57mm)	2.00" (51mm)
M171	15	1.70" (42mm)	1.34" (34mm)
M172	20	1.70" (42mm)	1.54" (39mm)
M173	30	1.70" (42mm)	1.84" (47mm)
M231	60	2.23" (57mm)	2.00" (51mm)
M232	100	2.23" (57mm)	3.25" (83mm)
M233	150	2.23" (57mm)	4.00" (102mm)
M341	150	3.35" (85mm)	2.45" (62mm)

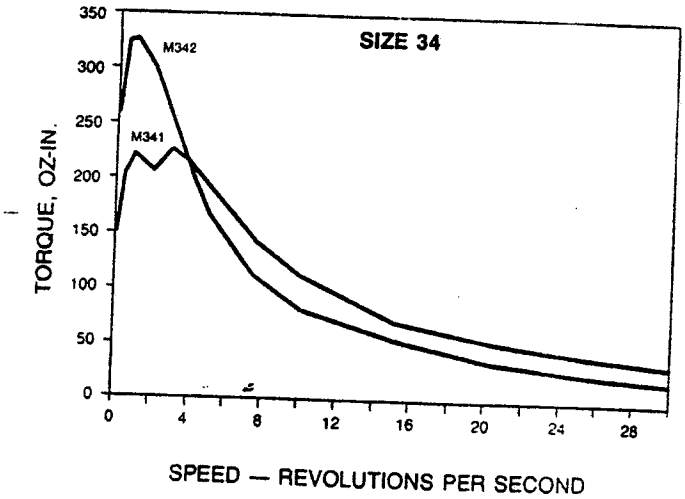
** — Linear Actuator model. Force is 40-100 lbs.

Select two motors for a complete two axis system.

*** P51 Performance Curves ***







Pullout curves generated utilizing 115VAC input, 200 steps per revolution, and the SAC-560 Smart Axis Controller to provide ramping routines and step pulses.

SYSTEM SELECTIONS/MOTOR DIMENSIONS

Part #	Static Torque (Oz. In.)	Width	Length
P51-A231	**	2.23" (57mm)	2.00" (51mm)
P51-M171	15	1.70" (42mm)	1.34" (34mm)
P51-M172	20	1.70" (42mm)	1.54" (39mm)
P51-M173	25	1.70" (42mm)	1.84" (47mm)
P51-M231	60	2.23" (57mm)	2.00" (51mm)
P51-M232	100	2.23" (57mm)	3.25" (83mm)
P51-M233	150	2.23" (57mm)	4.00" (102mm)
P51-M341	150	3.35" (85mm)	2.45" (62mm)
P51-M342	300	3.35" (85mm)	3.70" (93mm)

** — Linear Actuator model. Force is 40-100 lbs.

AMERICAN PRECISION INDUSTRIES
CONTROLS DIVISION

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