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# Sanyo Denki
# PY Servo System

## Installation and Operation Manual

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**SANYO DENKI**

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# Introduction

## About this Guide

### In this Chapter

This chapter covers the following topics:


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### Introduction

This guide provides you with information needed to install, operate, and maintain PY model servo amplifiers and matching motors.

### Manual Organization

This guide consists of the following chapters:

**Chapter 1.** **Introduction** provides an overview of the Safety issues associated with the application of servo motors and amplifiers, informs you about all your product support options, and finally provides an overview of the PY family of amplifiers, the P2, P3, P5, and P6 family of motors, and system options and accessories.

**Chapter 2.** **Installation** provides detailed directions that take you step by step from unpacking your system, through installing the motor and installing the amplifier, and concludes with an installation checklist.

**Chapter 3.** **Wiring** describes how to wire a system - starting first with a summary table indicating recommended wire sizes, followed by connection diagrams, and concluding with details for connecting external regeneration resistors and the remote operator. Detailed connector pin assignments are provided as well as a partial schematic for input and output signals.


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**Chapter 4.** **System Configuration** describes how to use the remote operator and then walks you through the configuring and tuning of your system. This chapter concludes with a detailed description of each amplifier parameter.

**Chapter 5.** **Operation** chapter provides a detailed description of the sequence and timing of operation within the amplifier.

**Chapter 6,** **Drive Setup** chapter provides information on setup of the drive configuration for operation

**Chapter 7,** **Amplifier Parameters** chapter provides a list of all parameters used for the drive configuration.

**Chapter 8.** **Maintenance and Troubleshooting** provides you with a recommended maintenance program designed to keep your system in top operating condition. Should you experience any difficulty with your system, a detailed troubleshooting guide is provided to help you restore normal operation quickly.

**Chapter 9.** **Specifications** section includes detailed specifications for PY drive systems. This includes a detailed reference for all the amplifier parameters.

## Syntax Information

To help you locate and interpret information easily, this guide uses consistent visual cues and text formats. The different symbols and typefaces displayed in this guide are used for the following purposes:

**Table 1: Manual Syntax**

| | |
|---|---|
| ♫ | This symbol is used to identify important information of which you should take note. |
| ! | DANGER, WARNING or CAUTION require accompanying information notices to prevent potential personal injury and equipment damage.<br>DANGER: Indicates an imminently hazardous situation which, if not avoided, will result in serious injury or death. This signal word is limited to the most extreme situations.<br>WARNING: Indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.<br>CAUTION: Indicates a potentially hazardous situation which, if not avoided, may result in equipment damage or minor or moderate injury. |
| Earth Gnd | Protective conductor terminal, Earth Ground. |
| Chassis Gnd | Chassis terminal, Not a protective ground. |


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# Safety

| | |
|---|---|
| ! | **DANGER**<br>Only qualified personnel familiar with the construction and operation of this equipment and the hazards involved should install, adjust, operate, or service this equipment. Read and understand this manual and other applicable manuals in their entirety before proceeding. Failure to observe this could result in severe injury or loss of life. |

| | |
|---|---|
| ! | **DANGER**<br>The user is responsible for conforming with all applicable local, national, and international codes. The wiring examples in this manual are intended only as a guide. Wiring practices, grounding and disconnects, and over-current protection are of particular importance. Failure to observe this could result in severe injury or loss of life. |

| | |
|---|---|
| ! | **DANGER**<br>Do not operate the system in an explosive atmosphere. Failure to observe this could result in severe injury or loss of life and equipment damage. |

| | |
|---|---|
| ! | **WARNING**<br>Perform the initial power-up with the motor shaft disconnected from the load and the shaft key removed. Improper wiring or undiscovered shipping damage could result in undesired motion. Be prepared to remove power if excessive motion occurs. Failure to observe this precaution could result in bodily injury. |

| | |
|---|---|
| ! | **WARNING**<br>Large leakage currents exist in AC line filters. They must be grounded properly before applying power. Filter capacitors retain high voltages after power is removed. Before handling the equipment, voltage should be measured to determine safe levels. Failure to observe this precaution could result in severe bodily injury. |

| | |
|---|---|
| ! | **WARNING**<br>Avoid damaged cables. Cables may be damaged by applying excessive stress, placing a heavy object on them, or cutting them. Damaged cables may result in electrical shock which can cause severe bodily injury and damage equipment. |


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| ! | **CAUTION** |
|---|---|
| | Observe all installation directions. Failure to do so may result in injury, damage to equipment, or poor performance.<br><br>1. Make sure nothing obstructs or impedes ventilation around the amplifier.<br>2. Observe all mounting clearance distances around the unit.<br>3. Never install the system in a location where water, or other fluids, may be splashed, or in a flammable gas atmosphere.<br>4. Never place objects on this equipment. Doing so may result in damage, burns or fire.<br>5. Avoid strong shocks to equipment. This may result in injury or damage to equipment. |

| ! | **WARNING** |
|---|---|
| | During normal operation, the amplifier, motor and peripheral equipment could become hot enough to cause a burn. |


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# Technical Support

**Online Support**

The most convenient and effective method for support is online at our web site

**www.MotionOnline.com**

In addition to this manual, you may download our *Handbook of AC Servo Systems*, application notes and answers to frequently asked questions from this site.

---

**Telephone Support**

Sanyo Denki America maintains a Technical Support center that is staffed weekdays (except holidays) between 8:30 AM and 5:30 PM Eastern Standard Time.

- Telephone: 770-497-8086 or Toll Free 1-888-531-8213
- Facsimile: 770-497-8666

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# Product Family Overview




## Amplifiers

Sanyo Denki designs and manufactures a wide range of servo and stepper drives. Eight models from the PY family are available to you from Sanyo Denki America via MotionOnline.com.

- PY2A015 15A
- PY2A030 30A
- PY2A050 50A
- PY0A015 15A
- PY0A030 30A
- PY0A050 50A
- PY0A100 100A
- PY0A150 150A

## Motors

Sanyo Denki designs and manufactures a wide range of servo and stepper motors. Twenty (10 without brakes and 10 with brakes) models from the P2, P3, P5 and P6 families are available to you from Sanyo Denki America via MotionOnline.com.

- P20B10150D 1.5kW 4.9Nm
- P20B10250D 2.5kW 8.8Nm
- P20B13300D 3.0kW 10.8Nm
- P20B13500D 5.0kW 18.1Nm
- P30B04010D 100W 0.35Nm
- P30B06040D 400W 1.37Nm
- P30B08075D 750W 2.55Nm
- P50N05020D 200W 0.686Nm
- P50N08100D 1kW 3.92Nm
- P60B13150H 1.5kW 7.5Nm


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## Systems

From these motors and amplifiers, the following 17 systems can be assembled. All the systems can operate up to 4,500 RPM (except for the P6 motor that is 3000 RPM). The power listed is continuous at 3,000 RPM (except for the P6 motor at 2000 RPM) while the torque listed is continuous at 0 RPM.

**Table 2: Valid Drive Systems**

| Motor Model | W | Nm | PY2 Amplifiers | | | PY0 Amplifiers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 15A | 30A | 50A | 15A | 30A | 50A | 100A | 150A |
| P30B04010D | 100 | 0.35 | ⊙ | | | ⊙ | | | | |
| P30B06040D | 400 | 1.37 | | ⊙ | | | ⊙ | | | |
| P30B08075D | 750 | 2.55 | | ⊙ | | | ⊙ | | | |
| P20B10150D | 1500 | 4.9 | | | ⊙ | | | ⊙ | | |
| P20B10250D | 2500 | 8.8 | | | | | | | ⊙ | |
| P20B13300D | 3000 | 10.8 | | | | | | | ⊙ | |
| P20B13500D | 5000 | 18.1 | | | | | | | | ⊙ |
| P50N05020D | 200 | 0.686 | ⊙ | | | ⊙ | | | | |
| P50N08100D | 1000 | 3.92 | | | ⊙ | | | ⊙ | | |
| P60B13150H | 1500 | 7.5 | | | ⊙ | | | ⊙ | | |

## Remote Operator / Software

The remote operator or PY software is required to set/change all the parameters in the traditional PY amplifiers.

The remote operator is not required for operation and may therefore be shared between all the drives in a system. The same remote operator is used for the PY amplifiers.

The PC-SETUP software can be used to set/change all parameters in the traditional PY amplifiers (except for power phasing). This item may be purchased instead of the remote operator.


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**Cables**

To lower life-cycle cost and improve reliability, Sanyo Denki America requires customers to use Sanyo Denki motor power and feedback cables. These cables may be ordered in standard (10, 15, 20, 30, 50, 75, or 100 ft) or custom lengths. Standard cables are usually available directly from stock.

**External Regen Resistors**

Optional external regeneration resistors are available to extend the continuous regeneration power of the amplifier.


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# Installation

## Chapter Overview

This chapter contains a guide for the installation of the amplifier and matching motor, from unpacking the equipment, performing an initial test, to mounting it in a panel.


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# Unpacking and Inspection Procedure

**Unpack the Amplifier**

- Before opening packages, verify that the model numbers of the box match your order. If they do not, please contact Sanyo Denki America (see page 9 - Technical Support).
- After opening, verify that the model numbers on the product match the box. If they do not, please contact Sanyo Denki America (see page 9 - Technical Support).

**Inspection**

- After unpacking, verify that the servo amplifier and motor are free from any physical damage that may have occurred during shipment. If you find damage, contact your Buyer to make a claim with the shipper.
- Perform the Inspection Test to verify functionality of the system.


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# Amplifier Installation

**General Requirement**

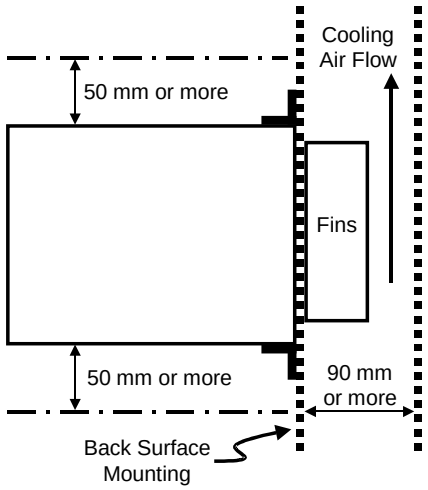
| Condition | Recommended Precautions |
|---|---|
| Amplifier In An Enclosure | The temperature inside an enclosure may be higher than the outside temperature, depending on the power loss of internal equipment and the dimensions of the box.<br><br>Be sure to determine the dimensions of the box, cooling method, and panel layout so that the ambient temperature is lower than 55C. |
| Amplifier Near A Vibrating Source | Install the amplifier with a shock absorber to dampen the vibration that is transmitted directly to amplifier. |
| Amplifier Near A Heat Source | Shield the amplifier so that convection or radiation does not raise the ambient temperature 55C. |
| Corrosive Gas Environment | If the amplifier is operated for extended time periods in a corrosive environment, contact failure will occur at contact points (e.g., connectors). Therefore, never install the amplifier in a corrosive gas environment. |
| Explosive Or Combustible Gas Environment | Never install the amplifier in an explosive gas or combustible gas environment. Relays and contactors, which generate arcs (sparks) inside boxes and hot parts such as regeneration brake resistor, may become ignition sources, causing a fire or explosion. |
| Dust And Oil Environments | Never install the amplifier in an environment containing dust or oil mist. Dust and oil mist, which adheres to or accumulates on the amplifier, will result in damage to the amplifier from lower insulation resistance or leakage currents between conductors or components. |
| Electrical Noise Environments | Induction noise will enter input signals and the power supply circuit, causing the amplifier to malfunction. When installing the amplifier in an electrically noisy environment, take proper measures such as inserting a noise filter, shielding, or suppressing the noise source. |

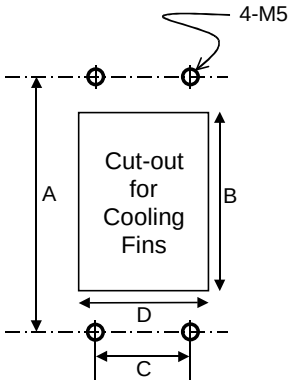

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## Mounting and Clearance Requirements

Install the amplifier vertically as shown in the figure below, with the indicated clearances. Because the amplifier uses convection cooling it may not be mounted horizontally. Provide the indicated space above, below and to the side of the amplifier for airflow. If this space cannot be provided, install a fan to increase airflow around the amplifier. At least 10 mm space should be provided on each side of the amplifier to allow air flow.



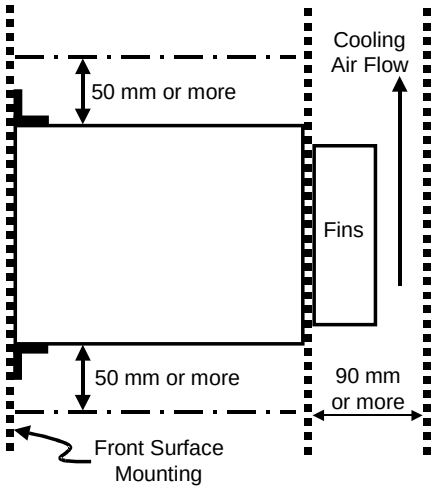



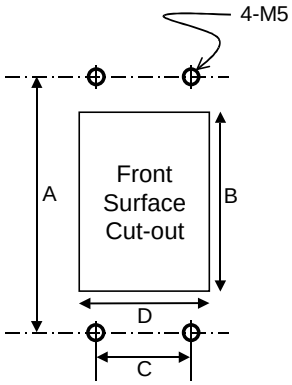

| | A | B | C | D |
|---|---|---|---|---|
| PY2A015 | 160 mm | NA | 25 mm | NA |
| PY2A030 | 160 mm | NA | 25 mm | NA |
| PY2A050 | 160 mm | NA | 50 mm | NA |
| PY0A015 | 225 mm | NA | 25 mm | NA |
| PY0A030 | 225 mm | NA | 25 mm | NA |
| PY0A050 | 225 mm | >197 mm | 50 mm | >67 mm |
| PY0A100 | 225 mm | >197 mm | 50 mm | >92 mm |
| PY0A150 | 225 mm | >197 mm | 75 mm | >142 mm |

- Only the PY0A050, PY0A100, and PY0A150 are equipped with the “cooling fins”.


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| | A | B | C | D |
|---|---|---|---|---|
| PY2A015 | 160 mm | NA | 25 mm | NA |
| PY2A030 | 160 mm | NA | 25 mm | NA |
| PY2A050 | 160 mm | NA | 50 mm | NA |
| PY0A015 | 225 mm | >205 mm | 25 mm | NA |
| PY0A030 | 225 mm | >205 mm | 25 mm | NA |
| PY0A050 | 225 mm | >212 mm | 50 mm | >67 mm |
| PY0A100 | 225 mm | >212 mm | 50 mm | >92 mm |
| PY0A150 | 225 mm | >212 mm | 75 mm | >142 mm |

- Only the PY0A050, PY0A100, and PY0A150 are equipped with the “cooling fins”.


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## Amplifier Environmental Requirements

The amplifier should be installed in an environment that meets these requirements.

**Table 3: Amplifier Environmental Requirements**

| Item | Specification |
|---|---|
| Ambient Temperature | |
| Operating | 0 to 55C<br>32° to 131°F |
| Non-operating | -20 to 65C<br>-4° to 149°F |
| Humidity Maximum | 90% Non-condensing |
| Vibration Maximum | 0.5G 10 to 55Hz |
| Shock Maximum | 2G |
| Air Quality | Dust-free<br>Oil-free<br>Non-corrosive<br>Non-combustible<br>Non-explosive |

## Power Dissipation

During operation, the amplifier dissipates power that results in cabinet heating. The following table lists power dissipation values for valid system configurations. These values assume continuous rated load operation. Calculate the cabinet cooling requirements using the power dissipation information and the formulas that follow.

**Table 4: Power Dissipation**

| Drive Model | Motor Model | Power Dissipation [W] | | |
|---|---|---|---|---|
| | | Total | PCB | Heatsink |
| PY2A015 | P30B04010D | 19 | - | - |
| PY2A015 | P50N05020D | 23 | - | - |
| PY2A030 | P30B06040D | 32 | - | - |
| PY2A030 | P30B08075D | 45 | - | - |
| PY2A050 | P50N08100D | 54 | - | - |
| PY2A050 | P20B10150D | 85 | 55 | 30 |
| PY2A050 | P60B13150H | 85 | 50 | 50 |
| PY0A015 | P30B04010D | 19 | - | - |
| PY0A015 | P50N05020D | 23 | - | - |
| PY0A030 | P30B06040D | 32 | - | - |
| PY0A030 | P30B08075D | 16 | - | - |
| PY0A050 | P50N08100D | 80 | 50 | 30 |
| PY0A050 | P20B10150D | 85 | 55 | 30 |
| PY0A050 | P60B13150H | 85 | 50 | 50 |
| PY0A100 | P20B10250D | 170 | 98 | 72 |
| PY0A100 | P20B13300D | 175 | 103 | 72 |
| PY0A150 | P20B13500D | 260 | 150 | 110 |

Power dissipation values shown in the table do not include values for the internal regeneration resistor.

When using an external regeneration resistor, the internal resistor is disconnected.


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## Enclosure Size

When sizing a NEMA 12 or equivalent enclosure with no active method for cooling, the following equation approximates the size of enclosure required.

$$T = 4.08 \times \left( \frac{Q}{A} \right) + 1.1$$

Where:

$T$ = Temperature difference between inside air (130 °F maximum) and outside air [°F]

$Q$ = Total amount of heat generated in the enclosure [W]

$A$ = Surface area of the enclosure in $ft^2$ = $(2DW + 2DH + 2WH) / 144$

$D$ = Depth in inches

$H$ = Height in inches

$W$ = Width in inches


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# Motor Installation

## Environmental Requirements

The motor should be installed in an environment that meets these requirements.

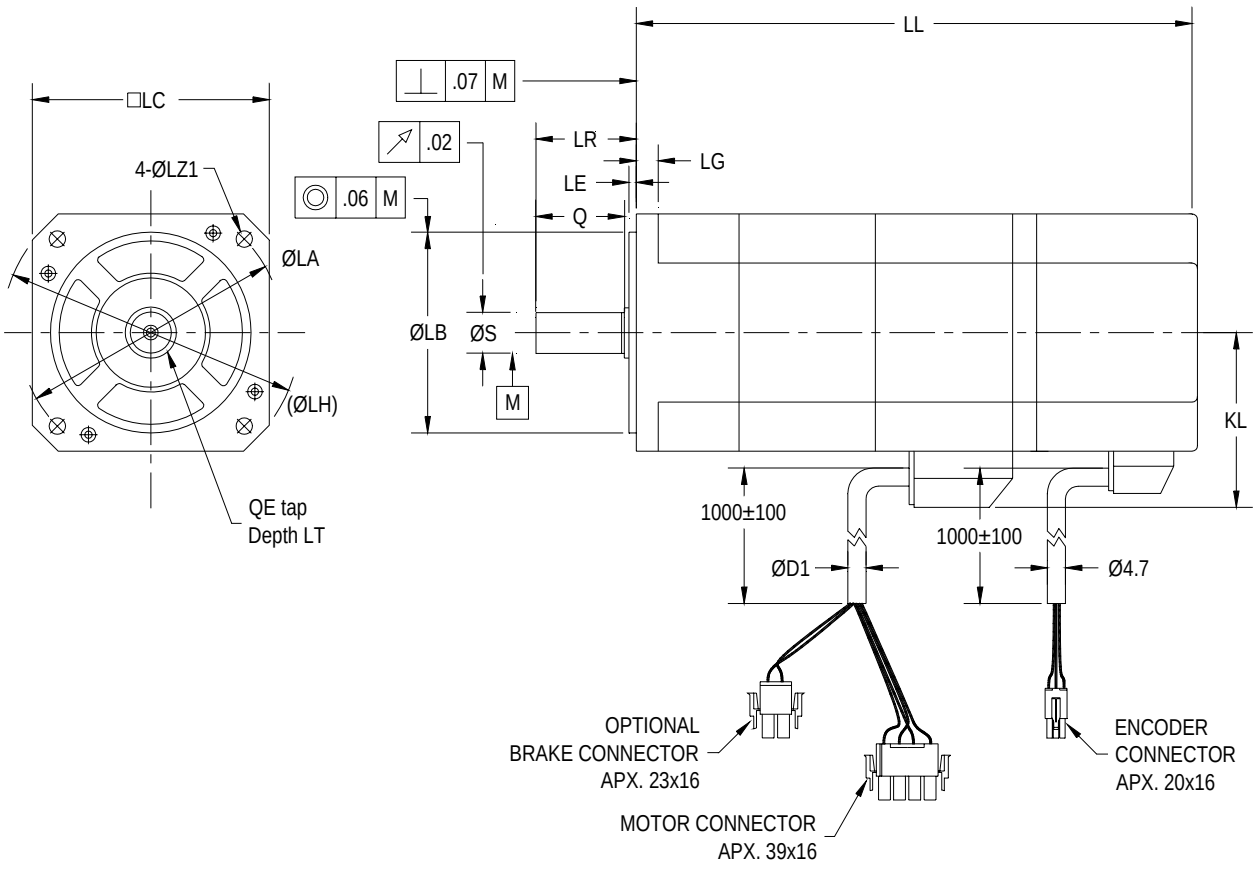
**Table 5: Motor Environmental Requirements**

| Item | Specification |
|---|---|
| Ambient Temperature | |
| Operating | 0 to 40C<br>32° to 104°F |
| Non-operating | -20 to 65C<br>-4° to 149°F |
| Humidity Maximum | 20% to 90% Non-condensing |
| Air Quality | Dust-free<br>Oil-free<br>Non-corrosive<br>Non-combustible<br>Non-explosive |


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**Motor Mounting** *P3/P5 Motor Dimensions Diagram (all dimensions in mm)*

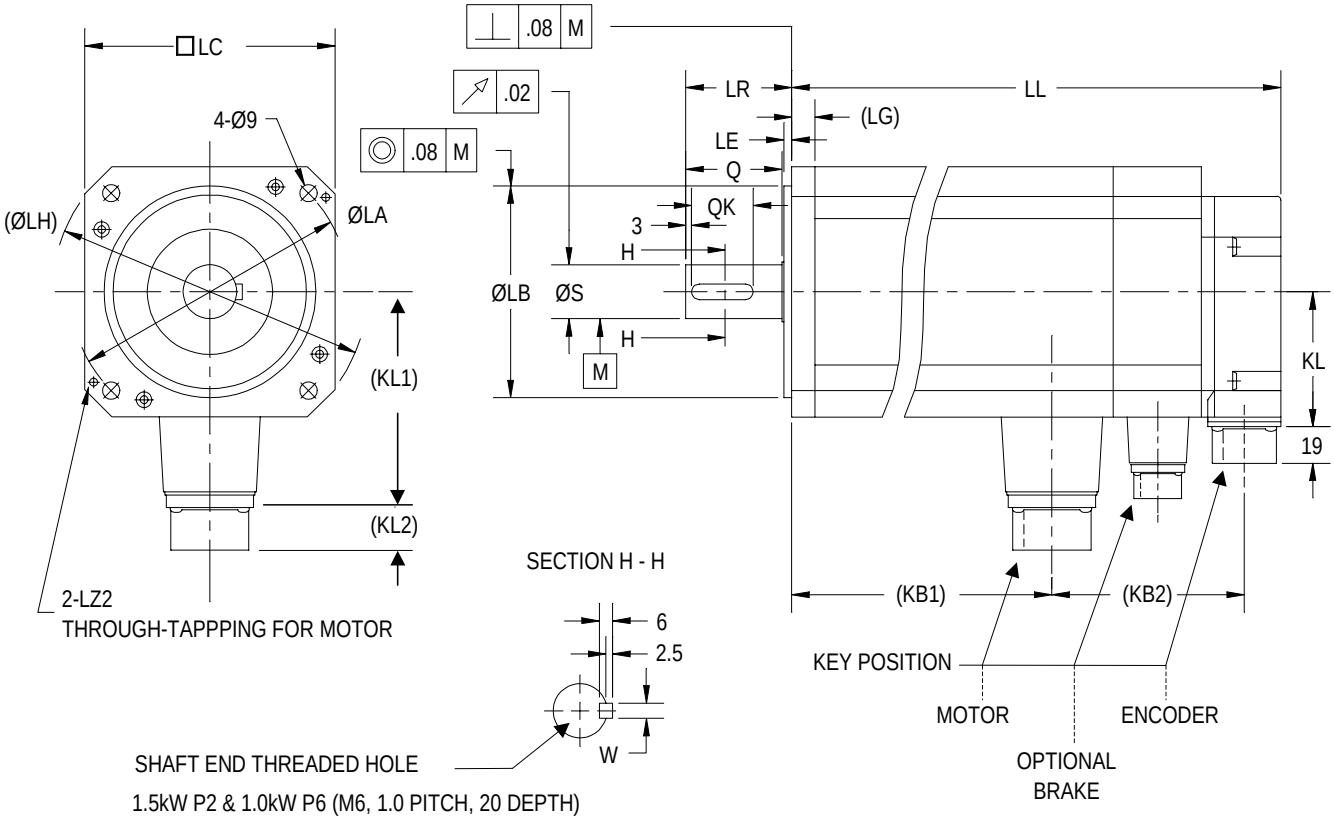



| Type | LL w/o brake | LL w/ brake | LG | KL | LA | LB | LE | LH | LC | LZ1 | LR | S | Q | QE | LT | D1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P30B04010 | 88 | 126.5 | 5 | 30 | 46 | 30 +0.000 -0.021 | 2.5 | 54 | 40 | 4.5 | 25 | 8 +0.000 -0.009 | - | - | - | 6 |
| P30B06040 | 123.5 | 161.5 | 6 | 41 | 70 | 50 +0.000 -0.025 | 3 | 81 | 60 | 5.5 | 30 | 14 +0.000 -0.011 | - | M5 | 12 | 6.7 |
| P30B08075 | 140 | 180.5 | 8 | 52 | 90 | 70 +0.000 -0.030 | 3 | 107 | 80 | 6.6 | 40 | 16 +0.000 -0.011 | 35 | M5 | 12 | 6.7 |
| P50N05020 | 105 | 134 | 5 | 38 | 66.68 | 38.1 +0.000 -0.051 | 1.524 | 71.5 | 57.15 | 5.207 | 30 | 11 +0.000 -0.011 | 25 | M4 | 10 | 7.5 |
| P50N08100 | 172 | 212 | 8 | 55 | 98.43 | 73.025 +0.000 -0.051 | 2.5 | 115 | 86 | 5.588 | 35 | 16 +0.000 -0.011 | 30 | M5 | 12 | 7.5 |


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**Motor Mounting** *P2/P6 Motor Dimension Diagram (all dimensions in mm)*




| | w/o brake | | w/ brake | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Type** | **LL** | **KB2** | **LL** | **KB2** | **KB1** | **KL1** | **KL2** | **LG** | **LA** | **LB** | **LE** | **LH** | **LC** | **LZ2** | **LR** | **S** | **Q** | **QK** | **W** |
| P20B10150 | 172 | 48 | 216 | 92 | 105 | 76 | 19 | 10 | 115 | 95 +0.000 -0.035 | 3 | 130 | 100 | - | 45 | 22 +0.000 -0.013 | 40 | 32 | 6 | +0.000 -0.030 |
| P20B10250 | 222 | | 266 | | 155 | | | | | | | | | | | | | | | |
| P20B13300 | 194 | 58 | 236 | 100 | 117 | 98 | 21 | 12 | 145 | 110 +0.000 -0.035 | 4 | 165 | 130 | M6 | 55 | 28 +0.000 -0.013 | 50 | 42 | 6 | +0.000 -0.030 |
| P20B13500 | 267 | | 309 | | 190 | | | | | | | | | | | | | | | |
| P60B13150 | 152 | 57 | 185 | 90 | 75 | 98 | 21 | 12 | 145 | 110 +0.000 -0.035 | 4 | 165 | 130 | M6 | 55 | 22 +0.000 -0.013 | 50 | 42 | 6 | +0.000 -0.030 |

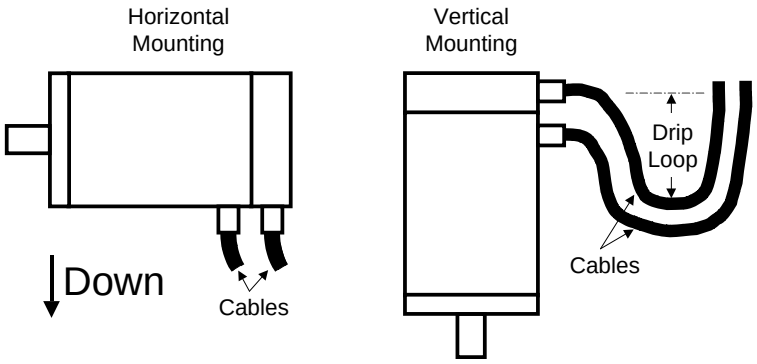

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## Motor Orientation and Cable Routing

### *Cable and Motor Orientation*

The servomotor can be installed horizontally or vertically with the shaft pointing down. If the motor is positioned horizontally, rotate the motor so that the cables exit downward. If the motor is mounted vertically, provide a cable trap to prevent oil or water from flowing down the cable to the motor.




### *Prevention Against Fluids*

The motor, as a single unit, satisfies the IEC standard for sealing against water as indicated in the table below.

**Table 6: Motor IP Rating**

| Motor | Rating | Conditions |
|---|---|---|
| P3 | IP43 | • Protected against solid objects (diameter 1 mm) and splashing water. |
| P5 | IP55 | • Motor shaft seal installed, standard<br>• Cable with environmental connectors are connected to motor, standard. The motor is not protected when cables are not attached.<br>• Protected against dust – limited ingress (no harmful deposit) and low pressure jets of water from all directions – limited ingress permitted. |
| P2 & P6 | IP67 | • Motor shaft seal installed, standard<br>• Cable with environmental connectors are connected to motor, standard. The motor is not protected when cables are not attached.<br>• Protected against dust and effects of immersion. |

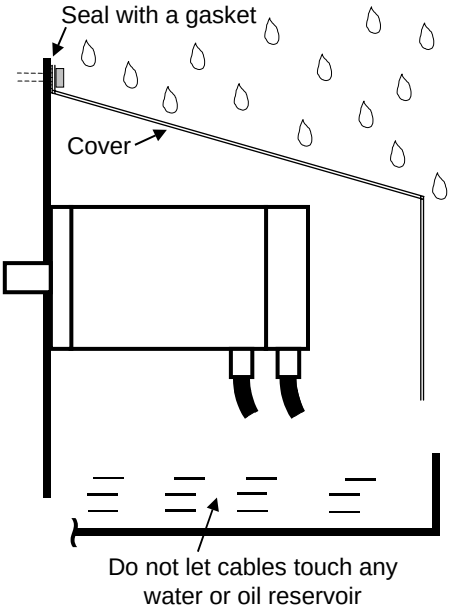
Since the IEC standard is intended to check performance over a short period of time, the following measures against fluids are required for actual usage.

- Handle the system carefully to prevent damage to cable jackets, which may deteriorate waterproofing.
- Mount the motor with the connectors (lead outlet) pointing downward.
- Install a cover, with a gradient, over the motor to prevent oil or water from splashing directly on the motor.

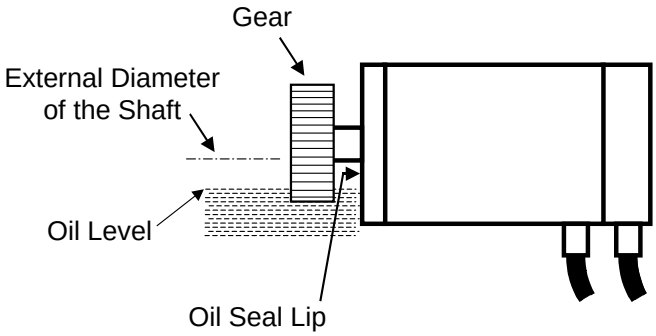

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- Avoid dipping the cable into oil or water.
- Slacken the cable outside the cover and provide a cable trap so that oil and water may not travel up the cable.




- If an oil-filled gearbox is used, make the oil level of the gearbox lower than the oil seal lip. Provide a vent in the gearbox to prevent internal pressure in the gearbox from rising and forcing oil into the motor.




## Connecting the Load to the Motor

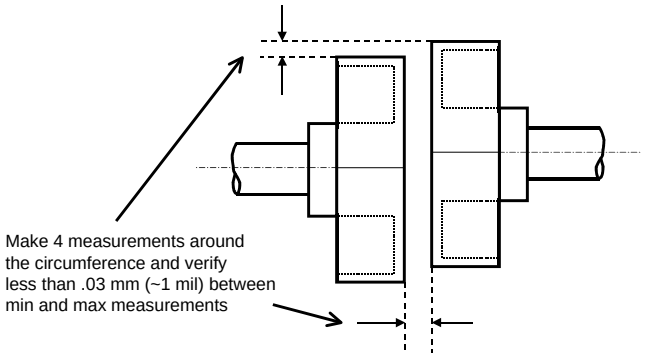
The mechanical connection between the motor and the load is critical. An improper connection can limit performance and shorten the life of the motor.

- Perform centering accurately between the motor shaft and the load as shown in the figure below. Note that with a rigid coupling, a slight offset will lead to damage of the output shaft.

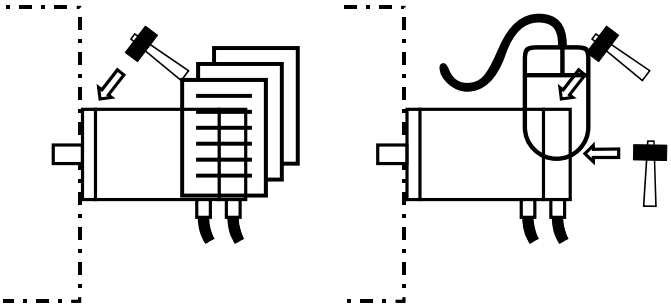

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- To check centering, make a measurement at 4 points on the circumference, the difference between maximum and minimum should be 0.03 mm or less.

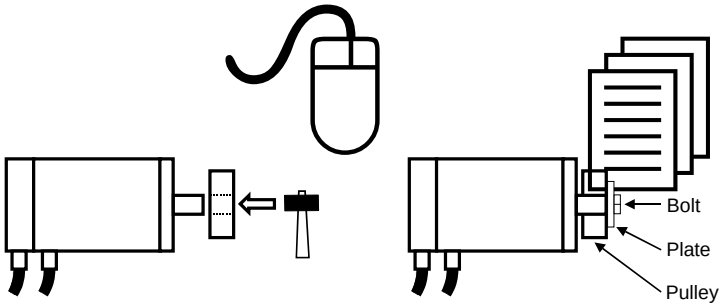



- A precision encoder is directly connected to the motor shaft. A shock to the motor shaft during installation may damage the encoder. If tapping on the motor is unavoidable for position adjustment or other reasons, tap on the front flange with a rubber or plastic hammer.



- When installing the motor to the machine, make the mounting holes precise. Also, make the mounting surface as flat as possible to avoid damage to the motor shaft or bearing.

- When installing a gear, pulley, or coupling on the shaft avoid striking the shaft, which will damage the motor encoder. Use a bolt on the end of the shaft to pull tight fitting parts together.

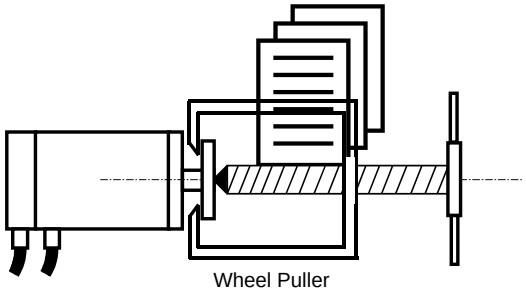




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- When removing the gear, pulley, or coupling from the shaft, use a dedicated extracting tool to avoid damaging the shaft or motor encoder.



Wheel Puller

- When mounting motor to a timing belt drive, check that the shaft-converted value of the belt tension does not exceed the allowable value shown in Table 7: Allowable Radial and Thrust Loads.

## Bearing Load Specifications

When attaching a pulley or gear directly to the motor shaft, do not apply an excessive thrust or radial load. The thrust and radial loads in the table below are the maximum allowable loads when independently applied to the shaft.

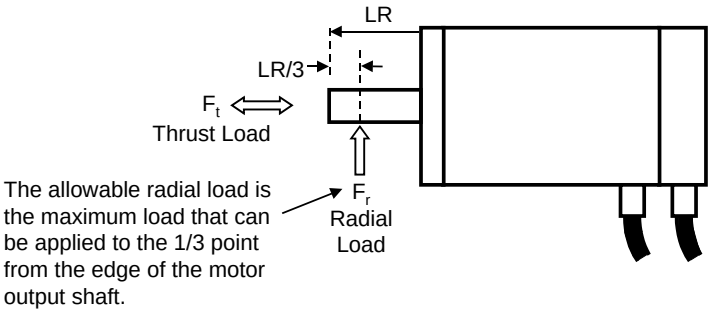



**Table 7: Allowable Radial and Thrust Loads**

| Model | During Assembly | | During Operation | |
|---|---|---|---|---|
| | Radial Load Fr [kg] | Thrust Load Ft [kg] | Radial Load Fr [kg] | Thrust Load Ft [kg] |
| P30B04010D | 15 | 10 | 10 | 3 |
| P30B06040D | 40 | 20 | 25 | 10 |
| P30B08075D | 60 | 40 | 35 | 20 |
| P50N05020D | 25 | 20 → 15 ← | 20 | 8 |
| P50N08100D | 60 | 80 → 30 ← | 35 | 20 |
| P20B10150D | 100 | 30 | 70 | 30 |
| P20B10250D | 100 | 30 | 70 | 30 |
| P60B13150H | 173 | 194 | 65 | 50 |
| P20B13300D | 200 | 40 | 100 | 40 |
| P20B13500D | 200 | 40 | 120 | 40 |

(1kg = 2.2lb)


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# Installation Check List

- ☑ Amplifier is mounted in a clean protected environment free from dust, water, oil mist, corrosive gas, and combustible gas.
- ☑ Proper amplifier ventilation has been provided. The ambient temperature near the amplifier does not exceed 55°C during operation.
- ☑ The motor has been securely mounted to the machine and the load has been securely attached to the motor shaft.
- ☑ The radial and perpendicular alignments of the motor and load have been measured and are within specification.
- ☑ The radial and thrust loading on the motor shaft have been measured and are within specification.


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# Wiring

## Chapter Overview

This chapter contains a guide for wiring of the amplifier and matching motor.


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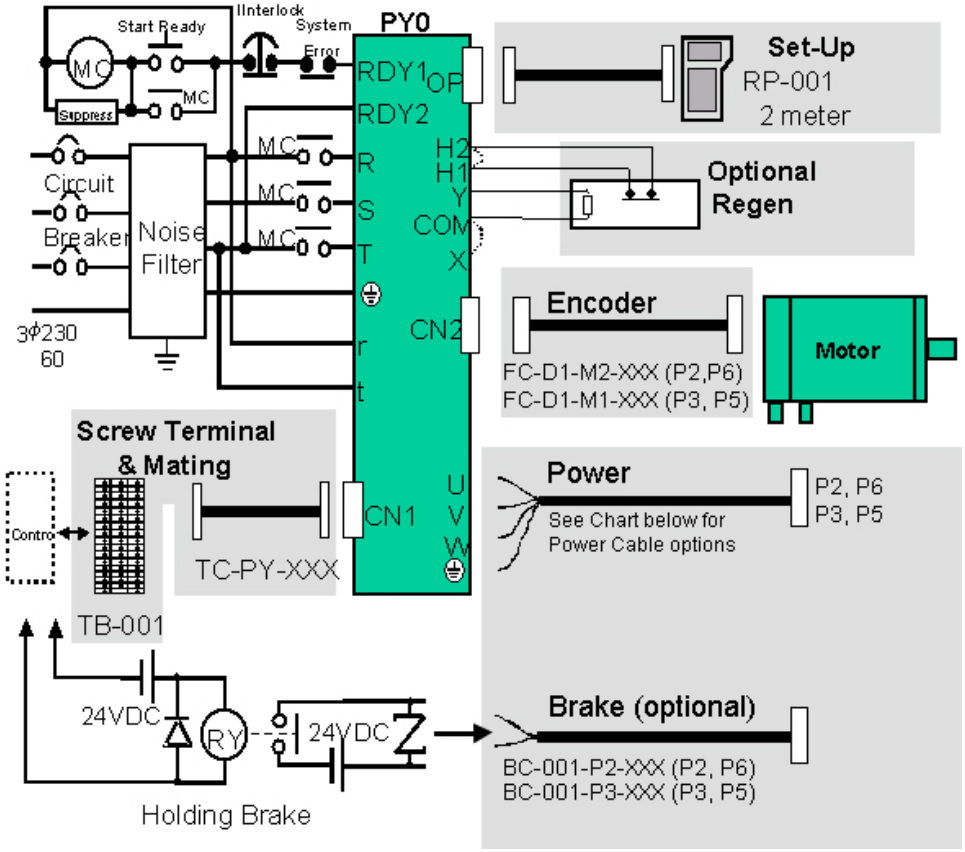


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**Cable Connection Diagram for PY0**

Below is a simplified connection diagram for a PY0. This diagram shows how to connect a system using standard cables. A detailed connection diagram follows.




| Power Cable Part # | Motor |
|---|---|
| **PC-D2-M2-XXX** | P2(1.5kW) |
| **PC-D3-M2-XXX** | P2(2.5kW) |
| **PC-D3-M3-XXX** | P2(3&5kW) |
| **PC-D2-M3-XXX** | P6(1.5kW) |
| **PC-D1-M1-XXX** | P3 & P5 (except P5 1kW) |
| **PC-D2-M1-XXX** | P5(1kW) |

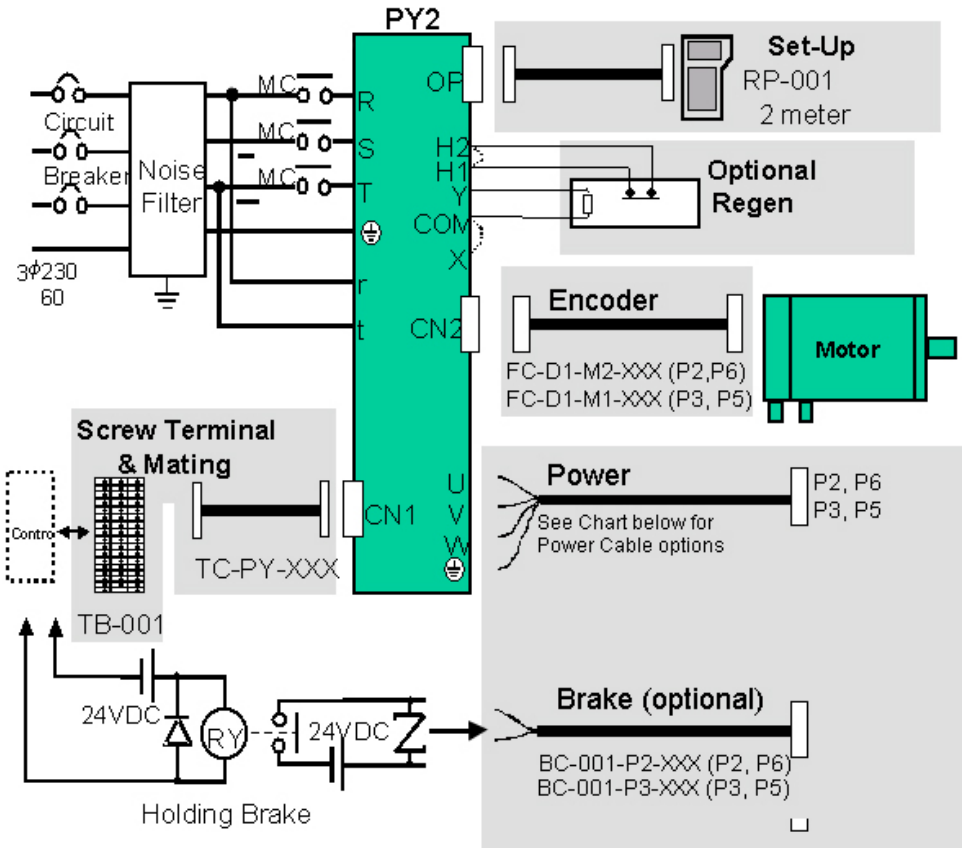
- For 1Φ (single phase) power, do not connect 230VAC to the "S" terminal of the bus power. Leave this terminal unconnected.


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## Cable Connection Diagram for PY2

Below is a simplified connection diagram for a PY2. This diagram shows how to connect a system using standard cables. A detailed connection diagram follows.




| Power Cable Part # | Motor |
|---|---|
| **PC-D2-M2-XXX** | P2(1.5kW) |
| **PC-D2-M3-XXX** | P6(1.5kW) |
| **PC-D1-M1-XXX** | P3 P5 (except P5 1kW) |
| **PC-D2-M1-XXX** | P5(1kW) |

- For 1Φ (single phase) power, do not connect 230VAC to the "S" terminal of the bus power. Leave this terminal unconnected.


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# Wiring Precautions

1. Always follow all local, regional, national and international electrical codes! In case of conflicts between regulations and this instruction manual please contact the factory.

2. Connect ground signals first and remove them last when installing or removing equipment.

3. Arrange the servo amplifier, noise filters and motion controller as closely to each other as possible to minimize signal length and reduce effects of noise.

4. Install surge suppression circuits on relays, electromagnetic contactors, brake solenoids and other inductive loads.

5. Do not pass the bus power and circuits and control signals in the same conduit or bind them together.

6. When a large electrical noise source such as an arc-welder is nearby, install noise filters.

7. Terminate all control signal inputs, digital and analog.


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# Applicable Wire Sizes

The chart below identifies the recommended wire sizes for all connections. This is only a guide. The installer is responsible for satisfying all applicable codes and regulations.

| ! | **DANGER** |
|---|---|
| | The user is responsible for conforming with all applicable local, regional, national, and international codes. The wiring examples in this manual are intended only as a guide. Wiring practices, grounding, disconnects and over-current protection are of particular importance. Failure to observe this could result in severe injury or loss of life. |

**Table 8: Applicable Wire Sizes**

| | Terminal | PY2A015<br>PY0A015 | PY2A030<br>PY0A030 | PY2A050<br>PY0A050 | PY0A100 | PY0A150 |
|---|---|---|---|---|---|---|
| Bus Power | R, S, T | 16 | 14 | 12 | 10 | 8 |
| Control Power | r, t | 16 | | | | |
| Motor Power | U, V, W | 16 | 14 | 12 | 10 | 8 |
| Regen Resistor<br>Power<br>Thermostat | Y, COM<br>(P)<br>H1, H2 | 16<br>20 | | 14<br>20 | | |
| Drive Ready Relay | RDY1, RDY2 | 20 | | | | |
| Encoder | CN2 | 28 | | | | |
| Control (CN1) | CN1 | 28 | | | | |
| Remote Operator | OP | | | | | |

1. Wire sizes are AWG.
2. To avoid electrical interference, separate the bus circuit wiring (high voltage) from the signal wiring (CN1, CN2).


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# Input Power

The table below shows the power supply capacity requirements for each of the systems.

**Table 9: Power Supply Capacity Requirement**

| Drive Model | Motor Model | Bus Circuit | | | Control Circuit | | |
|---|---|---|---|---|---|---|---|
| | | Capacity KVA | Capacity (A) | In Rush § @600mS | Capacity VA | Capacity (A) | In Rush § @1mS |
| PY2A015 | P30B04010D | 0.3kVA | 2.1A | 18A | 40VA | 0.2A | 40A |
| PY2A015 | P50N05020D | 0.8kVA | TBA | 18A | 40VA | 0.2A | 40A |
| PY2A030 | P30B06040D | 1.0kVA | 6.6A | 18A | 40VA | 0.2A | 40A |
| PY2A030 | P30B08075D | 1.7kVA | 9.5A | 18A | 40VA | 0.2A | 40A |
| PY2A050 | P50N08100D | 2.5kVA | 5.5A | 18A | 40VA | 0.2A | 40A |
| PY2A050 | P60B13150H | 2.5kVA | 7.3A | 18A | 40VA | 0.2A | 40A |
| PY2A050 | P20B10150D | 3.0kVA | 8.7A | 18A | 40VA | 0.2A | 40A |
| PY0A015 | P30B04010D | 0.3kVA | 1.2A | 18A | 40VA | 0.2A | 40A |
| PY0A015 | P50N05020D | 0.8kVA | 3.0A | 18A | 40VA | 0.2A | 40A |
| PY0A030 | P30B06040D | 1.0kVA | 3.8A | 18A | 40VA | 0.2A | 40A |
| PY0A030 | P30B08075D | 1.7kVA | 5.5A | 18A | 40VA | 0.2A | 40A |
| PY0A050 | P50N08100D | 2.5kVA | 7.3A | 18A | 40VA | 0.2A | 40A |
| PY0A050 | P60B13150H | 2.5kVA | 7.3A | 18A | 40VA | 0.2A | 40A |
| PY0A050 | P20B10150D | 3.0kVA | 8.7A | 18A | 40VA | 0.2A | 40A |
| PY0A100 | P20B10250D | 4.2kVA | 12.2A | 18A | 40VA | 0.2A | 40A |
| PY0A100 | P20B13300D | 5.0kVA | 14.5A | 18A | 40VA | 0.2A | 40A |
| PY0A150 | P20B13500D | 8.3kVA | 24.0A | 18A | 40VA | 0.2A | 40A |

§ Zero to peak currents, not RMS current.

# Leakage Current

The servomotor is driven under the PWM control of an IGBT inverter in the amplifier. This produces a high-frequency leakage current, which flows through the floating capacitance of the motor winding, power cable and amplifier. This leakage current can cause the malfunction of leakage detection circuit breakers or protective relays installed on the power line.

**Table 10: System Leakage Current**

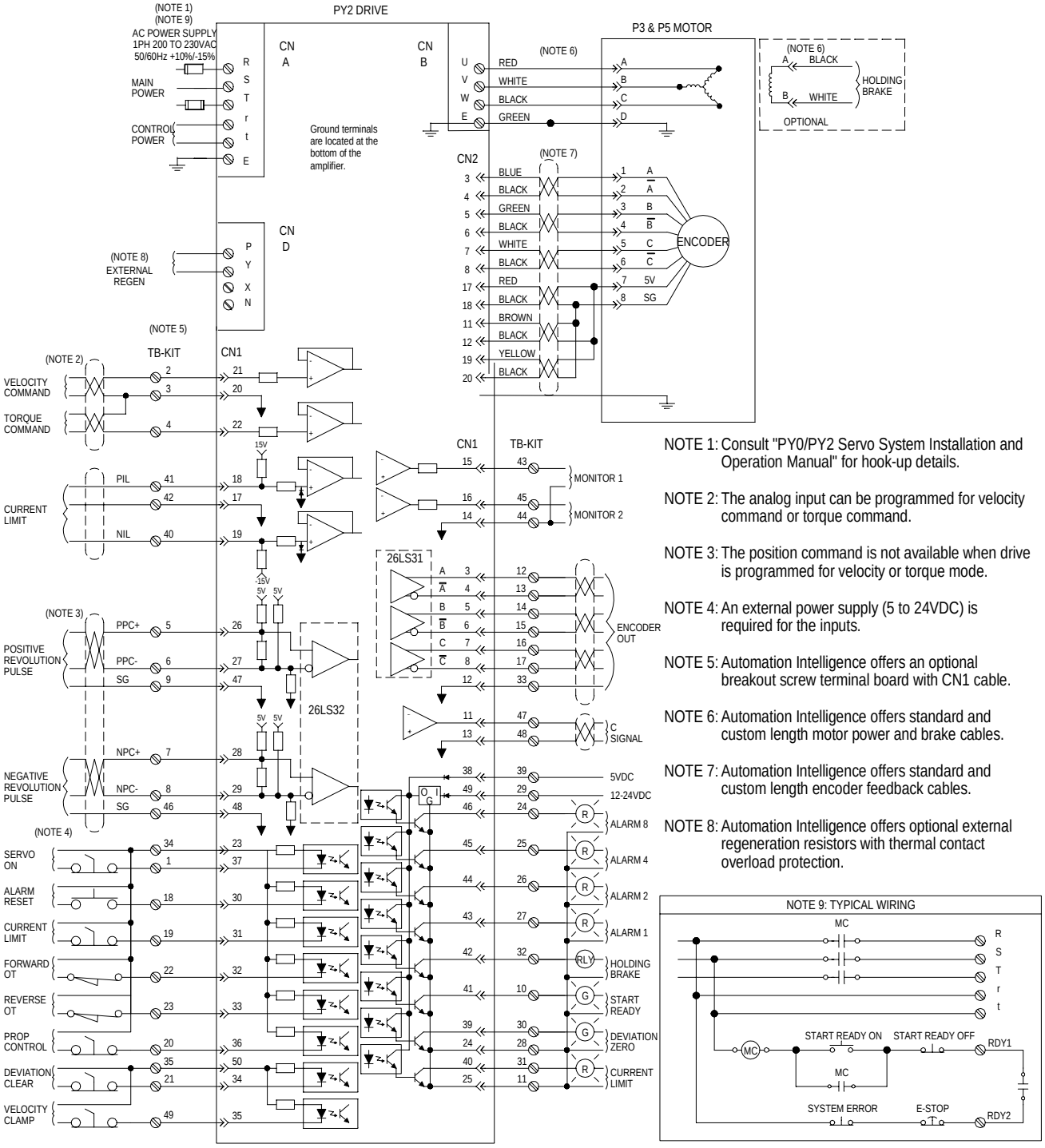
| Motor Model | Leakage Current per Motor |
|---|---|
| P20B | 3.0mA |
| P30B | 3.0mA |
| P50N | 3.0mA |
| P60B | 3.0mA |

1. When using two or more motors, add the leakage current of each motor to determine the system leakage current.
2. The table above assumes 2m cables. The leakage current will increase with longer cables and decrease with shorter cables.


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# Connection Diagram (PY2 with P3/P5 Motor)




NOTE 1: Consult "PY0/PY2 Servo System Installation and Operation Manual" for hook-up details.

NOTE 2: The analog input can be programmed for velocity command or torque command.

NOTE 3: The position command is not available when drive is programmed for velocity or torque mode.

NOTE 4: An external power supply (5 to 24VDC) is required for the inputs.

NOTE 5: Automation Intelligence offers an optional breakout screw terminal board with CN1 cable.

NOTE 6: Automation Intelligence offers standard and custom length motor power and brake cables.

NOTE 7: Automation Intelligence offers standard and custom length encoder feedback cables.

NOTE 8: Automation Intelligence offers optional external regeneration resistors with thermal contact overload protection.

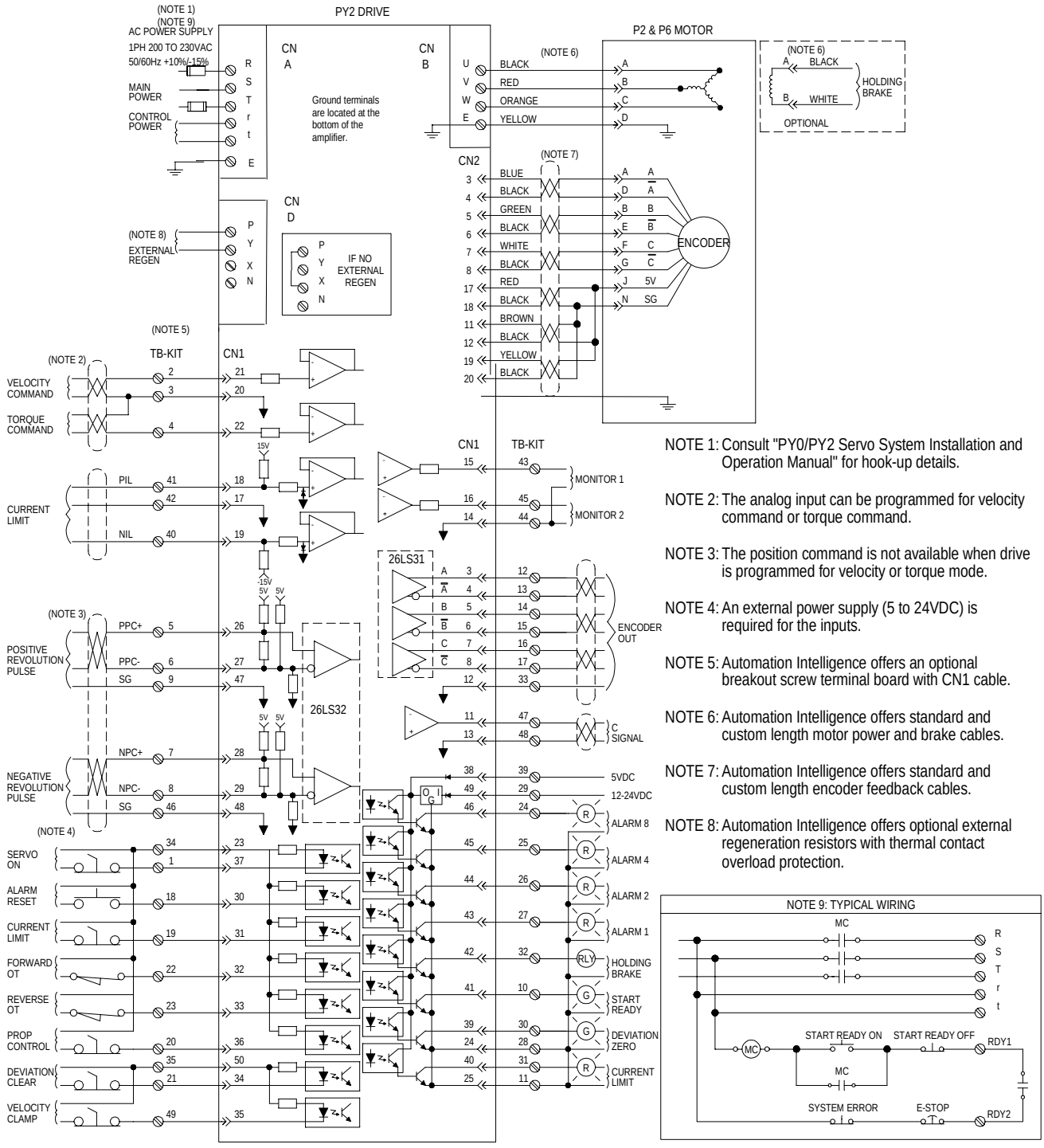



Please note that PY2 drives do not provide RDY signals. Ignore references to this contact on all PY2 drawings.


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# Connection Diagram (PY2 with P2/P6 Motor)




NOTE 1: Consult "PY0/PY2 Servo System Installation and Operation Manual" for hook-up details.

NOTE 2: The analog input can be programmed for velocity command or torque command.

NOTE 3: The position command is not available when drive is programmed for velocity or torque mode.

NOTE 4: An external power supply (5 to 24VDC) is required for the inputs.

NOTE 5: Automation Intelligence offers an optional breakout screw terminal board with CN1 cable.

NOTE 6: Automation Intelligence offers standard and custom length motor power and brake cables.

NOTE 7: Automation Intelligence offers standard and custom length encoder feedback cables.

NOTE 8: Automation Intelligence offers optional external regeneration resistors with thermal contact overload protection.

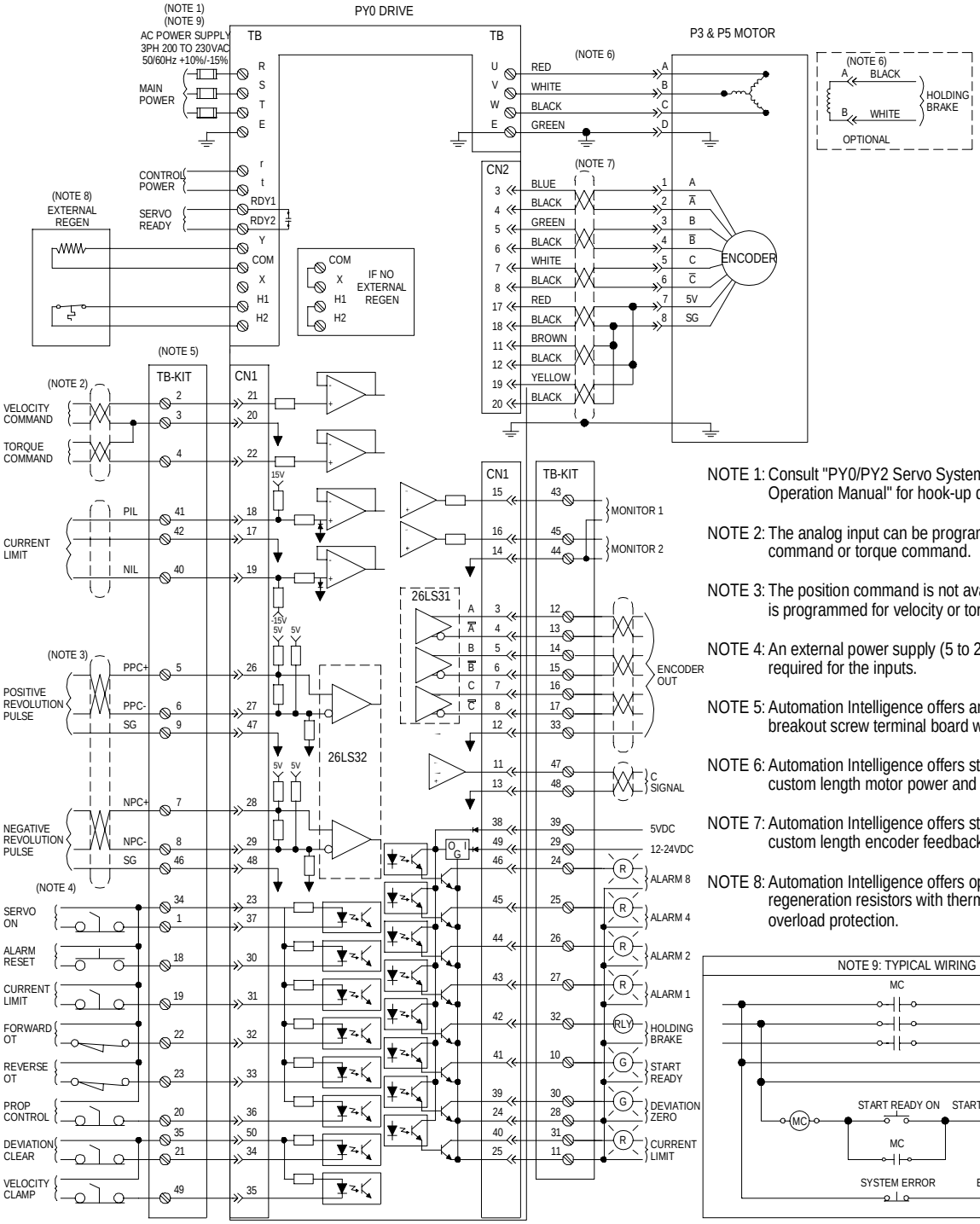



Please note that PY2 drives do not provide RDY signals. Ignore references to this contact on all PY2 drawings.


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# Connection Diagram (PY0 with P3/P5 Motor)




NOTE 1: Consult "PY0/PY2 Servo System Installation and Operation Manual" for hook-up details.

NOTE 2: The analog input can be programmed for velocity command or torque command.

NOTE 3: The position command is not available when drive is programmed for velocity or torque mode.

NOTE 4: An external power supply (5 to 24VDC) is required for the inputs.

NOTE 5: Automation Intelligence offers an optional breakout screw terminal board with CN1 cable.

NOTE 6: Automation Intelligence offers standard and custom length motor power and brake cables.

NOTE 7: Automation Intelligence offers standard and custom length encoder feedback cables.

NOTE 8: Automation Intelligence offers optional external regeneration resistors with thermal contact overload protection.

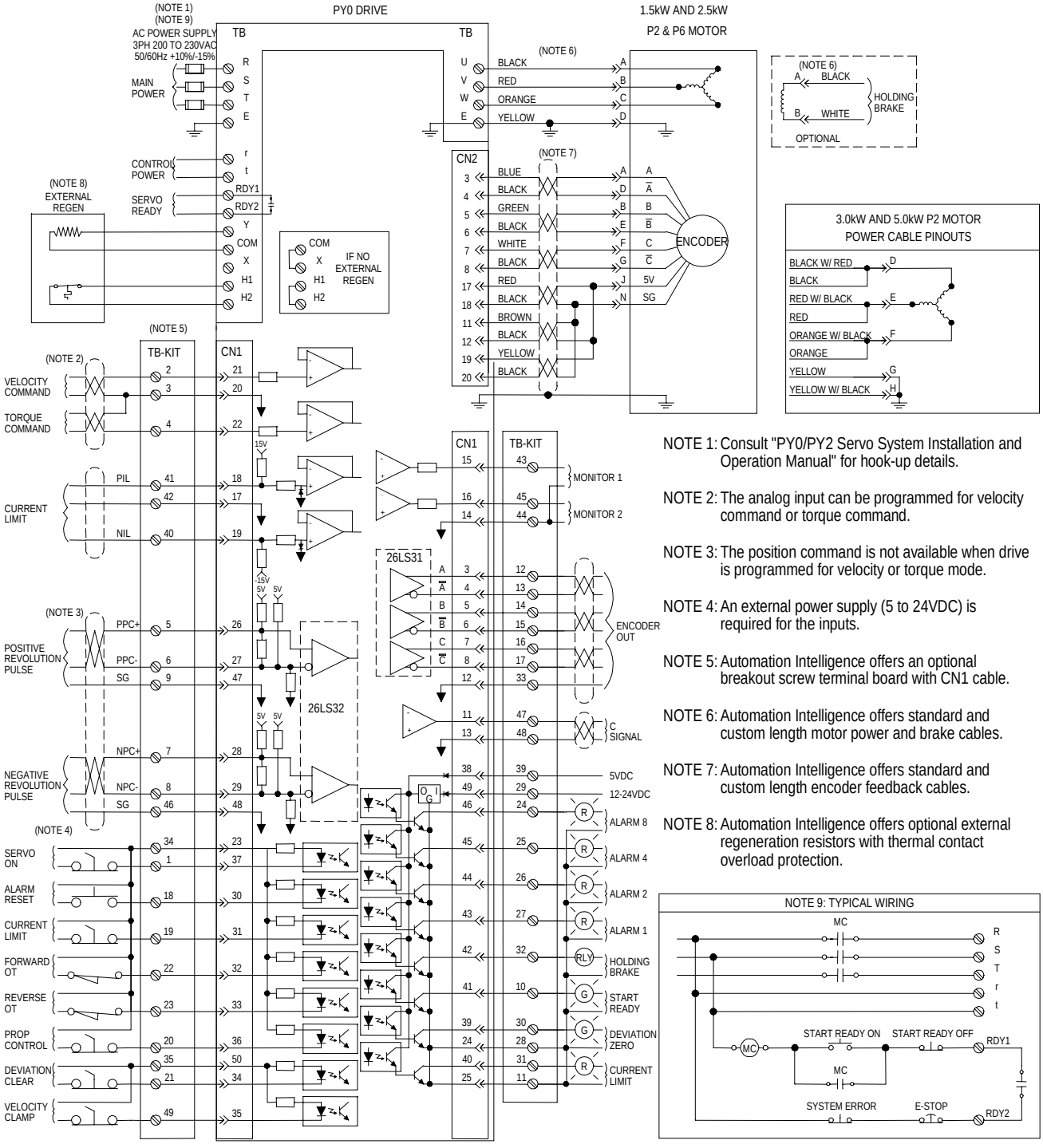




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# Connection Diagram (PY0 with P2/P6 Motor)




NOTE 1: Consult "PY0/PY2 Servo System Installation and Operation Manual" for hook-up details.

NOTE 2: The analog input can be programmed for velocity command or torque command.

NOTE 3: The position command is not available when drive is programmed for velocity or torque mode.

NOTE 4: An external power supply (5 to 24VDC) is required for the inputs.

NOTE 5: Automation Intelligence offers an optional breakout screw terminal board with CN1 cable.

NOTE 6: Automation Intelligence offers standard and custom length motor power and brake cables.

NOTE 7: Automation Intelligence offers standard and custom length encoder feedback cables.

NOTE 8: Automation Intelligence offers optional external regeneration resistors with thermal contact overload protection.





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# CNA, CND and CNB Connectors

**Table 11: CNA, CND, and CNB Connector Pin Assignments**

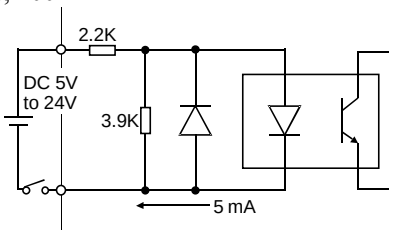
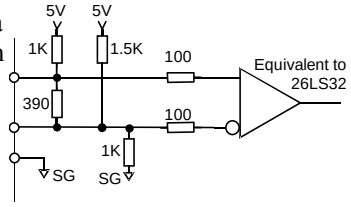
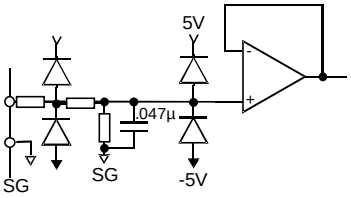
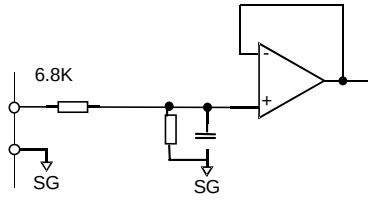
| Symbol | Explanation |
|---|---|
| R<br>S<br>T<br>W | Bus circuit power input. Single/Three-phase 200-230Vac (+10%, -15%) and grounding terminal. This is only the high power input for the amplifier. Control power for the amplifier is supplied on the "r" and "t" terminals. For single-phase connection, do not connect to the "S" terminal. |
| r<br>t | Control circuit power input terminals. Single-phase 200-230Vac (+10%, -15%). This is the only control power input for the amplifier. The bus power (high power) for the amplifier is supplied on the "R", "S", and "T" terminals. |
| COM<br>Y<br>P | Regeneration Resistor power connections. When an external regeneration resistor is not used, the internal resistor is connected to "X" and "COM" (PY0 Drive) and "X" and "P" (PY2 Drive). When an external regeneration resistor is used, the internal resistor must be disconnected and the external resistor(s) are connected between "COM" and "Y" (PY0 Drive) and "P" and "Y" (PY2 Drive). |
| RDY1<br>RDY2 | Amplifier ready output terminals. RDY1 and RDY2 are two terminals of a relay. When the control power supply is ON and there are no alarms, this relay closes; otherwise it is open. The RDY signal is only provided on PY0 drives. |
| H1<br>H2 | (PY0 Drives only…) Input terminal for thermostat of external regeneration resistor. If an external regeneration resistor is not required, a shorting bar is connected between H1 and H2. An open circuit indicates an external regeneration resistor overheat condition. |
| U<br>V<br>W<br>W | Motor power connection and grounding terminal. |


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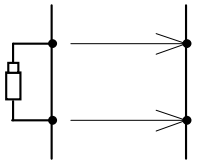
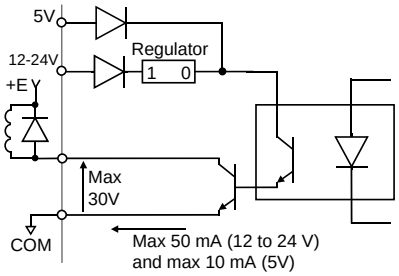
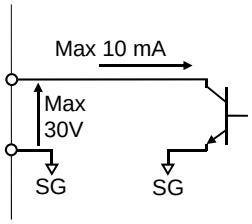
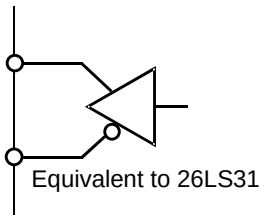
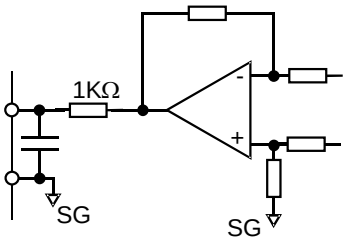
# Input/Output Internal Circuits

**Table 12: CN1 Internal Circuits**

| Circuit Type | Description | Figure |
|---|---|---|
| 1 | Photo-coupler Input<br>These inputs share a common user-supplied 5 to 24VDC supply. Connecting the input pin to ground turns them "ON". The required power specification is 5-24VDC ±10%, 100 mA or more<br>CN1-30 RST<br>CN1-31 ILM<br>CN1-32 PROT<br>CN1-33 NROT<br>CN1-34 CLE<br>CN1-35 PCON/PMUL/INH/ZCMD<br>CN1-36 PCON/PMUL/INH/ZCMD<br>CN1-37 SON |  |
| 2 | Line Driver Inputs<br>This input circuit is designed to receive signals for a line driver output equivalent to a 26LS31. It may also be connected to an open collector type output.<br>CN1-26 PPC+<br>CN1-27 PPC-<br>CN1-28 NPC+<br>CN1-29 NPC- |  |
| 3 | Analog Input<br>CN1-21 VCMD<br>CN1-22 TCOMP/TCMD |  |
| 4 | Analog Input<br>This input is designed to receive positive analog voltage.<br>CN1-18 PIL |  |


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| Circuit Type | Description | Figure |
|---|---|---|
| 5 | Analog Input<br>This input is designed to receive negative analog voltage.<br>CN1-19 NIL |  |
| 6 | Isolated Open Collector Output<br>All outputs share a common 5 or 12 to 24Vdc supply (5Vdc ±10% 20ma or more, 12-24Vdc ±10% 20mA or more)<br>CN1-39 INP/LTG<br>CN1-40 ILIM<br>CN1-41 SRDY<br>CN1-42 HBON<br>CN1-43 ALM1<br>CN1-44 ALM2<br>CN1-45 ALM4<br>CN1-46 ALM8 |  |
| 7 | Open Collector Output<br>CN1-11 COP |  |
| 8 | Line Driver Output<br>This line driver output circuit is designed to drive signals for a line receiver input equivalent to a 26LS32. Signals valid about 1 second after control power is applied.<br>CN1-3 A+<br>CN1-4 A-<br>CN1-5 B+<br>CN1-6 B-<br>CN1-7 C+<br>CN1-8 C- |  |
| 9 | Analog Output<br>CN1-15 MON1<br>CN1-16 MON2 |  |


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# CN1 Control Connector

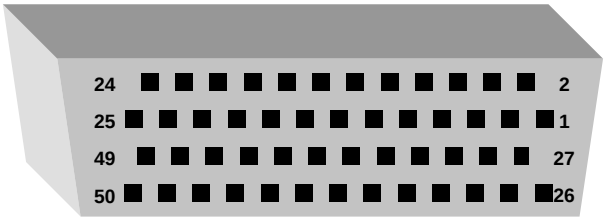



**Table 13: CN1 Pin Assignments**

| Pin | TB Pos | Abbrev. | Description | Circuit Type |
|---|---|---|---|---|
| 1 | - | None | Reserved | N/A |
| 2 | - | None | Reserved | N/A |
| 3 | 12 | A+ | Encoder Positive A Signal Output. Output by line driver (26LS31) after the encoder pulses are divided (ENCR). The divider is set using the Remote Operator, Mode 1 Page 4. This output is not specified for 1 second after the control supply is turned "ON". | 8 |
| 4 | 13 | A- | Encoder Negative A Signal Output | 8 |
| 5 | 14 | B+ | Encoder Positive B Signal Output | 8 |
| 6 | 15 | B- | Encoder Negative B Signal Output | 8 |
| 7 | 16 | C+ | Encoder Positive Index Signal Output | 8 |
| 8 | 17 | C- | Encoder Negative Index Signal Output | 8 |
| 9 | - | None | Reserved | N/A |
| 10 | - | None | Reserved | N/A |
| 11 | 47 | COP | Encoder C channel (Open Collector Output). The logic can be reversed using the Func5 parameter (Mode 2, Page 6, Bit 6). | 7 |
| 12 | 33 | SG | Encoder Signal Ground | N/A |
| 13 | 48 | COPG | Signal Ground for COP signal, Pin 11 | N/A |
| 14 | 44 | SG | Monitor Signal Ground for MON1 and MON2, Pins 15 and 16 | N/A |
| 15 | 43 | MON1 | Monitor 1 Output. 2V ±10% per 1000RPM (velocity monitor). Positive voltage indicates CCW direction of rotation. Load less than 2mA (output resistance 1kΩ). | 9 |
| 16 | 45 | MON2 | Monitor 2 Output. 2V ±20% per rated current (current monitor). Positive voltage indicates torque is being applied in the CCW direction. Load less than 2mA (output resistance 1kΩ). | 9 |
| 17 | 42 | SG | Signal Ground for analog current limits, Pins 18 and 19 | N/A |


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| Pin | TB Pos | Abbrev. | Description | Circuit Type |
|---|---|---|---|---|
| 18 | 41 | PIL | Positive Current Limit. The current is limited to the rated current at +2V. This input is effective when the ILM (CN1 pin 31) input is "ON". | 4 |
| 19 | 40 | NIL | Negative Current Limit. The current is limited to the rated current at -2V. This input is effective when the ILM (CN1 pin 31) input is "ON". | 5 |
| 20 | 3 | VCMDG<br>TCMDG | Velocity/Torque Command Common, see pins 21 and 22. | N/A |
| 21 | 2 | VCMD | Velocity Command. With a ±2V input, the velocity becomes ±1000 RPM (standard setting). The maximum input voltage is ±10V. The input impedance is approximately 20kΩ. | 3 |
| 22 | 4 | TCOMP | Torque Compensation (Position Control Mode)<br>The rated torque (Tr) is obtained by inputting ± 2V, but is limited by the maximum instantaneous stall torque. To enable the torque compensation, use the Func1 parameter (Mode 2, Page 2, Bit 6). | 3 |
| | | TCMD | Torque Command (Torque Control Mode).<br>With a ±2V input, the commanded torque becomes the rated torque (Tr) and is limited to the instantaneous maximum stall torque. | |
| 23 | 34 | 12-24 VDC | Input sequence power supply 1. External power for CN1-30, 31, 32, 33, 36 and 37. | N/A |
| 24 | 28 | 12-24 VDC COM | Output sequence power common. Common for CN1-39, 40, 41, 42, 43, 44, 45, and 46. | N/A |
| 25 | 11 | 12-24 VDC COM | Output sequence power common. Common for CN1-39, 40, 41, 42, 43, 44, 45, and 46. | N/A |
| 26 | 5 | PPC+ | Positive Pulse Command. Counter clockwise (CCW) revolution pulse train command (positive signal). | 2 |
| 27 | 6 | PPC- | Positive Pulse Command. Counter clockwise (CCW) revolution pulse train command (complement signal). | 2 |
| 28 | 7 | NPC+ | Negative Pulse Command. Clockwise (CW) revolution pulse train command (positive signal). | 2 |
| 29 | 8 | NPC- | Negative Pulse Command. Clockwise (CW) revolution pulse train command (complement signal). | 2 |
| 30 | 18 | RST | Alarm Reset input is used to clear error display, alarm code, and alarm bit outputs. | 1 |
| 31 | 19 | ILM | Current Limit Permit. Current is limited when this input is ON. The value that current is limited to may come from an internal drive source, IILM, or external inputs PIL (CN1-18) and NIL (CN1-19). | 1 |


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| Pin | TB Pos | Abbrev. | Description | Circuit Type |
|---|---|---|---|---|
| 32 | 22 | PROT | Positive Rotation Over-travel. Counter clockwise (CCW) over-travel limit. This input is used to indicate that a travel limit has been reached in the CCW direction of travel. When the input turns "ON", a 120% current limit is automatically applied, inhibiting commands in the CCW direction. | 1 |
| 33 | 23 | NROT | Negative Rotation Over-travel. Clockwise (CW) over-travel limit. This input is used to indicate that a travel limit has been reached in the CW direction of travel. When the input turns "ON", a 120% current limit is automatically applied, inhibiting commands in the CW direction. | 1 |
| 34 | 21 | GEN. PUR. | Several outputs can be selected:<br>Clear Deviation Error—(Position Mode). Turning "ON" this input for 10mS or more will clear the contents of the position deviation counter.<br>Internal Velocity Command—(Velocity Mode). | 1 |
| 35/36 | 49/20 | GEN. PUR. | Several outputs can be selected:<br>This selection is set with Func3 parameter (Mode 2, Page 4, Bits 0 and 1). | 1 |
| | | PCON | Proportional Control On. With this input "ON", the velocity loop becomes proportional control. | |
| | | ECLR | This switch is turned "ON" to clear the position deviation. | |
| | | PMUL/VCS1 | Pulse Multiplier. With this input "ON", command pulses are multiplied by the gear ratio set by the PMUL parameter (Mode 1, Page 3). | |
| | | INH/ZCMD | Inhibit. With this input "ON", incoming pulses are inhibited (position mode) or velocity is clamped (velocity mode). | |
| 37 | 1 | SON | Servo ON. Enables the amplifier, if there are no alarms. | N/A |
| 38 | 39 | 5V | Output Sequence Power Supply. External power supply for CN1-39, 40, 41, 42, 43, 44, 45, and 46. Use only Pin 38 or 49, NOT both. | N/A |
| 39/40 | 30/31 | GEN. PUR | **Several outputs can be selected:** | 6 |
| | | | **ILIM**—Current Limit Status Output. This signal comes "ON" to indicate the amplifier is in current limit. | |
| | | | **LTG**—Low Speed (Velocity Mode). When the motor speed becomes ±50 RPM or less of the set value, this signal goes to low impedance. | |
| | | | **HTG**—High Speed (Velocity Mode). When the motor speed becomes ±1000 RPM or more of the set value, this signal goes to low impedance. | |


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| Pin | TB Pos | Abbrev. | Description | Circuit Type |
|---|---|---|---|---|
| | | | **SPE**—Speed Matching. When the velocity command and velocity feedback is smaller than the specified value, this signal goes to low impedance. | |
| | | | **INP**—In Position (Position Mode). This signal indicates that the content of the deviation counter is within the setting range, OVF. OVF many be set using the Remote Operator (Mode 1, Page 1). | |
| | | | **CMD**—Command Accept Permit | |
| 41 | 10 | SRDY | Start Ready Complete. This signal comes ON and goes to low impedance after the bus power (R, S, and T) is applied to signify readiness to receive the Servo "ON" (SON) signal. | 6 |
| 42 | 32 | HBON | Holding Brake. This output is used to control the holding brake relay. | 6 |
| 43 | 27 | ALM1 | Alarm Output 1. Alarm output 1 may be set to indicate any alarm (Alarm bit) or to be the least significant bit of a four-bit alarm code. This choice is made using the Remote Operator to set Func2 bit 6 (Mode 2, page 3). The default is Alarm Code Output. | 6 |
| 44 | 26 | ALM2 | Alarm Output 2 see ALM1 | 6 |
| 45 | 25 | ALM4 | Alarm Output 3 see ALM1 | 6 |
| 46 | 24 | ALM8 | Alarm Output 8 see ALM1 | 6 |
| 47 | 9 | SG | Signal Ground for forward revolution pulse command pins 26 and 27. | N/A |
| 48 | 46 | SG | Signal Ground for reverse revolution pulse command pins 28 and 29. | N/A |
| 49 | 29 | 12-24 VDC | Output Sequence Power Supply. External power supply for CN1-39, 40, 41, 42, 43, 44, 45, and 46. Use only pins 38 or 49, NOT BOTH. | N/A |
| 50 | 35 | 12-24 VDC | Input sequence power supply 2. External power for CN1-34 and CN1-35. | N/A |


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# CN2 Motor Encoder Connector

The motor encoder is connected to the amplifier via the CN2 connector. The figure below identifies the pin assignment for this connector.

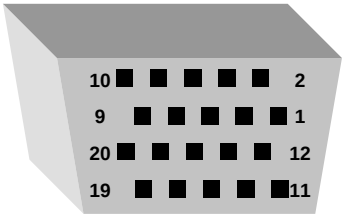



**Table 14: CN2 Pin Assignments**

| Pin | Abbreviation | Description | Circuit Type |
|---|---|---|---|
| 1 | None | Reserved | N/A |
| 2 | None | Reserved | N/A |
| 3 | A+ | Encoder Positive A Signal Input | 2 |
| 4 | A- | Encoder Negative A Signal Input | 2 |
| 5 | B+ | Encoder Positive B Signal Input | 2 |
| 6 | B- | Encoder Negative B Signal Input | 2 |
| 7 | C+ | Encoder Positive Index Signal Input | 2 |
| 8 | C- | Encoder Negative Index Signal Input | 2 |
| 9 | None | Reserved | N/A |
| 10 | None | Reserved | N/A |
| 11 | SG | Signal Ground | N/A |
| 12 | SEN | Sense. This signal is used to sense the power supply voltage at the motor. The amplifier then regulates the supply to maintain the proper voltage at the encoder. | N/A |
| 13 | None | Reserved | N/A |
| 14 | None | Reserved | N/A |
| 15 | None | Reserved | N/A |
| 16 | None | Reserved | N/A |
| 17 | +5V | 5 Volt Power | N/A |
| 18 | SG | Signal Ground | N/A |
| 19 | +5V | 5 Volt Power | N/A |
| 20 | SG | Signal Ground | N/A |


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# Operator Terminal

The operator terminal connector is only intended to be used with the optional cable for the Sanyo Denki Remote Operator or PY Setup Software. This connector is therefore not specified further.


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# External Regeneration Resistors

**When to use an External Regeneration Resistor**

When operating, servo systems transform electrical energy to mechanical energy to accelerate the motor and to overcome system losses such as friction. When a moving load is decelerated, or another system is "pulling" the load, the servo system converts this mechanical energy into electrical energy, which is then dissipated as heat in a resistor. This resistor is called a regeneration resistor or regen resistor for short. The amplifier has an internal regen resistor which is adequate for most applications. Connections are provided for an external regen resistor if more capacity is required.

Applications with a load that moves in a vertical direction, applications with load inertia that is high relative to the motor (15:1), and applications where the motor is used to provide a tension load are most likely to require external regen resistors. In order to determine if an external resistor is required, the amount of energy generated must be calculated and then compared to the capacity of the internal resistor. An external regeneration (Regen) resistor is used when the internal regeneration resistor's allowable power is exceeded. See the table below.

**Table 15: Amplifier Regeneration Power**

| Drive Model | Maximum Regeneration Power [W] | |
|---|---|---|
| | Internal | Maximum available from AI |
| PY2A015 | 0 | 220 |
| PY2A030 | 0 | 220 |
| PY2A050 | 60 | 220 |
| PY0A015 | 20 | 220 |
| PY0A030 | 20 | 220 |
| PY0A050 | 60 | 500 |
| PY0A100 | 90 | 500 |
| PY0A150 | 120 | 500 |

***Calculating Regeneration Power***

The formulas below may be used to calculate the amount of power generated by the moving load. There are separate formulas for horizontal moving loads and vertical loads.

| | |
|---|---|
| $P_M$ = Regeneration power | [W] |
| $E_M$ = Total regeneration energy | [J] |
| $E_{Hb}$ = Regeneration energy during deceleration | [J] |
| $E_{VUb}$ = Regeneration energy during up decel | [J] |
| $E_{VD}$ = Regeneration energy during down drive | [J] |
| $E_{VDb}$ = Regeneration energy during down decel | [J] |
| $K_E$ = Motor voltage constant | [V / RPM] |
| $K_T$ = Motor torque constant | [Nm / $A_{rms}$] |
| $N$ = Motor speed | [RPM] |
| $T_b$ = Torque during acceleration | [Nm] |

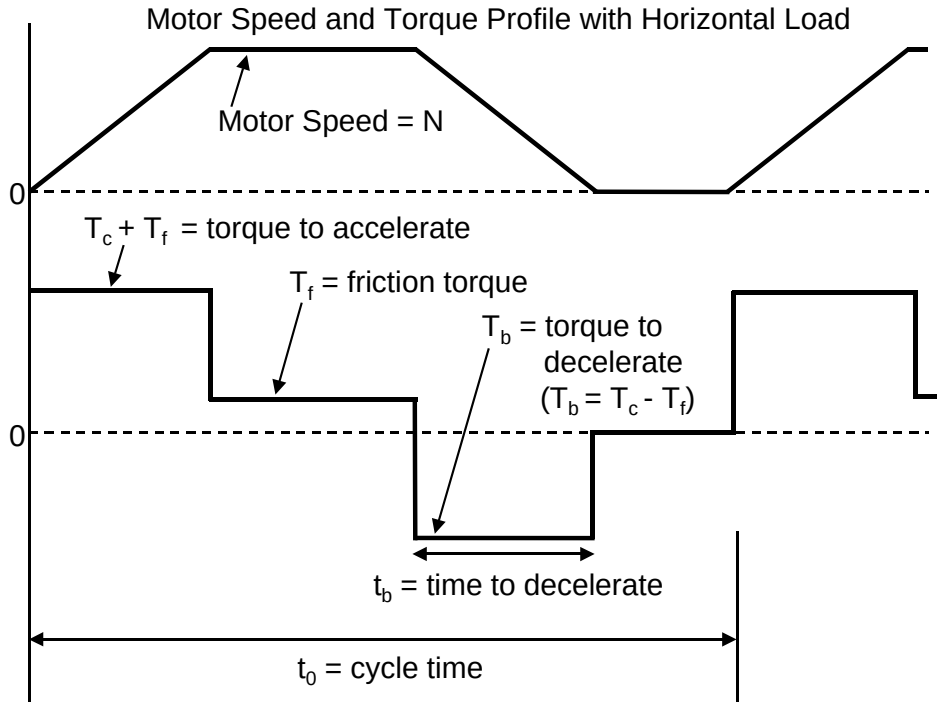

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$T_{Ub}$ = Torque during up deceleration [Nm]
$T_D$ = Torque during down drive [Nm]
$T_{Db}$ = Torque during down deceleration [Nm]
$R_\phi$ = Armature resistance [Ohms]
$t_b$ = Deceleration time [s]
$t_{Ub}$ = Up deceleration time [s]
$t_D$ = Down drive time [s]
$t_{Db}$ = Down deceleration time [s]
$t_0$ = Cycle time [s]

| Motor Model | $K_T$ [Nm / $A_{rms}$] | $K_E$ [V / RPM] | $R_\phi$ [Ohms] |
|---|---|---|---|
| P20B10150D | 0.82 | 0.0292 | 0.67 |
| P20B10250D | 0.79 | 0.0276 | 0.31 |
| P20B13300D | 0.80 | 0.0280 | 0.19 |
| P20B13500D | 0.85 | 0.0297 | 0.11 |
| P30B04010D | 0.292 | 0.0102 | 4.30 |
| P30B06040D | 0.533 | 0.0186 | 1.40 |
| P30B08075D | 0.565 | 0.0197 | 0.52 |
| P50N05020D | 0.436 | 0.0152 | 3.4 |
| P50N08100D | 0.553 | 0.0193 | 0.41 |
| P60B13150H | 0.900 | 0.0314 | 0.27 |

Horizontal load

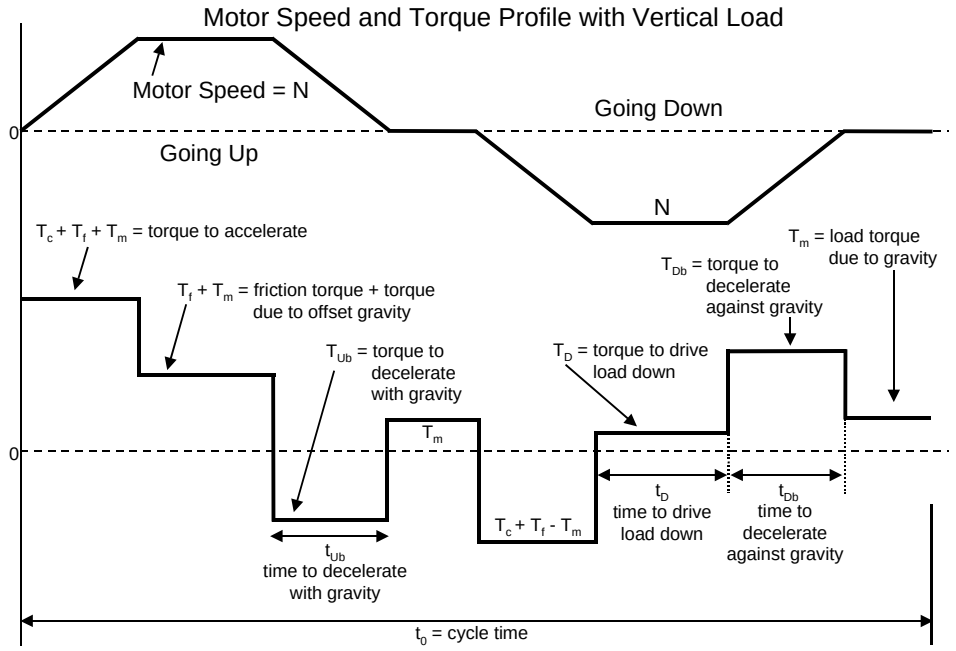



$$E_M = E_{Hb} = \frac{N \text{ x } 3 \text{ x } K_E \text{ x } T_b \text{ x } t_b}{2 \text{ x } K_T} - \left( \frac{T_b}{K_T} \right)^2 \text{ x } 3 \text{ x } R_\phi \text{ x } t_b \qquad P_M = \frac{E_M}{t_0}$$


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Vertical Load




$$E_M = E_{VUb} + E_{VD} + E_{VDb}$$

$$E_{VUb} = \frac{N \times 3 \times K_E \times T_{Ub} \times t_{Ub}}{2 \times K_T} - \left(\frac{T_{Ub}}{K_T}\right)^2 \times 3 \times R_\phi \times t_{Ub} \quad \text{for}\left(E_{VUb} \geq 0\right) \text{else}\, 0$$

$$E_{VD} = \frac{N \times 3 \times K_E \times T_D \times t_D}{K_T} - \left(\frac{T_D}{K_T}\right)^2 \times 3 \times R_\phi \times t_D \quad \text{for}\left(E_{VD} \geq 0\right) \text{else}\, 0$$

$$E_{VDb} = \frac{N \times 3 \times K_E \times T_{Db} \times t_{Db}}{2 \times K_T} - \left(\frac{T_{Db}}{K_T}\right)^2 \times 3 \times R_\phi \times t_{Db} \quad \text{for}\left(E_{VDb} \geq 0\right) \text{else}\, 0$$

$$P_M = \frac{E_M}{t_0}$$


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## Selecting the Right External Regen Resistor

If the calculated regeneration power is greater than the capacity of the internal resistor, an external regeneration resistor is required. The table below provides details on the factory external regen options. There is a low, medium, and high power option for amplifiers up through 100A. There is a low and high option for the 150A amplifier. Select an option that has a higher power rating than $P_M$, calculated above.

**Table 16: Regeneration Resistor Selection**

| | | PY2A015 PY0A015 | PY2A030 PY0A030 | PY2A050 PY0A050 | PY0A100 | PY0A150 |
|---|---|---|---|---|---|---|
| 55w | Resistor | | | | | |
| | Part Number REGIST- | 220W100B | 220W50B | | | |
| | Quantity | 1 | 1 | | | |
| | Resistance [Ω] | 100 | 50 | | | |
| | Power [W] | 55 | 55 | | | |
| | Dimensions w, l, d [mm] | 60, 230, 20 | 60, 230, 20 | | | |
| | Connection Diagram | Type D | Type D | | | |
| 110w | Resistor | | | | | |
| | Part Number REGIST- | 220W50B | 220W100B | | | |
| | Quantity | 2 | 2 | | | |
| | Resistance [Ω] | 50 | 100 | | | |
| | Power [W] | 55 | 55 | | | |
| | Dimensions w, l, d [mm] | 60, 230, 20 | 60, 230, 20 | | | |
| | Connection Diagram | Type S | Type P | | | |
| 125W | Resistor | | | | | |
| | Part Number REGIST- | | | 500W20B | 500W10B | 50W7B |
| | Quantity | | | 1 | 1 | 1 |
| | Resistance [Ω] | | | 20 | 10 | 7 |
| | Power [W] | | | 125 | 125 | 125 |
| | Dimensions w, l, d [mm] | | | 80, 250, 40 | 80, 250, 40 | 80, 250, 40 |
| | Connection Diagram | | | Type D | Type D | Type D |
| 220w | Resistor | | | | | |
| | Part Number REGIST- | 220W100B | 220W50B | | | |
| | Quantity | 4 | 4 | | | |
| | Resistance [Ω] | 100 | 50 | | | |
| | Power [W] | 55 | 55 | | | |
| | Dimensions w, l, d [mm] | 60, 230, 20 | 60, 230, 20 | | | |
| | Connection Diagram | Type SP | Type SP | | | |
| 250w | Resistor | | | | | |
| | Part Number REGIST- | | | 500W10B | 500W20B | |
| | Quantity | | | 2 | 2 | |
| | Resistance [Ω] | | | 10 | 20 | |
| | Power [W] | | | 125 | 125 | |
| | Dimensions w, l, d [mm] | | | 80, 250, 40 | 80, 250, 40 | |
| | Connection Diagram | | | Type S | Type P | |
| 500w | Resistor | | | | | |
| | Part Number REGIST- | | | 500W20B | 500W10B | 50W7B |
| | Quantity | | | 4 | 4 | 4 |
| | Resistance [Ω] | | | 20 | 10 | 7 |
| | Power [W] | | | 125 | 125 | 125 |
| | Dimensions w, l, d [mm] | | | 80, 250, 40 | 80, 250, 40 | 80, 250, 40 |
| | Connection Diagram | | | Type SP | Type SP | Type SP |

Note:

- When using an external regen resistor, Func2 bit 4 of the remote operator must be set for external resistor.

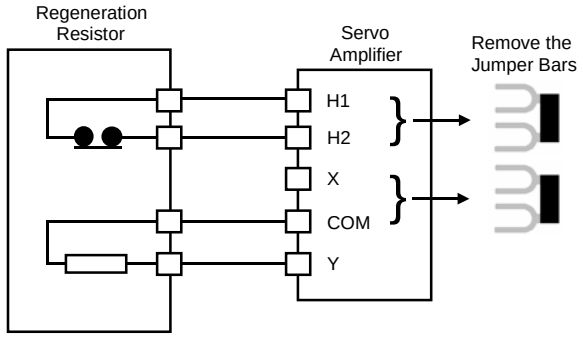

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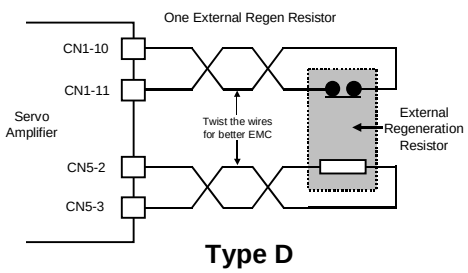
**How to connect a Regen Resistor**

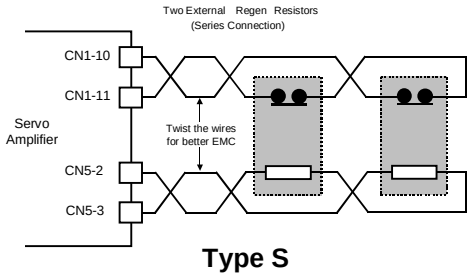
Disconnect the internal resistor from H1, H2, "X", and "COM" terminals and then connect according to diagram below. See figure below.

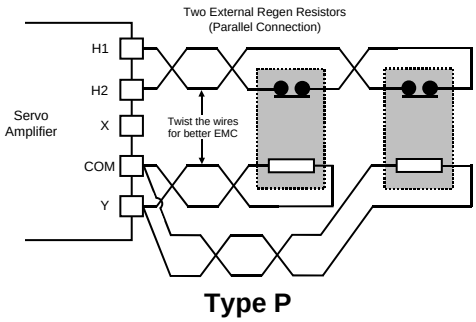
The PY2 (15A & 30A drives) has no shorting bars. For the PY2 (50A), disconnect the jumper bars from "P" and "X", then connect the leads of the regen resistor to "COM" and "Y". There is no connection for the thermostat.

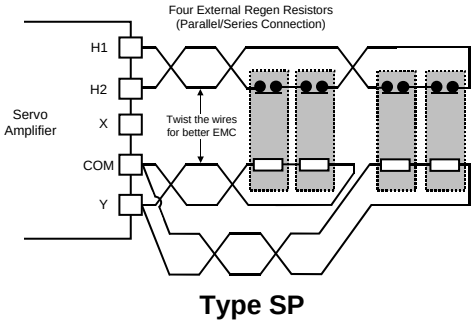



1. Using the Table 16: Regeneration Resistor Selection above, determine the proper circuit configuration, type D or S.




2. Make the connection wires as short as possible. Twist resistor leads together. Twist thermostat connection together.

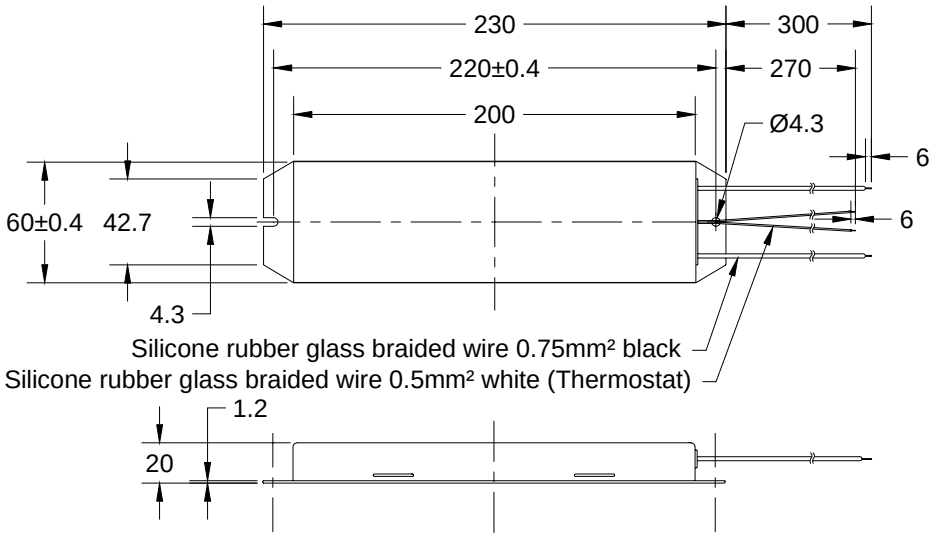
3. If possible, mount the resistor(s) above the amplifier. The resistors get hot so protect adjacent equipment from the heat generated by the regen resistors.


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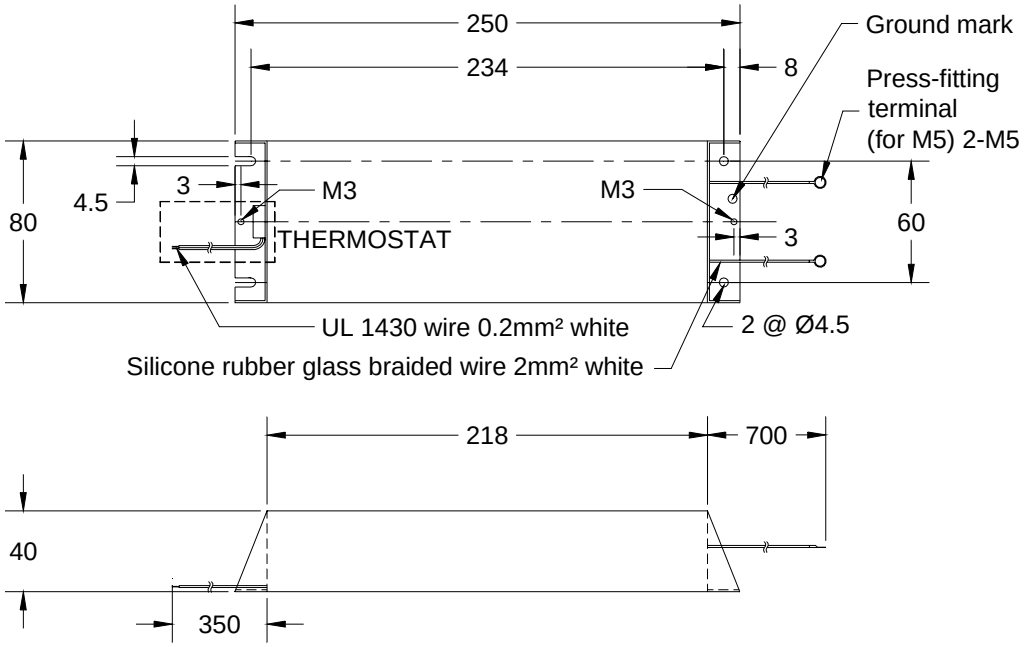
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**Regeneration**
**Resistor Mounting**

***REGIST-220W100B and REGIST-220W50B (dimensions in mm)***




***REGIST-500W20B, REGIST-500W10B or REGIST-500W7B (dimensions in mm)***





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# Wiring Check List

- ☑ 1. The shortest possible factory-supplied cables have been used for motor power, encoder feedback, control signals and remote operator.
- ☑ 2. All local electrical and safety regulations have been satisfied.
- ☑ 3. All screw terminals are tight.
- ☑ 4. The motor power and motor encoder cables are routed separately.
- ☑ 5. All ground connections are secure.
- ☑ 6. The bus power (R, S, and T) voltage and control signal voltages are within specification.
- ☑ 7. If an external regeneration resistor is used, ensure that the internal resistor is disconnected from (H1 & H2—PY0, and X & COM—PY2).
- ☑ 8. If an external regeneration resistor is used, ensure that power leads are twisted together and the thermostat leads are twisted together.
- ☑ 9. Control wires are as short as possible. The command input is 3m or less and the other control wires are 50m or less.


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# Operation

## Chapter Overview

This chapter contains a guide for the operation of the amplifier. Included in this section are timing diagrams showing the state of inputs and outputs during normal and alarm operation.


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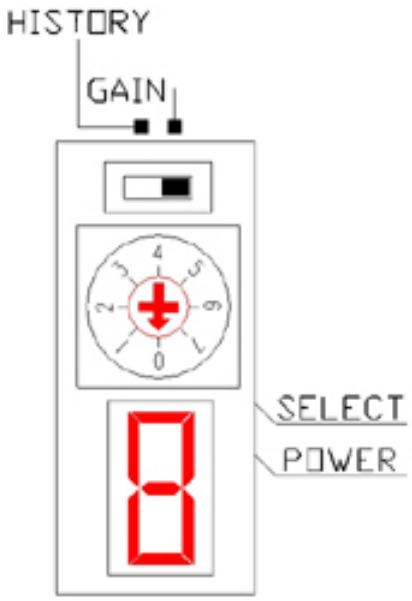
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# Pre-Operation

## Amplifier Status Display

The amplifier has a 7-segment display, a power LED and a Charge LED on the face that is used to indicate the operating status and alarm conditions. The display has two modes (History and Gain) that are selected by switching a DIP switch above the LED. When placed in History mode, the seven-position dial can be adjusted to see the current staus (0) or one of the last seven alarms (1-7).




In Gain Mode the current status is also displayed.

**Table 17: Amplifier Status Display**

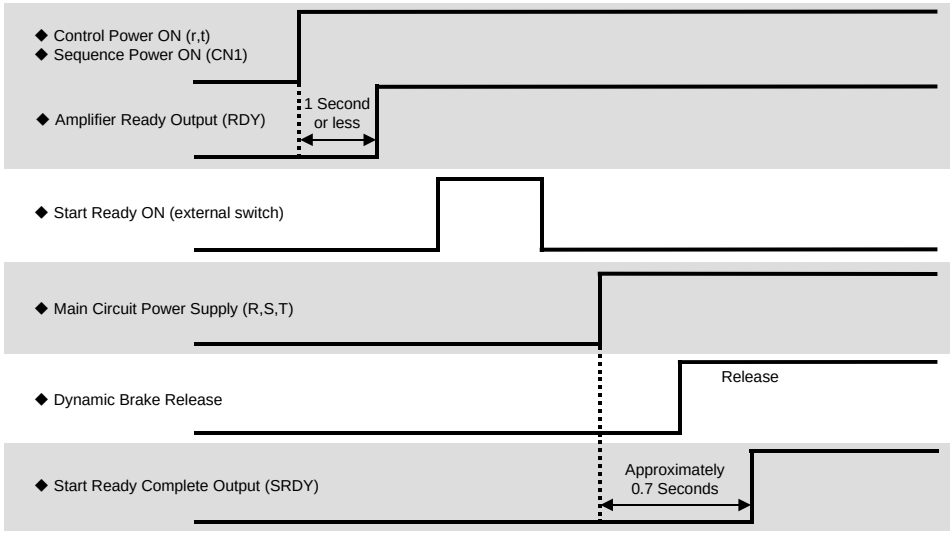
| Display | Status |
|---|---|
|  | Control power (r, t) is present and the amplifier-ready output (RDY) signal is ON. |
|  | The bus power (R, S, and, T) is present but the start ready complete (SRDY) signal is OFF. |
|  | The bus power (R, S, and, T) is present and the start ready complete (SRDY) signal is ON. |
|  Rotating in a figure 8 | The Servo ON signal is ON. |
|  | In the position/velocity control, the forward over-travel limit (PROT) input is active. |
|  | In the position/velocity control, the reverse over-travel limit (NROT) input is active. |
| Power | The control power supply +5V is present. |
| Charge | The bus capacitors are charged. While this LED is ON be careful of high voltage. |
| Flashing Code | When an alarm occurs then the alarm code is flashed on the 7-segment display. |


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# Power “On” Sequence

The timing diagram and circuit diagram below details the proper sequence of operation for turning on the power to the amplifier.





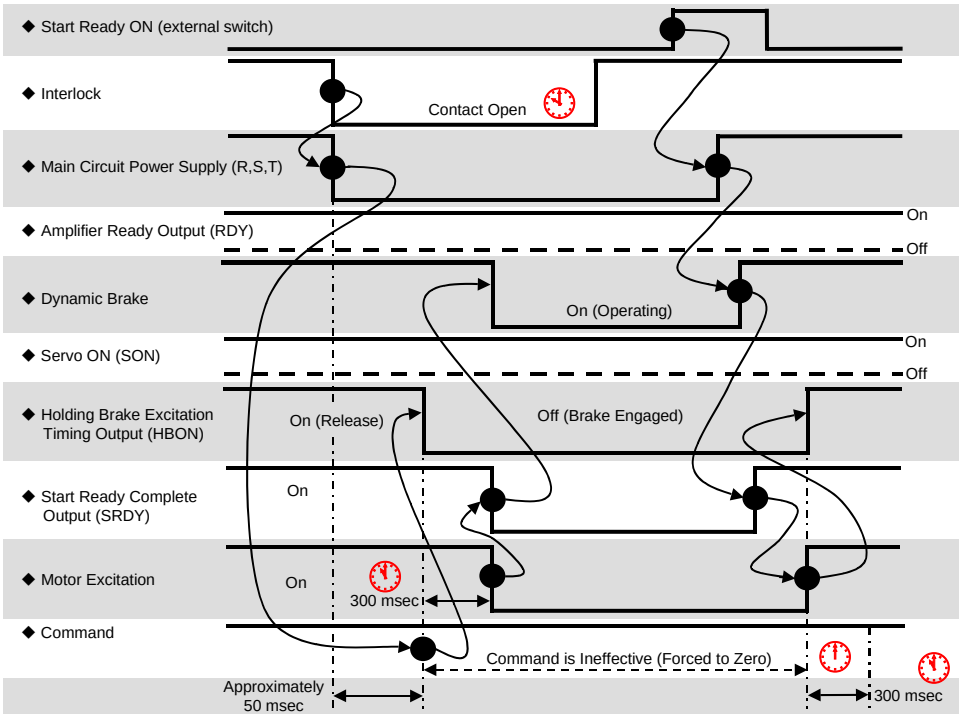
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# Stop Sequences

## Stop and recovery due to loss of bus power (interlock)

During normal operation, bus power (**R**, **S**, and **T**) may be removed from the amplifier without removing the control power (**r** and **t**). For example, this may be done to create a safe environment so the operator may remove a product sample mid-process for quality control or to clear a product jam. Since control power is not removed, the position of the motor continues to be tracked and alarm information remains available.




Notes:

1. Release the "interlock" before inputting the "start ready" input.

2. This value can be changed to 0mS by setting the "Holding Brake Excitation Timing" to "0" (Mode 1, Page 13). The current is limited by the sequence current limit value for 300mS. The default value for the sequence current limit (SILM) is 120%. It may be change in Mode 1, Page 12.

3. It is possible to force the command to 0 for 300mS after Servo "ON" (SON) by setting ZCLP. When in position mode, the command pulses continue to affect the deviation for 300mS. It is possible to make the command effective immediately after Servo ON (SON) by setting INH

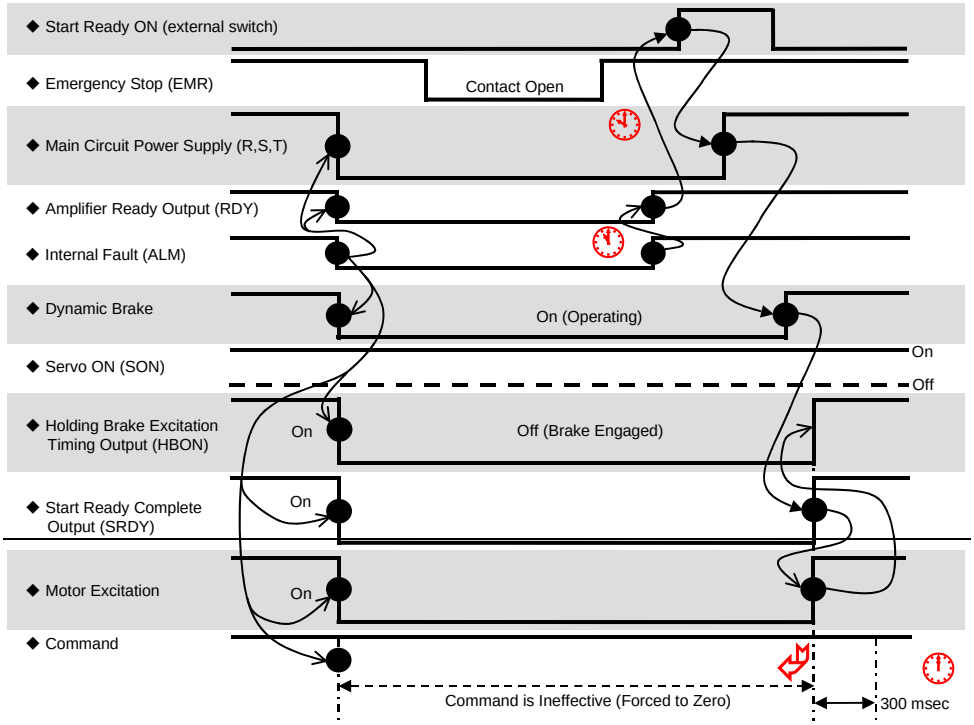
4. If an interlock condition occurs while moving a heavy load a Bus Circuit Power Error (MPE) alarm may occur.


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## Stop and recovery due to an internal error

If an error occurs during operation, the amplifier signals the alarm and stops motion. When the cause of the alarm is corrected and the amplifier alarm is reset, normal operation can continue. The following timing diagram defines the sequence of operation during a stop following an alarm and the restart after it is reset.




Notes:

1. During an internal alarm condition, opening the “Interlock” has no effect. However, release it before inputting “Start Ready”.

2. This value can be changed to 0mS by setting the “Holding Brake Excitation Timing” to “0” (Mode 1, Page 13). The current is limited by the sequence current limit value for 300mS. The default value for the sequence current limit (SILM) is 120%. It may be change in Mode 1, Page 12.

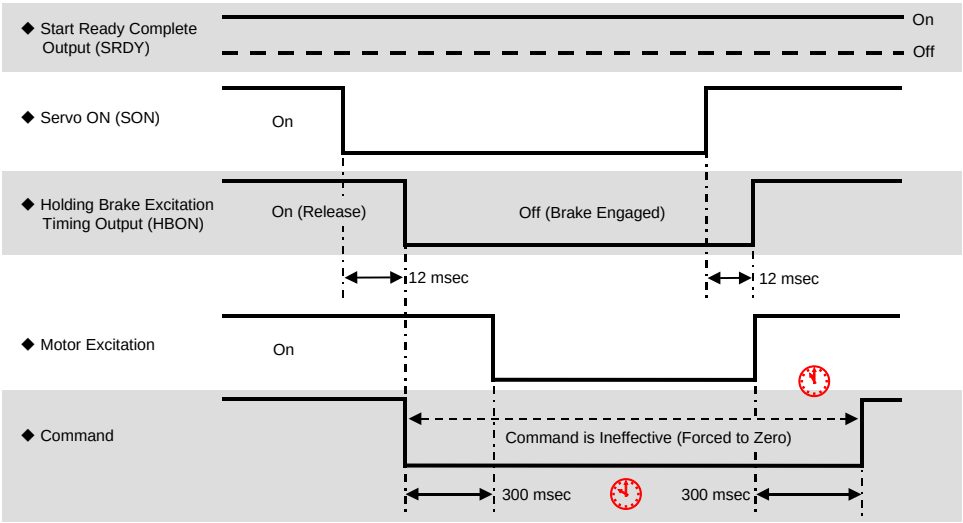

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# Servo “OFF” Sequence

## With 300mS Brake Delay

During normal operation, the Servo “ON” (SON) input may be used to enable and disable the amplifier. The timing diagram below defines the sequence of operation. In this configuration there is a 300mS delay from the time the brake is released and the motor excitation begins. This delay is present to allow mechanical delays in the actual release of the brake. During this time, the command is internally clamped to zero. If the amplifier is in position mode, the command pulses are counted during this 300mS delay and will be present as a position error when the motor is enabled. This 300mS delay may be eliminated by setting the “Holding Brake Excitation Timing” (Mode 1, Page 13) to “0”. Refer to the next section for more details.




Notes:

1. The current is limited by the sequence current limit value for 300mS. The default value for the sequence current limit (SILM) is 120%. It may be changed in Mode 1, Page 12.

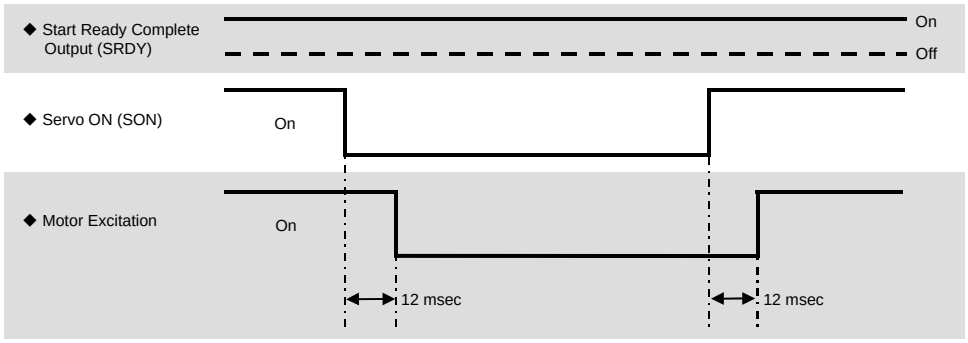

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## With no Brake Delay

As noted in the section above, the standard amplifier configuration has a 300mS delay between the release of the brake and motor excitation. During this time, the command is internally clamped to 0, but position commands are still being counted. In the case where the load may force the motor to move during this short time, the motor will jump on motor excitation. The amplifier will attempt to move the motor back to the position it was in when the Holding Brake Excitation output (HBON) was turned "OFF". This condition is common with vertical loads.

To eliminate this "jump," the holding brake delay can be set to 0 by changing the "Holding Brake Excitation Timing", Mode 1, Page 12 to" 0". In this case, the motor excitation will occur before the brake is actually released. The drawback to this configuration is increased wear and strain on the holding brake. The timing diagram below defines the sequence of operation.



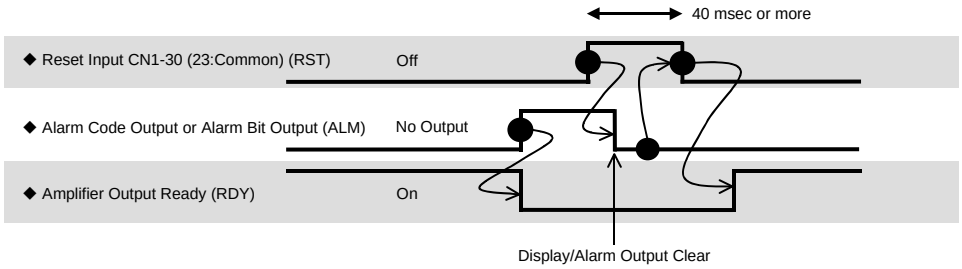


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# Alarm Reset Sequence

Should an alarm occur, it must be reset before normal operation can continue. The timing diagram below defines the sequence of operation for an Alarm Reset.




Notes:

1. Turn “OFF” the Reset Input (RST) after checking that the Alarm Code Output (ALM) is “OFF”.

2. Sensor Error (DE), DSP Errors (DSPE), Memory Errors (MEME) and CPU Errors (CPUE) cannot be reset unless the control power is cycled “OFF” and back “ON”.

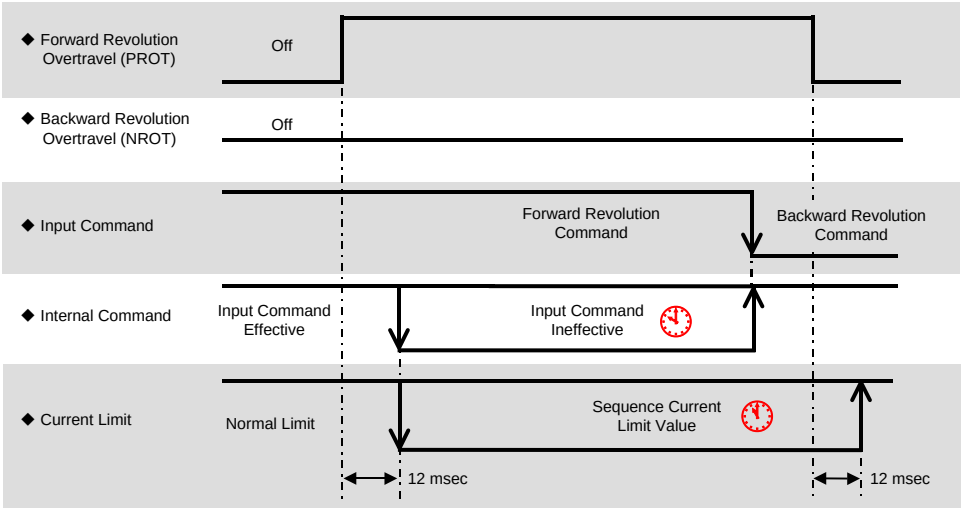

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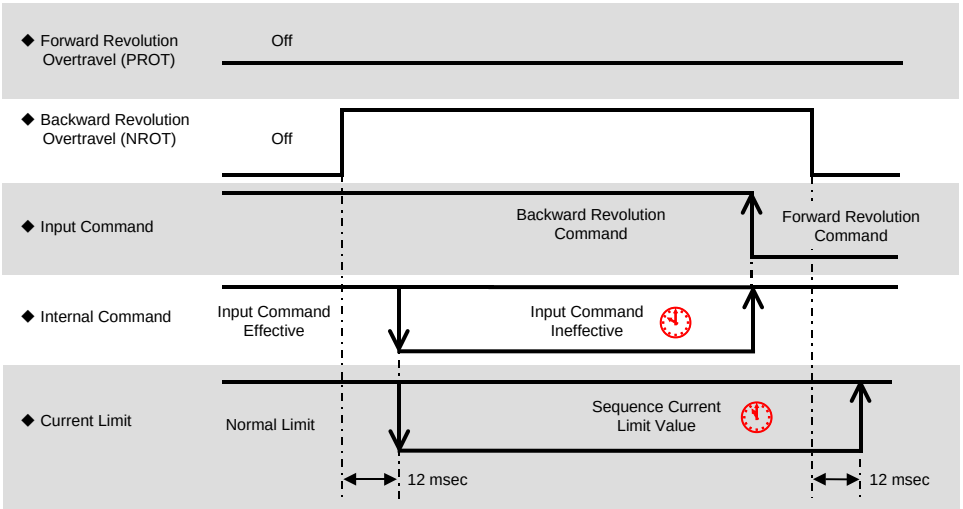
# Over-travel Sequence

Over-travel limit inputs are provided on CN1. The positive rotation over-travel (PROT) limit input is on pin CN1-32 and the negative rotation over-travel (NROT) limit is on pin CN1-33. This condition is not an alarm. The timing diagrams below define the sequence of operation for over-travel conditions. Func0 (Mode 2, Bit 5), may be used to change the sense of the NROT and PROT.

## Positive Over-Travel




## Negative Over-Travel




Notes:

1. The operation of the command invalidation differs between position and velocity controls. For position controls, command pulses are inhibited, and for velocity controls, the command is forced to 0 (VCMD=0). These settings are valid when the acceleration/deceleration time (Tvac, Tvde) or low pass filter (VLPF) parameters are set.

2. Setting the Sequence Current Limit (SILM) parameter using the Remote Operator (Mode 1, Page 12) can change sequence current limit values.


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# Drive Setup

## Chapter Overview

In this chapter, you will be introduced to setting parameters, viewing alarm history, tuning and monitoring the amplifier with the Remote Operator and the PY Setup Software.


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# Using the Remote Operator

**Overview**

The Remote Operator can be used to configure and test the amplifier. There are five modes of operation: Parameter Set, Parameter Select, Monitor, Alarm Trace, and Test.

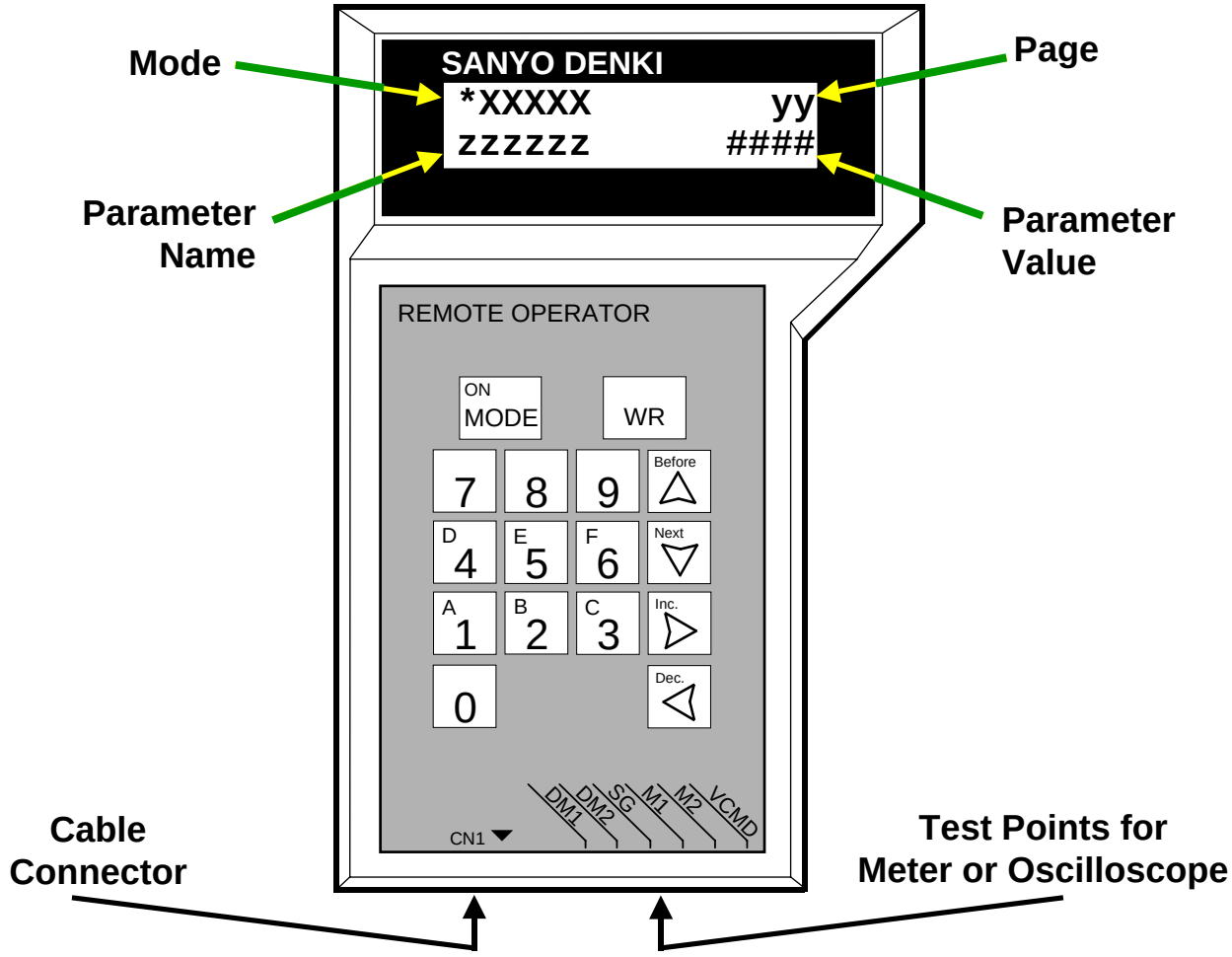
**Para. Set** The 4 parameters that allow the operator to enter a value are in this mode.

**Para. Select** There are 9 parameters where the operator can choose between several factory options. These parameters are contained in the parameter select mode.

**Monitor** The monitor mode is used to view internal values, and the state of inputs and outputs.

**Alarm Trace** In the Alarm Trace mode, the operator can review the current and previous 7 alarms.

**Test** In the test mode, the operator can jog the servomotor and run the auto-tuning algorithm.



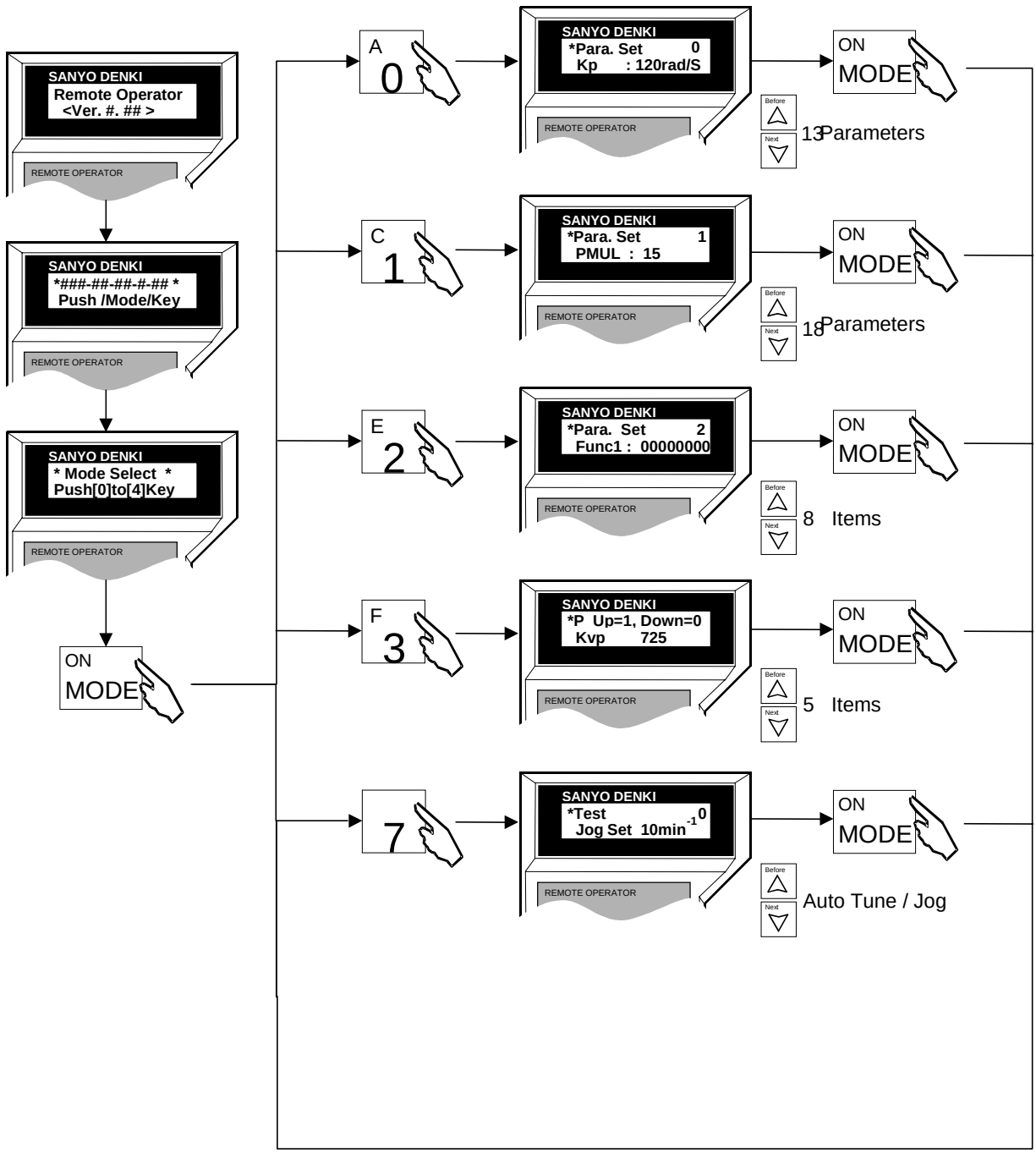


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## Remote Operator Modes Navigation

The remote operator has seven (7) modes, Parameter Set 0, 1, 2, & 8 Parameter Select, Monitor, Alarm Trace, and Test. The diagram below shows how to navigate through these modes. The up and down arrows are used to scroll through the elements within a mode.





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# PY Setup Software

**Overview**

Like the Remote Operator, PY Setup Software can be used to configure and test the amplifier. One advantage of the software is that it allows you to save a copy of your configuration for backup or for reuse as a later date.

The PY-PCSETUP Software Kit comes with a drive connection cable and software. This software uses COM1 or COM2 (9-Pin port) to connect to a PY0 or PY2 drive.

**Getting Started**

The PY Setup Software should be initialized as follows:

1) Install the software using the Setup program on the floppy disk.

2) Connect the PY Setup cable to the OP connector on the PY0 or PY2 drive for an online connection. A configuration file can also be opened offline without connecting to the drive. Insure that the drive is powered up if you wish to make an online connection.

3) Start the PY Setup Software program.

4) The initial screen will request that you to select either COM1 or COM2 for the online connection. Select the choice that matches your available online cable connection. If you intend to open a file offline, the choice does not matter.

5) The Main Menu will appear.

**Online Connections**

For an online connection, complete the following steps

1) After the Main Menu is displayed, click the ONLINE option under Communication.

2) Click the Yes button after you have confirmed that the drive is powered up and connected to the cable.

3) New choices will be available on the menu if the connection is successful.


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The following online options are available.

- Set Parameters – Allows access to parameter values for the drive. Current values can be viewed or modified.
- Digital Monitor – The Digital Monitor screen allows you to monitor servo status, CN1 I/O, torque, and miscellaneous feedback and command values.
- Alarm Trace – This screen shows the current error in addition to a history of the last seven errors.
- Test Mode – This screens provides commands for jogging the motor, tuning the motor, and adjusting the velocity or torque offset.

### Offline Modifications

For offline use, complete the following steps

1) After the Main Menu is displayed, click the EDIT PARAMETER button.
2) Browse to the folder on your computer that contains the saved configuration.
3) Select the file and click on the LOAD button. Parameters for the selected configuration will be displayed.

### Amplifier Parameter Modifications

Parameters are placed in six tabs labeled Mode 0-4 and Mode8. Current values for a parameter can be viewed by clicking on the required tab and using the scroll bars to find the desired parameter. Each row on the Mode tab has a Page assigned in the left column. This numbering system allows you to easily locate the parameter when it is referenced in the PY manual. The parameters are located in the same Mode areas as the Remote Operator.

To modify a parameter, click on the desired parameter to be modified. Its current value will be displayed in the Input Value window. This value can be changed to a different value. For parameters where one of a set number of choices is available, use the pull-down for the Input Value Window to select a different choice. If the Input Value Window requires a numeric value, type in a new value that is within the Setting Range displayed for the selected parameter. Once the value is changed, hit the "Set" button to send the new value to the drive.

### Saving Amplifier Parameter Values

After you have made modifications to a configuration (offline or online), the software will prompt you to save your settings when you attempt to return to the Main Menu. Provide a file name and browse to a desired path to preserve the settings.


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# Jogging Operations

The motor can be rotated forward and backward using the Remote Operator or PY Setup Software. The jogging speed may also be set during a jogging operation. Jogging is one of two operations that can be performed in the test mode. The other is auto-tuning.

***Precautions***

- Jogging is performed in the velocity control mode.
- If a load is attached to the motor, secure enough operating range before jogging the motor. In particular, when load inertia or jogging speed is high, consider the deceleration distance.
- During the JOG operation, current is limited by the sequence current limit value. The default value is 120%. It can be changed using the Remote Operator.
- During JOG operations, the overtravel limits are effective. For example, if a forward overtravel alarm occurs while jogging in the forward direction, the motor speed will reduce to zero and no forward motion will be permitted. The acceleration/ deceleration time setting is used when an overtravel limit alarm occurs. Therefore, consider the distance traveled during deceleration when setting these positions.
- Since a position loop deviation may remain after a JOG operation, be sure to perform a "deviation clear" before returning to normal operation.


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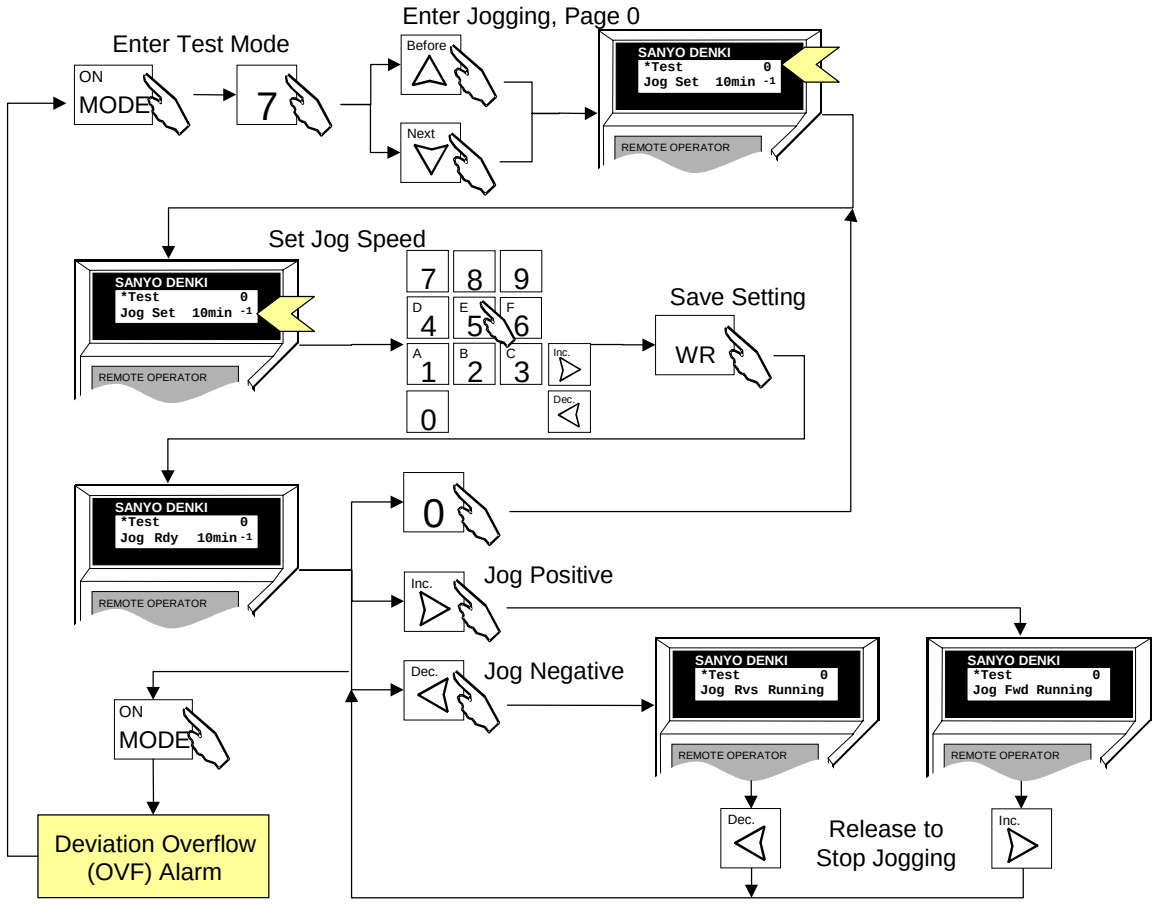
***Jogging Operation Procedure with Remote Operator.***

***Operations before Entering the Test Mode***

- Enable test mode operations by setting Func6 bit 6 in mode 2 on page 7 to "1".
- Set the command input to 0.
- The Remote Operator internally controls the Brake release.

Turn ON the bus power (r and t).

- Pressing the ► key performs Forward motion. "Fwd Running" is displayed when the motor revolves in the counter clockwise direction when looking at the motor shaft.
- Pressing the ◄ key performs Reverse motion. "Rvs Running" is displayed when the motor revolves in the clockwise direction when viewed looking at the motor shaft.




***Jogging Operation Procedure with PY Setup Software.***

Connect the computer to the drive and go online using the PY Setup Software. After reaching the Main Menu, complete the following actions.


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1) Click the TEST MODE button on the Main Menu screen.

2) Click the JOG OPERATION button on the Test Mode Screen.

3) You will be prompted whether or not an OFV (deviation) alarm should occur when jogging operations are completed. Select "yes" if you want an alarm generated (note that the amplifier is switched to velocity mode to accomplish the jogging operation). Otherwise select "no".

4) Once the Drive is ready, a prompt will appear for entry of a speed. Units are the speed are revolutions per minute. Keep in mind that this is revolutions of the motor shaft before entry to gearboxes, etc.

5) After entry of a speed, a new prompt will appear with CCW (Counter-Clockwise) and CW (Clockwise) buttons.

6) Press and hold the left mouse button on the desired direction button. Releasing the mouse will make the motor decelerate to a stop position.


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# Amplifier Tuning

## Auto-Tuning

### *General*

The auto-tuning function operates the motor using the Remote Operator and estimates the load inertia by moving the load and measuring amplifier currents. With this information, the tuning parameters are automatically set. The four (4) parameters that are set include position loop gain (Kp), velocity loop gain (Kvp), velocity loop integration time constant (Tvi) and current command low pass filter (ILPF).

### *Precautions*

- When auto-tuning is performed, a 60Hz peak torque command is applied for 0.5 seconds. This results in forward and backward motion of one or more turns depending on the load. Use this function only when motor vibrations will not damage the machine.
- If the motor starts vibrating before auto-tuning is performed, reduce the velocity loop gain (Kvp) and increase the integral time constant (Tvi).
- The presence of external current limits may adversely affect the auto-tuning results.

### *Best Results*

Auto-tuning algorithms work best under the following conditions; under other conditions, manual tuning may be required.

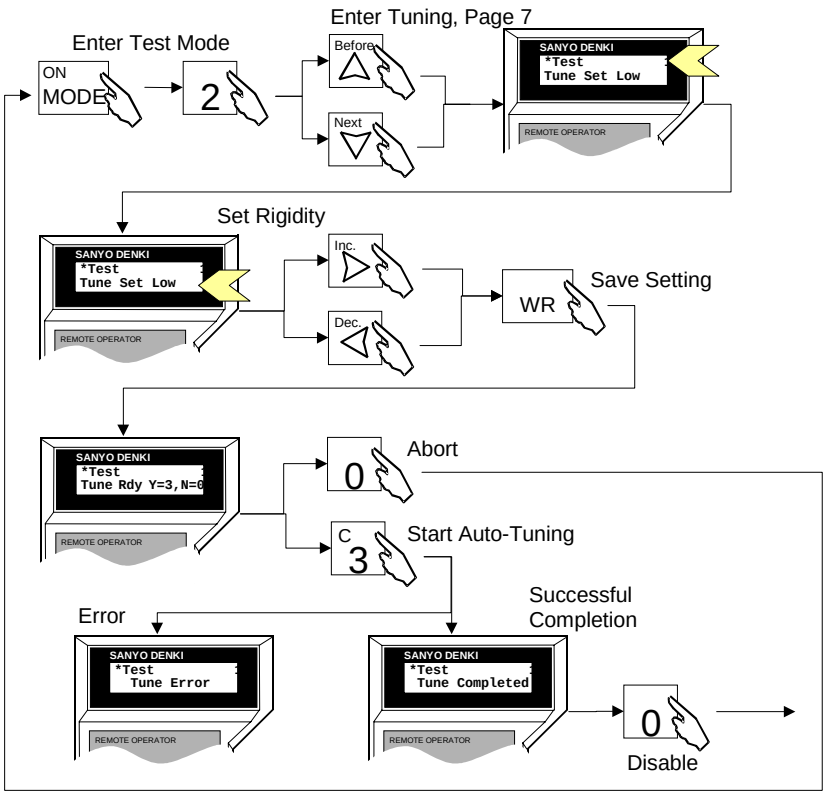
- The load inertia, reflected to the motor shaft, is similar to the inertia of the motor shaft.
- The variations in load inertia and friction are small, i.e., the load is not dynamic.
- The system backlash including motor coupling, gear reductions, ball screws, etc., is small. Backlash is typically measured in degrees and is the distance that the motor shaft can turn while the load is locked in position.
- Results are best when the mechanical system is rigid. Low rigidity systems, including the coupling, may cause mechanical resonance.

### *Auto-tuning operation with Remote Operator*

1. Enable test mode operations by setting Func6 bit 6 in mode 2 on page 7 to “1”.
2. Set the command input to 0.
3. The remote operator internally controls the brake release.
4. Turn ON the bus power (R, S, and T).


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5. Enter test mode, press **[ON / Mode]** and then press 7.

6. On page 1, choose the desired level of performance: high, medium, or low. For the longest mechanical life, and quietest operation, choose the lowest performance setting that will still meet the application requirements. High performance settings require rigid mechanical systems and cause the highest stresses and strains to the mechanical components.

7. To abort auto-tuning, press 0. To start auto-tuning, press 3.

8. At the conclusion of auto-tuning, the proper parameter values are automatically stored into nonvolatile memory.

9. If an error occurs during auto-tuning, the word ERROR appears on the Remote Operator. Mechanical problems are the most common cause of an error during auto-tuning (drivetrain backlash or compliance).

***Operations after Auto-Tuning with the Remote Operator***

- Upon exiting the Test Mode, an OVF (Deviation Over) alarm occurs. However, this alarm is not entered into the alarm history.


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- If a position controller is being used, a position error in that controller may have accumulated during the jogging operation. This error results in a command signal from the position controller to the amplifier. Clear this position error before starting normal operation; otherwise, the amplifier will make a sudden move in the direction to eliminate the position error.

***Auto-tuning operation with PY Setup Software***

1. Select **Test Mode** on Main Menu.
2. Select **Offline Auto Tuning** on Test Mode Menu.
3. You will be prompted whether or not an OFV (deviation) alarm should occur on when tuning is completed. Select "yes" if you want an alarm generated (this could serve as an indication to your controller that the axis is no longer in position). Otherwise select "no".
4. Select **High**, **Medium**, or **Low** Tuning on Menu.
5. Select **Yes** for **Offline Tuning Start Okay**?
6. **Tuning Successful** window will appear showing tuning values.
7. Select **Cancel** to exit Tuning Mode Menu.

## Manual Tuning

In applications where auto-tuning is not suitable, the servo loops may be tuned manually. If you are not familiar with the operation of PI (Proportional and Integral) controls, please review our *Handbook of AC Servo Systems* which is available as a PDF file from our website.

If you are in position mode, refer to the diagram on page 68 for a complete list of parameters that affect tuning. If you are using Velocity Control refer to page 79 for a complete list of parameters that affect tuning.

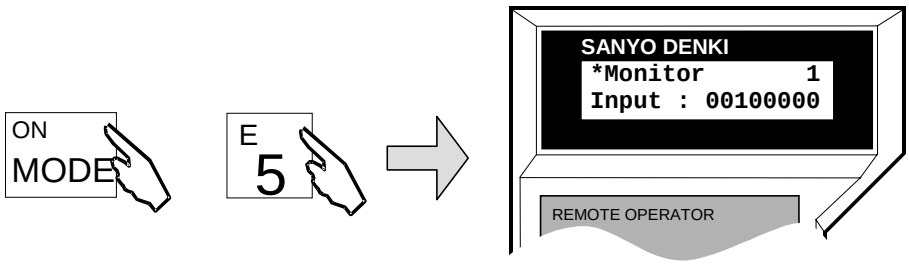

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# Monitor Screen

**Remote Operator**

The Remote Operator may be used to monitor inputs, outputs, velocity, current, etc., of the servo amplifier. The monitor mode is mode 5.




**PY Setup Software**

The PY Setup Software Monitoring Mode can be reached by clicking the DIGITAL MONITOR button on the Main Menu Screen.

**Table 18: Monitor Mode Page Descriptions**

| Page ▼▲ | Abbrev | Description |
|---|---|---|
| 0 | STATUS | Indicates the internal status of the amplifier. Power OFF, Servo Ready, Servo ON, Alarms. |
| 1 | INPUT | Indicates the input status of CN1 inputs, [1=ON, 0=OFF] and setting status. |
| 2 | OUTPUT | Indicates the output status of CN1 outputs, [1=ON,0=OFF] and internal drive status. |
| 3 | VCMD | Indicates the commanded velocity [RPM] |
| 4 | VFBK | Indicates the actual velocity [RPM] |
| 5 | ICMD | Indicates the commanded current as a percent [IP/IR x 100%] |
| 6 | IFBK | Indicates the actual current as a percent [IP/IR x 100%] |
| 7 | POS. E | Indicates the position error deviation counter value [Pulses] |
| 8 | CSU | Indicates the electric angle of phase U [Degrees] |
| 9 | PCMD F | Indicates the position command frequency [Pulses/sec] |
| 10 | PS | Indicates the absolute position (Hexadecimal) |
| 11 | FCCNT | Indicates the position free-run counter value (Hexadecimal) |
| 12 | Trms | Indicates the effective torque (Trma/Tr x 100%) |
| 13 | KpM | Indicates the position loop gain (rad/s) |
| 14 | KvpM | Indicates the velocity loop proportional gain (Hz) |
| 15 | TviM | Indicates the velocity loop integral action time (ms) |

Bit 7 6 5 4 3 2 1 0

| Name | HOME | 0 | 1 | PROB2 | PROB1 | CW Limit | CCW Limit | EXOH |
|---|---|---|---|---|---|---|---|---|
| Pin | 16 | - | - | 15 | 14 | 13 | 12 | 11 |

Bit 7 6 5 4 3 2 1 0

| Name | 0 | 0 | 0 | 0 | 0 | 0 | OUT1 | OUT2 |
|---|---|---|---|---|---|---|---|---|
| Pin | - | - | - | - | - | - | 19 | 17 |


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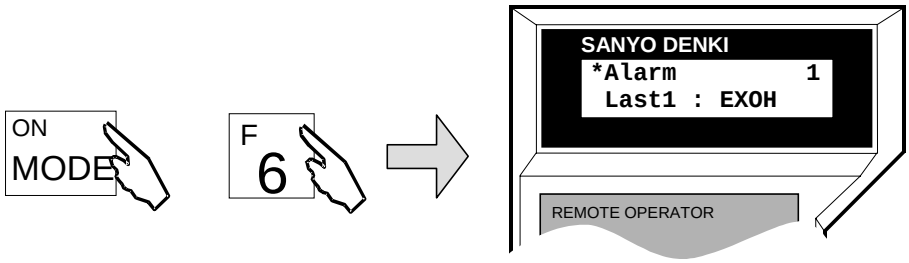
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# Alarm Trace Screen

This mode permits you to view a history of the last eight faults that have occurred on the amplifier. Using the Remote Operator, you may view the current alarm and the previous 7 alarms. Refer to Maintenance and Troubleshooting on page 117, for assistance determining and correcting the conditions that led to the alarms.

## Remote Operator

The monitor mode is mode 6.




## PY Setup Software

For the PY Setup Software, click on the ALARM TRACE button on the Main Menu Screen to view alarm history.

**Table 19: Alarm Mode Page Descriptions**

| Page ▼▲ | Switch Position | Description |
|---|---|---|
| 0 | 0 | Current Status or Alarm |
| 1 | 1 | Previous Alarm |
| 2 | 2 | |
| 3 | 3 | |
| 4 | 4 | |
| 5 | 5 | |
| 6 | 6 | |
| 7 | 7 | Oldest Alarm |


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# Quick Setup

The amplifiers are factory configured for the most common applications. Therefore, no setup is required in most cases. The most common configuration changes include the following:

- The selection of an alternative command mode, such as position or torque mode.
- The selection of the proper motor purchased with your system.
- For optimal performance in your application, tuning may also need to be adjusted.

**Table 20: Quick Setup Steps with Remote Operator**

| Step | Procedure |
|---|---|
| Select the proper motor and the desired control type.<br><br>• Position Mode | 1. Turn ON the control power, the 230Vac attached to the "r" and "t" terminals.<br>• The Remote Operator screen should display the [Push Mode Key] screen and a beep should sound.<br><br>2. Enable System Parameter changes using the Remote Operator.<br>• Press [ON / Mode] and 2 to enter the parameter set mode.<br>• Press the ▼ key until you have switched to page 7 where you can set the Func6 parameters.<br>• Press the 1 key to change bit 7 to a 1.<br>• Press the [WR] key to save the change.<br><br>3. Select the proper motor.<br>• Press [ON / Mode] and 4 to enter the parameter select mode.<br>• Press the ▼ key until you have switched to page 6 where you can set the motor type parameter.<br>• Press the ◄ and ► keys to change to the proper motor type.<br>• Press the [WR] key to save the change.<br>• Cycle the control power OFF and back ON |
| Adjust Tuning | In many cases, the default tuning will provide exceptional performance. With large motor-to-load inertia mismatches or in cases where very high performance is desired, servo loop tuning is required. This can be accomplished using the amplifiers internal auto-tuning algorithms or manual tuning. |

For the PY Setup Software, the Control Mode can be accessed in SET PARAMETERS. Go to Mode 4 on the tabs. Control Mode will be on Page 4 (4th item in list). The motor type is on Page 6 on the same Mode tab (6th item in list).

In addition to these fundamental setup features, the remote allows configuration for external regen resistor. Please refer to the function lists in the following section.


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# Amplifier Parameters

## Chapter Overview

In this chapter, you see a list of all Amplifier Parameters. A description, range of valid values, and default value is provided.


Chapter Overview ..... 77
*Summary* *77*
*Position Control* *78*
*Velocity Control* *79*
*Current Limiting* *79*
Parameter Summary, by Mode and Page ..... 80
Detailed Description of Parameters ..... 83


### Summary

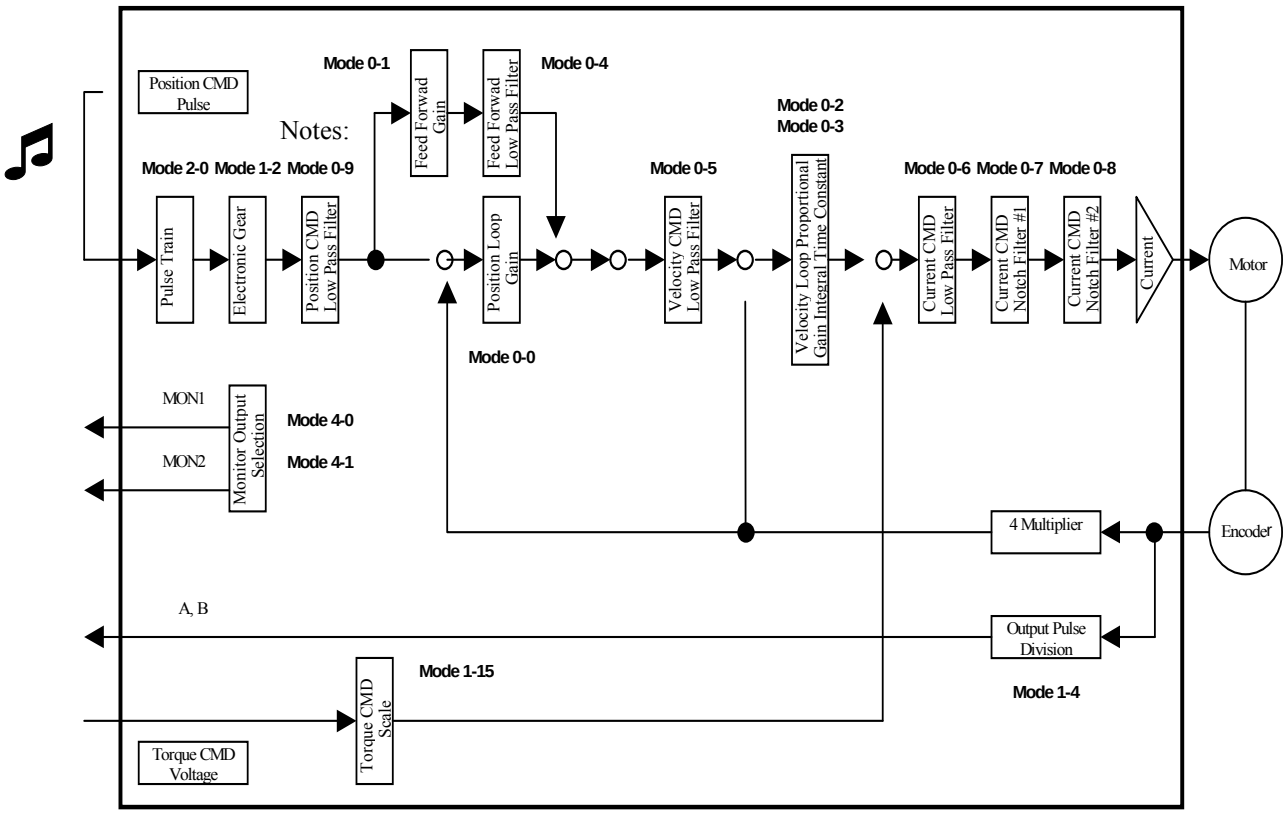
The PY Amplifier family has many features and functions. The behavior of those functions are controlled and configured by amplifier parameters. The descriptions of these parameters have been arranged in several ways for easy reference. The Remote Operator or PY Software can access the amplifier parameters.

| | |
|---|---|
| **Position Loop**<br>See page 78 | Pictorial reference of all the parameters associated with tuning a controller that is configured for position control. |
| **Velocity Loop**<br>See page 79 | Pictorial reference of all the parameters associated with tuning a controller that is configured for velocity control. |
| **Sorted by Mode and Page**<br>See page 80 | A table of all the parameters sorted by Remote Operator Mode and Page. For example, Kvp which is the symbol for Velocity Loop Proportional Gain is in mode 0 on page 2. |
| **Detailed Description of Parameters**<br>See page 83 | A detailed description of each parameters, including limits. |


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**Position Control** Position Loop Parameter Block Diagram

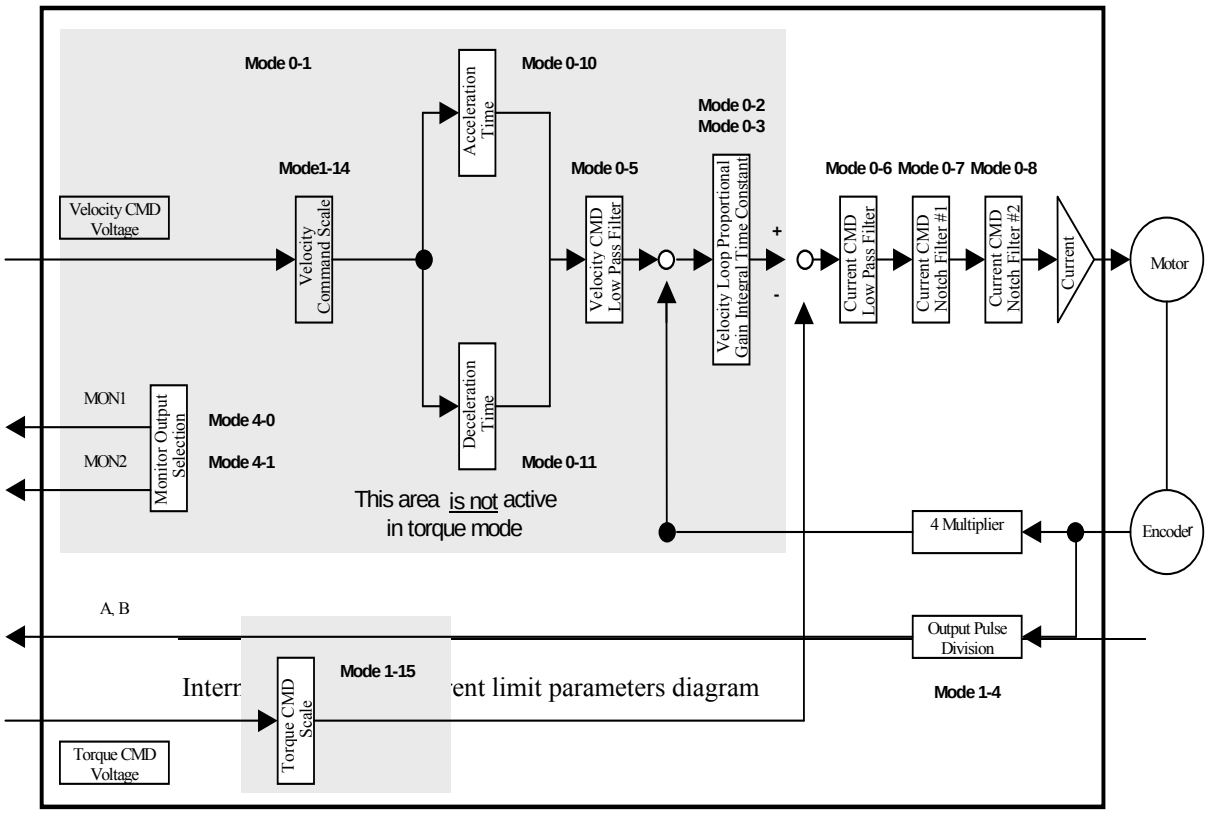



- Each low pass or notch filter is disabled when set to 1000 Hz.

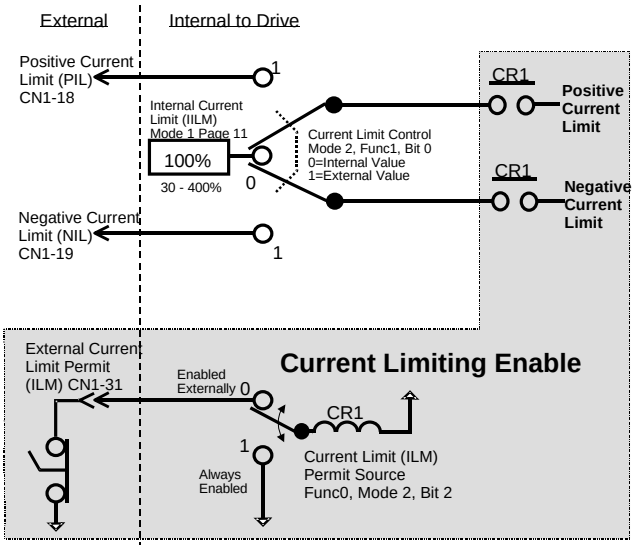

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**Velocity Control** Velocity Loop Parameter Block Diagram




**Current Limiting**





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# Parameter Summary, by Mode and Page

The table below contains a list of all the amplifier parameters arranged by mode and page as they appear in the remote operator. Detailed descriptions of the parameters follow this table. Values in parentheses on the table are applicable to motors other than P3 and P5 series.

| Name | Abbrev | Range | Default | Units | Mode-Page |
|---|---|---|---|---|---|
| Position Loop Gain | Kp | 1 to 1000 | 45 (30) | rad/S | 0-0 |
| Feed Forward Gain | Kff | 0 to 100 | 0 | % | 0-1 |
| Velocity Loop, Proportional Gain | Kvp | 10 to 3000 | 100 (70) | Hz | 0-2 |
| Velocity Loop, Integral Time Constant | Tvi | 1 to 1000 | 15 (20) | mS | 0-3 |
| Feed Forward Low Pass Filter | FLPF | 1 to 1000 | 1000 | Hz | 0-4 |
| Velocity Command Low Pass Filter | VLPF | 1 to 1000 | 1000 | Hz | 0-5 |
| Current Command Low Pass Filter | ILPF | 1 to 1000 | 450 | Hz | 0-6 |
| Current Command, Band Eliminate Filter #1 | IBF1 | 200 to 1000 | 1000 | Hz | 0-7 |
| Current Command, Band Eliminate Filter #2 | IBF2 | IBF1 to 1000 | 1000 | Hz | 0-8 |
| Position Command, Low Pass Filter Time Constant | Tpcm | 0 to 4000 | 0 | mS | 0-9 |
| Velocity Command, Acceleration Time | Tvac | 0 to 9999 | 0 | mS | 0-10 |
| Velocity Command, Deceleration Time | Tvde | 0 to 9999 | 0 | mS | 0-11 |
| Velocity Loop, Proportional Gain Addition | KvpA | 0 to 255 | 0 | Hz | 0-12 |

| Name | Abbrev | Range | Default | Units | Mode-Page |
|---|---|---|---|---|---|
| Positioning Complete Signal Width | INP | 1 To 32767 | 64 | P(+/-) | 1-0 |
| Excessive Deviation Value | OVF | 1 To 32767 | 256 | x256P | 1-1 |
| Electronic Gear Ratio | EGER | 1/32767 To 32767 | 4/1 | - | 1-2 |
| Command Pulse Multiplier | PMUL | 1To 63 | 1 | - | 1-3 |
| Output Pulse Division Ratio | ENCR | 1 To 1/8192 | 1/1 | - | 1-4 |
| Low Speed | LTG | 0 to 32767 | 50 | $min^{-1}$ | 1-5 |
| High Speed | HTG | 0 to 32767 | 1000 | $min^{-1}$ | 1-6 |
| Velocity Matching Width | SPE | 0 to 32767 | 50 | $min^{-1}$ | 1-7 |
| Internal Velocity, Command Value #1 | VCI1 | 0 to 32767 | 500 | $min^{-1}$ | 1-8 |
| Internal Velocity, Command Value #2 | VCI2 | 0 to 32767 | 1000 | $min^{-1}$ | 1-9 |


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| Name | Abbrev | Range | Default | Units | Mode-Page |
|---|---|---|---|---|---|
| Internal Velocity, Command Value #3 | VCI3 | 0 to 32767 | 1500 | $min^{-1}$ | 1-10 |
| Internal Current Limit Value | IILM | 30 To (IP/IR) x 100 | 100 | % | 1-11 |
| Sequence Current Limit Value | SILM | 30 To (IP/IR) x 100 | 120 | % | 1-12 |
| Holding Brake Timing | THB | 0 To 1000 | 300 | mS | 1-13 |
| Velocity Command Scale | VCMS | 0 To 3000 | 500 | $min^{-1}$/V | 1-14 |
| Torque Command Scale | TCMS | 0 To 400 | 50 | %/V | 1-15 |
| Motor Encoder Pulse Number | MENP | 500 to 65535 | $$$$ | P/R | 1-16 |
| Full Close Encoder Pulse Number | EENP* | 500 To 65535 | $$$$ | P/R | 1-17 |

| Name | Abbrev | Range | Default | Units | Mode-Page |
|---|---|---|---|---|---|
| Command Pulse Train Form | PMOD | 0, 1 | 00000000 | Bit | 2-0 |
| Amplifier Function Select #0 | Func0 | 0, 1 | 00000000 | Bit | 2-1 |
| Amplifier Function Select #1 | Func1 | 0, 1 | 00000000 | Bit | 2-2 |
| Amplifier Function Select #2 | Func2 | 0, 1 | 00100000 | Bit | 2-3 |
| Amplifier Function Select #3 | Func3 | 0, 1 | 00000001 | Bit | 2-4 |
| Amplifier Function Select #4 | Func4 | 0, 1 | 00000001 | Bit | 2-5 |
| Amplifier Function Select #5 | Func5 | 0, 1 | 00000000 | Bit | 2-6 |
| Amplifier Function Select #6 | Func6 | 0, 1 | 00000000 | Bit | 2-7 |

| Name | Abbrev | Range | Default | Units | Mode-Page |
|---|---|---|---|---|---|
| Position Loop, Gain | Kp | 1 To 1000 | 45 (30) | rad/S | 3-0 |
| Velocity Loop, Proportional Gain | Kvp | 10 To 3000 | 100 (70) | Hz | 3-1 |
| Velocity Loop, Integral Time Constant | Tvi | 1 To 1000 | 15 (20) | mSec | 3-2 |
| Zero Adjustment of Velocity Command | Vzero | +/-16383 | $$$$ | | 3-3 |
| Zero Adjustment of Torque Command | Tzero | +/-16383 | $$$$ | | 3-4 |

| Name | Abbrev | Range | Default | Units | Mode-Page |
|---|---|---|---|---|---|
| Monitor #1 Output | M1 | 12 Ranges | Vm2mV/$min^{-1}$ | | 4-0 |
| Monitor #2 Output | M2 | 12 Ranges | Ic2v/IR | | 4-1 |
| Gain Select (older models only) | GAIN | 2 Ranges | Fix | | 4-2 |
| Servo Function Choice (newer models) | Func | 4 Ranges | Normal | | 4-2 |
| Control Mode | TYPE | 6 Ranges | $$$$ | | 4-3 |
| Encoder Type | ENKD | 3 Ranges | $$$$ | | 4-4 |


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| Name | Abbrev | Range | Default | Units | Mode-Page |
|---|---|---|---|---|---|
| ABS Sensor Format | ABSF | 11 Ranges | $$$$ | | 4-5 |
| Motor Type | MOT. | For P1, P2, P3, P5, P6, and P8 motors | $$$$ | | 4-6 |
| Motor Configuration | MOKD | Rotary<br>(Can not be changed) | Rotary | | 4-7 |
| Power Supply Type | PSKD | 2 Ranges | AC 200V 1P | | 4-8 |
| Regenerative | RGKD | 2 Ranges | Built in R | | 4-9 |

| Name | Abbrev | Range | Default | Units | Mode-Page |
|---|---|---|---|---|---|
| Position Loop, Gain #2 | Kp2 | 1 To 1000 | 45 (30) | rad/S | 8-0 |
| Velocity Loop, Proportional Gain #2 | Kvp2 | 10 To 3000 | 100 (70) | Hz | 8-1 |
| Velocity Loop, Integral Time Constant #2 | Tvi2 | 1 To 1000 | 15 (20) | mS | 8-2 |
| Current Command Value with Automatic Notch Filter Tuning | Tn_F | 30 to (IP/IR) X 100 | 100 | % | 8-3 |
| Observer – load Inertia Ratio | O_JL | 0 to 3000 | 100 | % | 8-4 |


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# Detailed Description of Parameters

Following is a detailed description of the amplifier parameters arranged by mode number.

## *Position Loop Gain* — *Kp*

**Remote Operator Mode:** 0 **Page:** 0 **Default Value:** 45 (30) rad/s

**Function:** Tune **Setting Range:** 1 to 1000 rad/s

**Description:**

- Proportional gain of the position controller

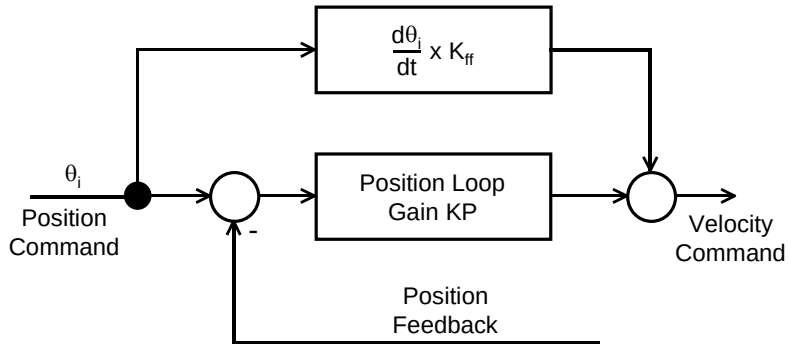
## *Feed Forward Gain* — *Kff*

**Remote Operator Mode:** 0 **Page:** 1 **Default Value:** 0 %

**Function:** Tune **Setting Range:** 0 to 100%

**Description:**

- When set to 100%, the following error becomes "0" when a constant speed is commanded.
- Higher values of Kff reduce the following error of the position loop. However, too high of a value may cause the system to become unstable and vibrate.





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## *Velocity Loop, Proportional Gain* — *Kvp*

**Remote Operator Mode:** 0 **Page:** 2 **Default Value:** 100 (70) Hz
**Function:** Tune **Setting Range:** 10 to 3,000 Hz

**Description:**

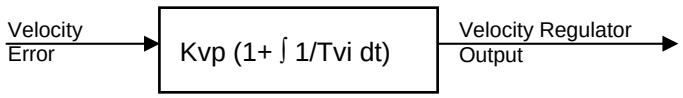
- Proportional gain of the velocity controller (PI control).
- The setting indicates the value when the load inertia is 0.

## *Velocity Loop, Integral Time Constant* — *Tvi*

**Remote Operator Mode:** 0 **Page:** 3 **Default Value:** 15 (20) ms
**Function:** Tune **Setting Range:** 1 to 1000 ms

**Description:**

- Integration time constant of the velocity controller (PI control) .





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## *Feed Forward, Low Pass Filter* *FLPF*

**Remote Operator Mode:** 0 **Page:** 4 **Default Value:** 1000 Hz
**Function:** Tune **Setting Range:** 1 to 1000 Hz

**Description:**

- The cut-off frequency of the low-pass filter is set for the feed-forward command of the position loop.

## *Velocity Command, Low Pass Filter* *VLPF*

**Remote Operator Mode:** 0 **Page:** 5 **Default Value:** 1000 Hz
**Function:** Tune **Setting Range:** 1 to 1000 Hz

**Description:**

- The cut-off frequency of the velocity command low-pass filter.

## *Current Command, Low Pass Filter* *ILPF*

**Remote Operator Mode:** 0 **Page:** 6 **Default Value:** 450 Hz
**Function:** Tune **Setting Range:** 1 to 1000 Hz

**Description:**

- The cut-off frequency of the current command low-pass filter.


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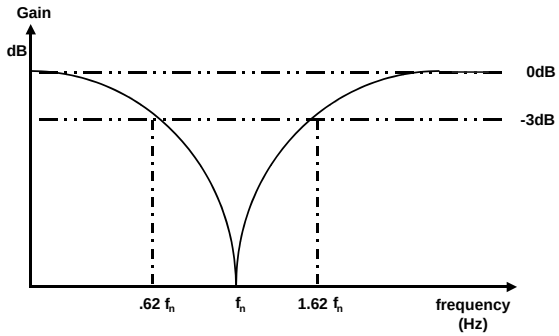
## *Current Command, Band Eliminate Filter #1 (Notch Filter)* — *IBEF*

**Remote Operator Mode:** 0 **Page:** 7 **Default Value:** 1000 Hz

**Function:** Tune **Setting Range:** 200 to 1000 Hz

**Description:**

- The center frequency of the notch filter with the characteristics shown in the following figure is set for the current command in the velocity loop.





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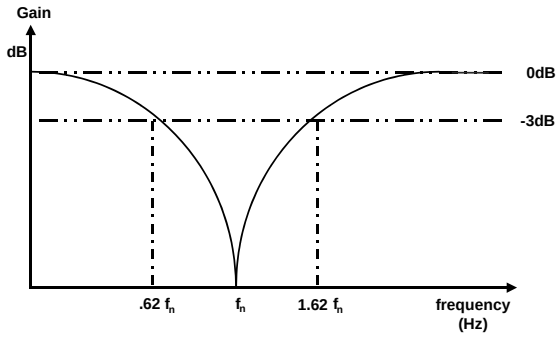
## *Current Command, Band Eliminate Filter* #2 Notch Filter) *IBEF*

**Remote Operator Mode:** 0 **Page:** 8 **Default Value:** 1000 Hz

**Function:** Tune **Setting Range:** IBF1 to 1000 Hz

**Description:**

- The center frequency of the notch filter with the characteristics shown in the following figure is set for the current command in the velocity loop.
- This parameter must satisfy the following requirement: IBF1 ≤ IBF2.




## *Position Command, Low Pass Filter Time Constant* *Tpcm*

**Remote Operator Mode:** 0 **Page:** 9 **Default Value:** 0 ms

**Function:** Tune **Setting Range:** 0 to 4000 ms

**Description:**

- The time constant for the position loop low-pass filter. When it is set to "0 ms", no filter is inserted.


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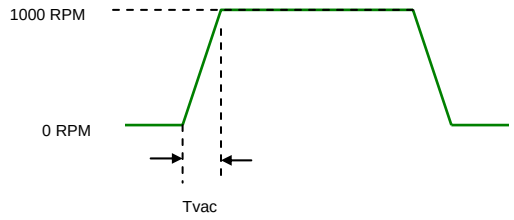
## *Acceleration Time* — *Tvac*

**Remote Operator Mode:** 0 **Page:** 10 **Default Value:** 0 ms

**Function:** CMD **Setting Range:** 0 to 9999 ms

**Description:**

- This parameter is used for limiting the acceleration time in the velocity control mode. The setting represents the minimum time over which the motor velocity can accelerate by 1000 $min^{-1}$ (rpm per minute).
- Even if the velocity command voltage suddenly changes, the velocity command inside the servo amplifier is limited so that the acceleration is equal to that determined by this time.




**Note:**

- This parameter is effective in the velocity control type. Using this when an external closed loop position controller is used introduces a phase delay that may cause instability and vibration.


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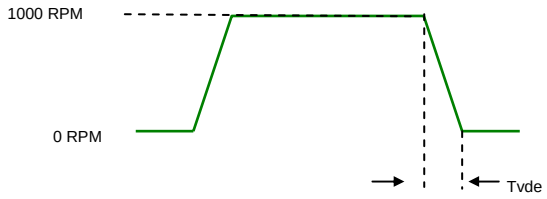
## *Deceleration Time* — *Tvde*

**Remote Operator Mode:** 0 **Page:** 11 **Default Value:** 0 ms

**Function:** CMD **Setting Range:** 0 to 9999 ms

**Description:**

- This parameter is used for limiting the deceleration time in the velocity command mode. The setting represents the minimum time over which the motor velocity can decelerate by 1000 $min^{-1}$ (rpm per minute).
- Even if the velocity command voltage suddenly changes, the velocity command inside the servo amplifier is limited so that the acceleration/deceleration is equal to that determined by this time.




**Note:**

- This parameter is effective in the velocity control type. Using this when an external closed loop position controller is used introduces a phase delay that may cause instability and vibration.
- This parameter determines the rate of deceleration when an over-travel limit is reached.

## *Velocity Loop Proportional Gain Addition* — *KvpA*

**Remote Operator Mode:** 0 **Page:** 12 **Default Value:** 0 Hz

**Function:** Alarm **Setting Range:** 0 to 255 Hz

**Description:**

- The actual velocity loop proportional gain is:
  Kvp + (KvpA x RSW)
  When Gain Switching is active, it will be:
  Kvp2 + (KvpA x RSW)
- RSW: A value set on the rotary switch.
- Moving the switch on front of the drive to the side labeled “GAIN” enables this.


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## *In-Position Window* — *INP*

**Remote Operator Mode:** 1 **Page:** 0 **Default Value:** 64 pulse

**Function:** Alarm **Setting Range:** 1 to 32767 pulses

**Description:**

- When the absolute value of the difference between the command position and the actual position is less than the In-Position Window (INP) the In-Position Output (CN1-39) is turned ON.
- The standard value is the encoder pulse multiplied by 4, irrespective of the electronic gear function, encoder dividing ratio, or the command multiplier setting.

  (Example)

  When the parameter is set to 64 with a 2,000 pulse encoder, the positioning complete signal is output when the value falls towards the target position in the following range:

$$64 \times \frac{1}{2000 \times 4} \times 360 = \pm 2.88 \text{ Degrees}$$

## *Following Error Limit* — *OVF*

**Remote Operator Mode:** 1 **Page:** 1 **Default Value:** 256

**Function:** Alarm **Units:** x256 pulses

**Setting Range:** 1 to 32767 pulses

**Description:**

- The following error limit is the absolute difference between the commanded position and the actual position. If the following limit is exceeded an OVF alarm occurs.
- A setting of 10 would equal the following error limit of 2,560 (10 x 256) encoder pulses.


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## *Electronic Gear Ratio* — *EGER*

**Remote Operator Mode:** 1 **Page:** 2 **Default Value:** 4/1
**Function:** CMD **Setting Range:** 1/32767 to 32767

**Description:**

- Electronic gear ratio is applied to incoming position commands.

$F_{in}$ = Frequency into the amplifier
$F_{out}$ = Frequency out of the gear function

EGER = N / D N (1 to 32767)
D (1 to 32767)

$F_{out} = F_{in} \times (N / D)$
$1 / 32767 \leq N / D \leq 32767$

**Note:**

- Since the electronic gear ratio is for changing the magnification ratio of the command pulses, changing this setting does not change the resolution of the position feedback.
- The encoder in use determines the minimum positioning resolution.

## *Position Command, Pulse Multiplier* — *PMUL*

**Remote Operator Mode:** 1 **Page:** 3 **Default Value:** 1
**Function:** CMD **Setting Range:** 1 to 63

**Description:**

- A multiplier for the position command pulse can be selected from 1 to 63.
- This multiplier is used when the PMUL input terminal is selected by the Func3 parameter.


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## *Output Pulse Divide Ratio* — *ENCR*

**Remote Operator Mode:** 1 **Page:** 4 **Default Value:** 1/1

**Function:** Monitor **Setting Range:** 1 to 1/8192

**Description:**

- Defines the ratio of encoder pulses (CN2) to control feedback pulses.

$F_{in}$ Frequency in from the motor encoder

$F_{out}$ Frequency out to a position controller

$$ENCR := \left(\frac{\beta}{\alpha}\right)$$

$\alpha$ = 1 to 64 or 8192
$\beta$ = 1 (when $\alpha$=1 to 64)
= 2 (when $\alpha$=3 to 64)
= 1 to 8191 (when $\alpha$= 8192)

$$F_{out} := F_{in} \cdot \left(\frac{\beta}{\alpha}\right)$$

## *Low Speed* — *LTG*

**Remote Operator Mode:** 1 **Page:** 5 **Default Value:** 50 $min^{-1}$

**Function:** Monitor **Setting Range:** 0 to 32767 $min^{-1}$

**Description:**

- Low Speed: When the speed decreases below this set level the “low speed” (LTG) status is turned ON if enabled.
- The LTG status can be output to CN1-39 or CN1-40 by setting Function Switch 4.


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## *High Speed* — *HTG*

**Remote Operator Mode:** 1 **Page:** 6 **Default Value:** 1000 $min^{-1}$

**Function:** Monitor **Setting Range:** 0 to 32767 $min^{-1}$

**Description:**

- High speed: When the speed exceeds this set level the “high speed” (HTG) status is turned ON (CN1-39) if enabled.
- The LTG status can be output to CN1-39 or CN1-40 by setting Function Switch 4.
- The following switching (control mode) enables a speed limit to be set in the torque control mode:

  Velocity ⟷ Torque

  Position ⟷ Torque

## *Speed Matching Width* — *SPE*

**Remote Operator Mode:** 1 **Page:** 7 **Default Value:** 50 $min^{-1}$

**Function:** **Setting Range:** 0 to 32767 $min^{-1}$

**Description:**

- When the difference between the velocity command and the velocity feedback is smaller than the specified value, the SPE status is turned on if enabled.
- The LTG status can be output to CN1-39 or CN1-40 by setting Function Switch 4.

## *Internal Velocity Command Value #1* — *VCI1*

**Remote Operator Mode:** 1 **Page:** 8 **Default Value:** 500 $min^{-1}$

**Function:** **Setting Range:** 0 to 32767 $min^{-1}$

**Description:**

- Sets a velocity command value.
- It is enabled by setting the Func3 parameter bits 3, 2, 1, and 0 to “1010” respectively, and turn the CN1-36 pin “ON” and CN1-35 pin “OFF”.
- The drive must be configured for velocity mode operation.


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## *Internal Velocity Command Value #2* — *VCI2*

**Remote Operator Mode:** 1 **Page:** 9 **Default Value:** 1000 $min^{-1}$

**Function:** **Setting Range:** 0 to 32767 $min^{-1}$

**Description:**

- Set a velocity command value.
- It is enabled by setting the Func3 parameter bits 3, 2, 1, and 0 to "1010" respectively, and turning the CN1-35 pin "ON" and the CN1-36 pin "OFF".
- The drive must be configured for velocity mode operation.

## *Internal Velocity Command Value #3* — *VCI3*

**Remote Operator Mode:** 1 **Page:** 10 **Default Value:** 1500 $min^{-1}$

**Function:** **Setting Range:** 0 to 32767 $min^{-1}$

**Description:**

- Sets a velocity command value.
- It is enabled by setting the Func3 parameter bits 3, 2, 1, and 0 to "1010" respectively, and simultaneously turning both the CN1-35 pin and the CN1-36 pins "ON".
- The drive must be configured for velocity mode operation.

## *Current Limit, Internal Value* — *IILM*

**Remote Operator Mode:** 1 **Page:** 11 **Default Value:** 100 %

**Function:** Current Limit **Setting Range:** 30 to (IP/IR) x 100

**Description:**

- By setting Func1, Bit 0 to "0" and turning "ON" pin ILM (CN1-31 pin), the current is clamped at the above set value. However, it is impossible to set the value higher than the IP value.
- This parameter can be set within the range from 30% to (IP/IR x 100)%.

  IP: Peak armature current.

  IR: Rated armature current.


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## *Current Limit, Sequence* — *SILM*

**Remote Operator Mode:** 1 **Page:** 12 **Default Value:** 120 %

**Function:** Current Limit **Setting Range:** 30 to (IP/IR) x 100

**Description:**

- This current limit applies under the following conditions: holding brake sequence, over-travel, and while jogging.
- Even if this parameter is set to a value larger than the peak current, the actual current will be limited to the peak current.
- Changes to this parameter do not take affect until the control power is cycled "OFF" and back "ON".
- The setting is a percentage of rated current (IR).

## *Holding Brake Excitation Timing* — *THB*

**Remote Operator Mode:** 1 **Page:** 13 **Default Value:** 300 ms

**Function:** **Setting Range:** 0 to 1000 ms

**Description:**

- Sets the holding brake excitation timing.
- Select "0" when this function is not used.

## *Velocity Command, Scale Adjustment* — *VCMS*

**Remote Operator Mode:** 1 **Page:** 14 **Default Value:** 500 $min^{-1}$/V

**Function:** **Setting Range:** 0 to 3000 $min^{-1}$/V

**Description:**

- Sets a velocity command scale corresponding to 1V of the command voltage.


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## *Torque Command, Scale Adjustment* — *TCMS*

**Remote Operator Mode:** 1 **Page:** 15 **Default Value:** 50 %/V
**Function:** **Setting Range:** 0 to 400 %/V

**Description:**

- Sets a torque command scale corresponding to 1V of the command voltage.

## *Motor Encoder Pulse Number* — *MENP*

**Remote Operator Mode:** 1 **Page:** 16 **Default Value:** 2000 P/R
**Function:** Motor **Setting Range:** 500 to 65535 P/R

**Description:**

- Sets the number of pulses of the encoder used.
- The following shows the number of encoder pulses for the standard combinations:
  "Wire-Saving" Incremental encoder—2000 P/R
  Absolute Encoder—2048 P/R
- Changes to this parameter do not take affect until the control power is cycled "OFF" and back "ON".
- When changing this setting, set Func6 Bit 7 to "1" from Mode 2 prior to the change.

## *Number of Pulses of Fully Closed Encoder* — *EENP*

**Remote Operator Mode:** 1 **Page:** 17 **Default Value:** 2000 P/R
**Function:** **Setting Range:** 500 to 65535 P/R

**Description:**

- Sets the number of pulses of the encoder used in terms of the motor shaft.
- This parameter is usable only on the servo system that supports the fully closed design.
- Changes to this parameter do not take affect until the control power is cycled "OFF" and back "ON".
- When changing this setting, set Func6 Bit 7 to "1" from Mode 2 prior to the change.


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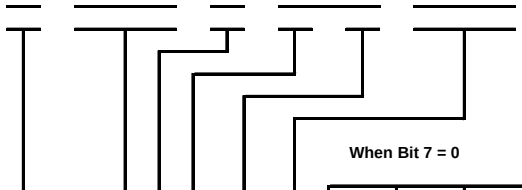
## *Position Command, Pulse Train Pattern* — *PMOD*

**Remote Operator Mode:** 2 **Page:** 0 **Default Value:** 00000000 Bit

**Function:** CMD **Setting Range:** 0,1

**Description:**

- The position command pulse train can be entered in 3 forms: Forward & Backward Revolution Pulse Train, Code & Pulse Train, 90º Phase Difference Two-Phase Pulse Train
- The rising/falling edge command, the revolution direction, and digital filter clock can be specified here.



**When Bit 7 = 0**

| Bit 1 | Bit 0 | Digital Filter for Command Pulse Input | |
|---|---|---|---|
| | | Maximum Frequency | Minimum Pulse Width |
| 0 | 0 | 666 kpulse/S | 750 nS |
| 0 | 1 | 2.6 Mpulse/S | 187.5 nS |
| 1 | 0 | 1.3 Mpulse/S | 375 nS |
| 1 | 1 | 333 kpulse/S | 1.5 uS |

**When Bit 7 = 1**

| Bit 1 | Bit 0 | Digital Filter for Command Pulse Input | |
|---|---|---|---|
| | | Maximum Frequency | Minimum Pulse Width |
| 0 | 0 | 166 kpulse/S | 3.0 uS |
| 0 | 1 | 666 kpulse/S | 750 nS |
| 1 | 0 | 333 kpulse/S | 1.5 uS |
| 1 | 1 | 83.3 kpulse/S | 6.0 uS |

| CCWP Input Polarity Switching | |
|---|---|
| 0 | Counts at the Rising Edge |
| 1 | Counts at the Falling Edge |

| CWP Input Polarity Switching | |
|---|---|
| 0 | Counts at the Rising Edge |
| 1 | Counts at the Falling Edge |

| Selection of Revolution Direction | |
|---|---|
| 0 | Standard |
| 1 | Backward Revolution |

| Bit 5 | Bit 6 | Command Pulse Form |
|---|---|---|
| 0 | 0 | Forward & Backward Revolution |
| 0 | 1 | Code & Pulse |
| 1 | 0 | 90 Degree Phase Difference |
| 1 | 1 | Prohibited |

| Switching of Digital Filter | |
|---|---|
| 0 | High Speed |
| 1 | Low Speed (1/4) |


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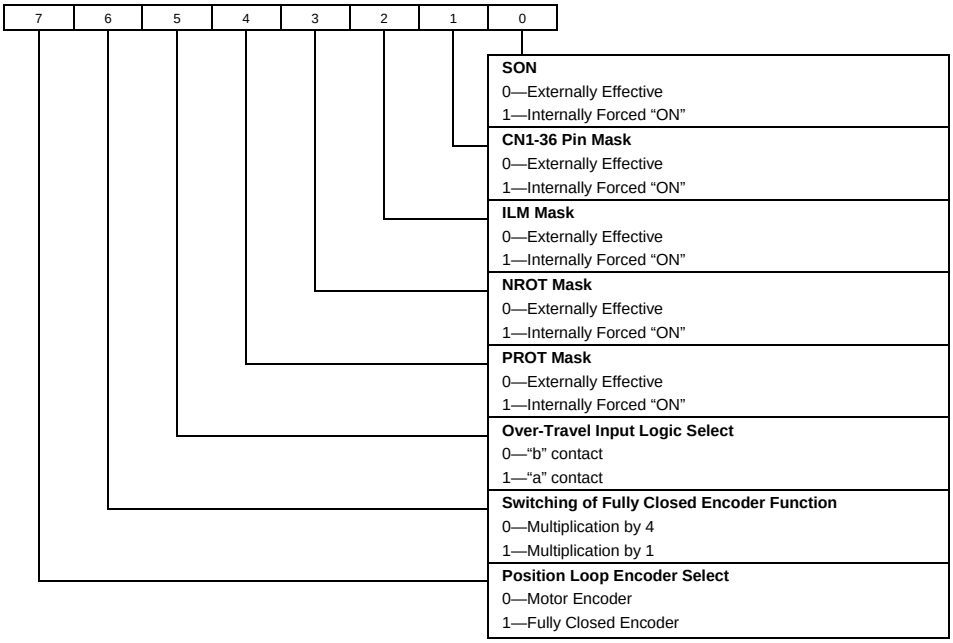
## *Function Switch 0* — *Func0*

**Remote Operator Mode:** 2 **Page:** 1 **Default Value:** 00000000 Bit

**Function:** I/O **Setting Range:** 0,1

**Description:**

- This parameter selects whether external signals are made effective or are forced "ON" internally. It also selects the overt-travel input logic, the encoder used (between motor or fully enclosed-external-encoder), and the multiplication factor of the encoder.




- Bits 6 and 7 are only available with servo systems that support the fully closed design.
- Selecting a fully closed encoder does not change the divided output. Thus, when you need a divided output for the fully closed encoder, set Func5, Bit 4 to "1".
- When over-travel bits 3 and 4 are internally turned "ON", they become ineffective if the over-travel input logic is "b" contact. Also, bits 3 and 4 are always in over-travel status if the over-travel input logic is "a" contact.
- When changing the setting of Bit 7 or 6, you must turn the control power "OFF" once prior to making the change.


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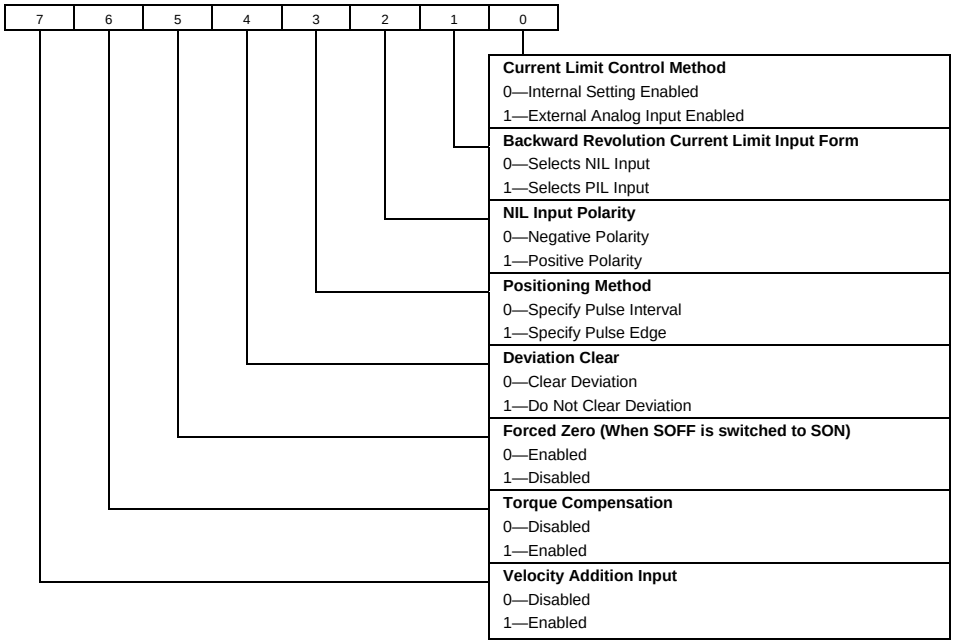
## *Function Switch 1* — *Func1*

**Remote Operator Mode:** 2 **Page:** 2 **Default Value:** 00000000 Bit

**Function:** I/O **Setting Range:** 0,1

**Description:**

- A desired function can be set from the digital switch




- Bit 7 is effective in the position control mode.
- Bit 6 is effective in both the position and velocity control modes.
- When Bit 4 is set to "1", the position deviation is not cleared upon the occurrence of an alarm. Therefore, be sure to clear the deviation before clearing the alarm.
- The current limit is enabled only after the CN1-31 pins are turned on.


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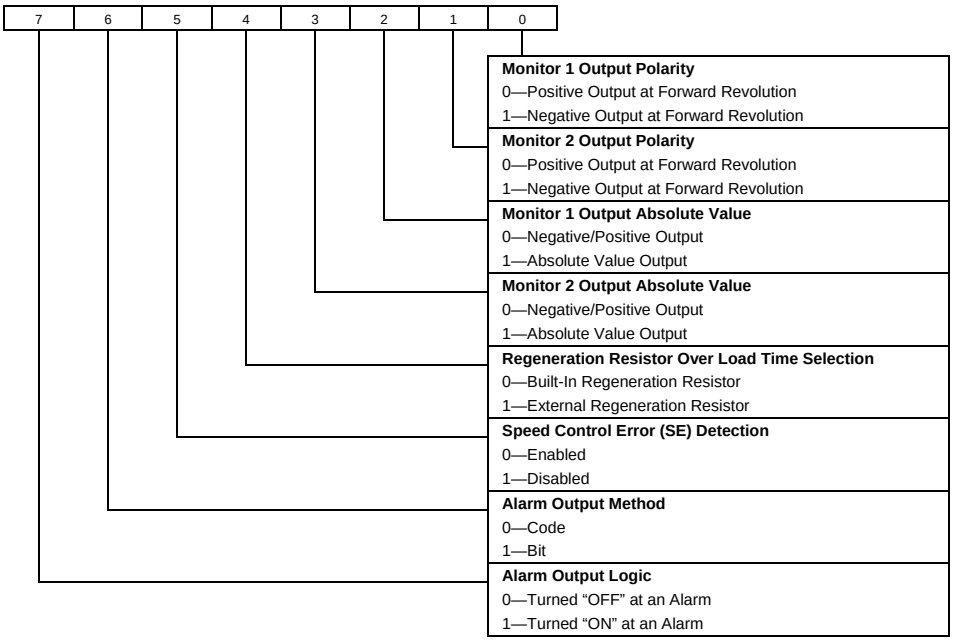
## *Function Switch 2* — *Func2*

**Remote Operator Mode:** 2 **Page:** 3 **Default Value:** 00100000 Bit

**Function:** I/O **Setting Range:** 0,1

**Description:**

- A desired monitor output method or regeneration resistor “over-load” time can ce selected.




- Changes to bit 4 do not take affect until the control power supply is cycled “OFF” and back “ON”.
- If Bit 7 is set at “1”, and alarm will not be indicated for a CPU error.
- Bit 4 cannot be changed unless the control power is turned “OFF”.
- Forward revolution refers to the counterclockwise revolution when viewed from the load (motor shaft) side.


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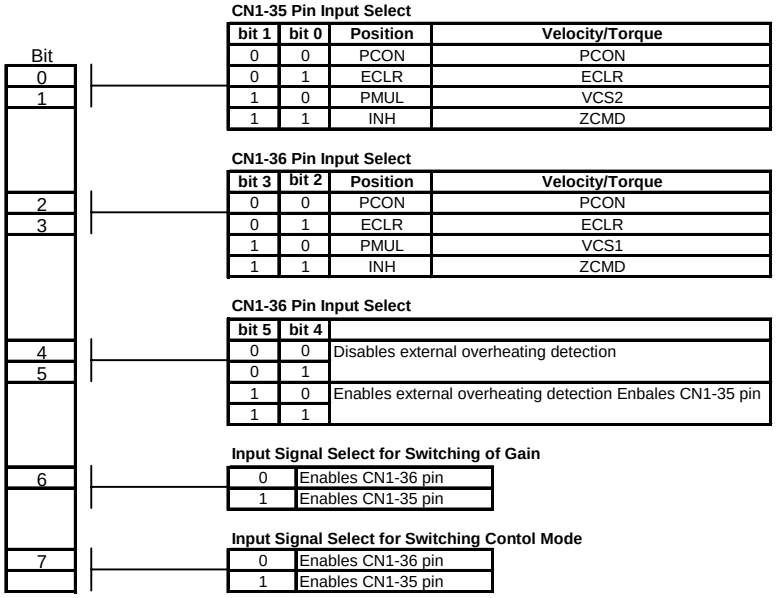
## *Function Switch 3* — *Func3*

**Remote Operator Mode:** 2 **Page:** 4 **Default Value:** 00000000 Bit

**Function:** I/O **Setting Range:** 0,1

**Description:**

- This parameter allows you to set the CN1-35 and CN1-36 pins to the desired terminals. It also allows you to select the input signal for switching the control mode or gain.




**CN1-35 Pin Input Select**

| bit 1 | bit 0 | Position | Velocity/Torque |
|---|---|---|---|
| 0 | 0 | PCON | PCON |
| 0 | 1 | ECLR | ECLR |
| 1 | 0 | PMUL | VCS2 |
| 1 | 1 | INH | ZCMD |

**CN1-36 Pin Input Select**

| bit 3 | bit 2 | Position | Velocity/Torque |
|---|---|---|---|
| 0 | 0 | PCON | PCON |
| 0 | 1 | ECLR | ECLR |
| 1 | 0 | PMUL | VCS1 |
| 1 | 1 | INH | ZCMD |

**CN1-36 Pin Input Select**

| bit 5 | bit 4 | |
|---|---|---|
| 0 | 0 | Disables external overheating detection |
| 0 | 1 | |
| 1 | 0 | Enables external overheating detection Enbales CN1-35 pin |
| 1 | 1 | |

**Input Signal Select for Switching of Gain**

| | |
|---|---|
| 0 | Enables CN1-36 pin |
| 1 | Enables CN1-35 pin |

**Input Signal Select for Switching Contol Mode**

| | |
|---|---|
| 0 | Enables CN1-36 pin |
| 1 | Enables CN1-35 pin |

- Bit 7 is enabled when the switching mode is selected for the control mode.
- Bit 6 is enabled when the gain-switching mode is selected.
- Setting bits 3, 2, 1, and 0 to “1010” in the velocity control mode enables the internal velocity command. Setting bits 3 and 2 “ON”, or 1 and 0 alone does not make this command valid.
- As long as the input signal for control mode or gain switching is assigned to the CN1-35 pin, input signal selection with Func3 Bits 1 and 0 is disabled except for the internal velocity select function. When the input signal for control mode or gain switching is assigned to the CN1-36 pin, input signal selection with Func3 bits 3 and 2 is disabled except for the internal velocity select function. If the internal velocity select function is enabled (Func3, Bits 2 and 0 are set at “1010”), the internally velocity set with the CN1-35 and CN1-36 pins are enabled. At the same time, control mode and gain switching are made valid. This, however, is only effective when the velocity control mode including the control mode-switching mode is selected.
- When the same signal is selected for CN1-35 and CN1-36 pins, the 36 pin take precedence.


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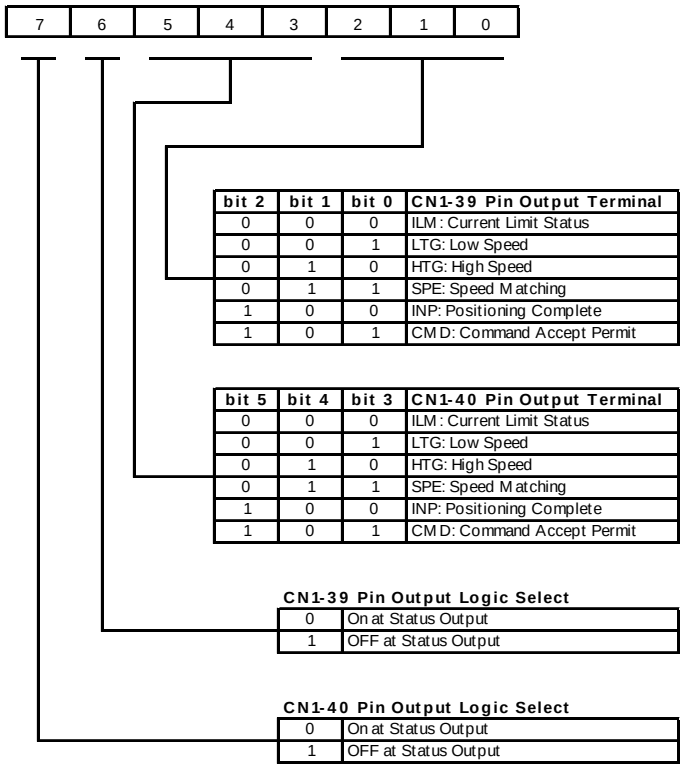
## *Function Switch 4* — *Func4*

**Remote Operator Mode:** 2 **Page:** 5 **Default Value:** 00000001 Bit

**Function:** I/O **Setting Range:** 0,1

**Description:**

- This parameter allows you to set the CN1-39 and CN1-40 pins to the desired terminals.




| bit 2 | bit 1 | bit 0 | CN1-39 Pin Output Terminal |
|---|---|---|---|
| 0 | 0 | 0 | ILM: Current Limit Status |
| 0 | 0 | 1 | LTG: Low Speed |
| 0 | 1 | 0 | HTG: High Speed |
| 0 | 1 | 1 | SPE: Speed Matching |
| 1 | 0 | 0 | INP: Positioning Complete |
| 1 | 0 | 1 | CMD: Command Accept Permit |

| bit 5 | bit 4 | bit 3 | CN1-40 Pin Output Terminal |
|---|---|---|---|
| 0 | 0 | 0 | ILM: Current Limit Status |
| 0 | 0 | 1 | LTG: Low Speed |
| 0 | 1 | 0 | HTG: High Speed |
| 0 | 1 | 1 | SPE: Speed Matching |
| 1 | 0 | 0 | INP: Positioning Complete |
| 1 | 0 | 1 | CMD: Command Accept Permit |

**CN1-39 Pin Output Logic Select**

| | |
|---|---|
| 0 | On at Status Output |
| 1 | OFF at Status Output |

**CN1-40 Pin Output Logic Select**

| | |
|---|---|
| 0 | On at Status Output |
| 1 | OFF at Status Output |

- The standard value is set at 00000100 in the position control mode.


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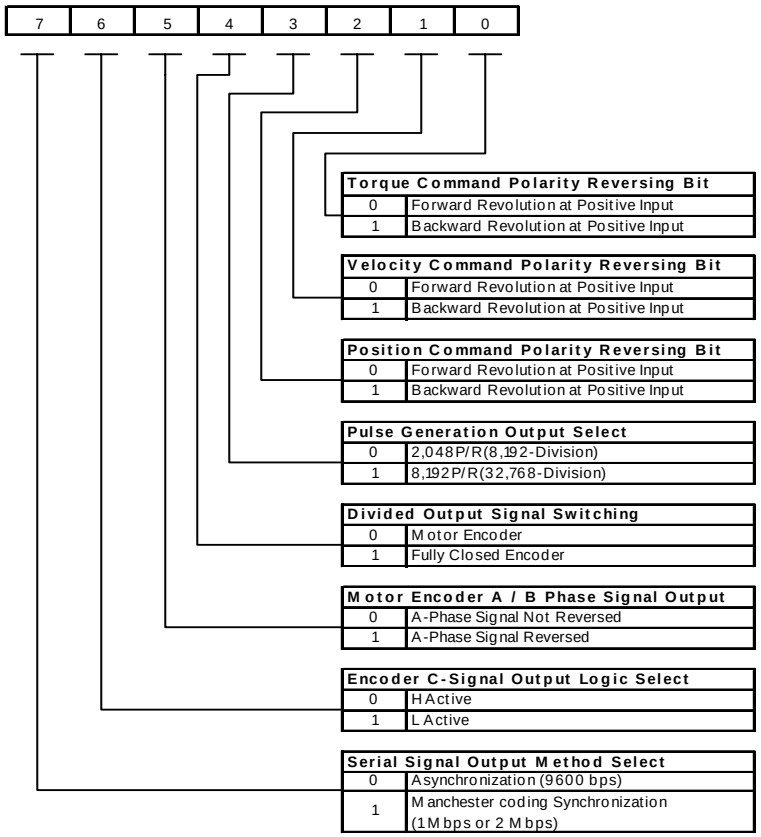
## *Function Switch 5* — *Func5*

**Remote Operator Mode:** 2 **Page:** 6 **Default Value:** 00000000 Bit

**Function:** I/O **Setting Range:** 0,1

**Description:**

- This parameter is used select the encoder output format or the command input polarity.




- Even if you choose the fully closed encoder using the Func0, Bit 7 parameter, the divided output remains the same.
- The “Fully Closed Encoder” setting can be used only on a servo system that supports the fully closed design.
- Before changing the settings of bits 7, 6, 5, and 4, you must turn off the control power once.
- Forward revolution means counterclockwise revolution as viewed from the load (motor shaft) side.
- Bit 3 is enabled when the ABS-RII absolute sensor is used. The number of incremental pulses to be outputted from CN1-3 to 8 pins can be selected
- Bit 2 of Func5 and Bit 4 of PMOD both function the same. When 1 is set to both bits, the system is rotated forward at the positive input.


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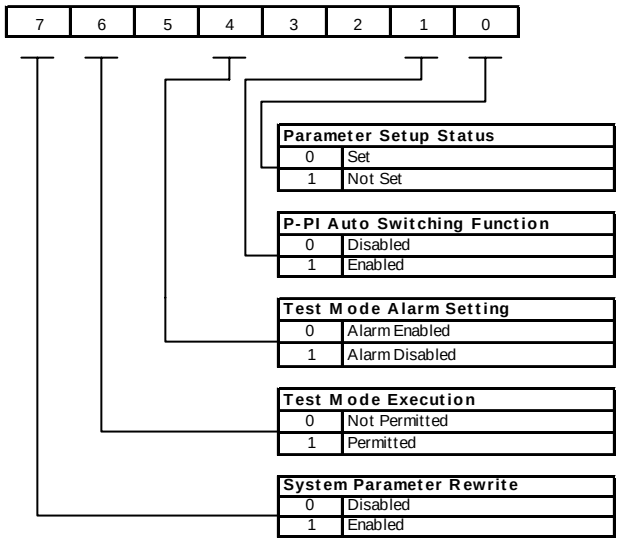
## *Function Switch 6* — *Func6*

**Remote Operator Mode:** 2 **Page:** 7 **Default Value:** 00000000 Bit

**Function:** I/O **Setting Range:** 0,1

**Description:**

- This parameter is used for changing the contents of parameters or permiting execution of the test mode.




- After operation, Bits 7 and 6 must be set at “0” again.
- Turning “OFF” the control power returns bits 7, 6, and 4 back to “0”.
- If Bit 0 is set to “1”, and alarm (memory error) will be indicated. After the necessary parameter setting is completed, set Bit 0 to “0”, then turn power “ON”.


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## *Position Loop Gain* — *Kp*

**Remote Operator Mode:** 3 **Page:** 0 **Default Value:** 45 (30) rad/s

**Function:** Tune **Setting Range:** 1 to 1000 rad/s

**Description:**

- Proportional gain of the position controller.
- Parameter can also be changed from Mode 0 Page 0.

## *Velocity Loop, Proportional Gain* — *Kvp*

**Remote Operator Mode:** 3 **Page:** 1 **Default Value:** 100 (70) Hz

**Function:** Tune **Setting Range:** 10 to 3,000 Hz

**Description:**

- Proportional gain of the velocity controller (PI control).
- The setting indicates the value when the load inertia is 0.
- Parameter can also be changed from Mode 0 Page 2.


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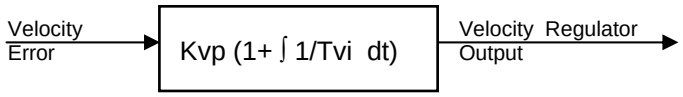
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## *Velocity Loop, Integral Time Constant* — *Tvi*

**Remote Operator Mode:** 3 **Page:** 2 **Default Value:** 15 (20) ms
**Function:** Tune **Setting Range:** 1 to 1000 ms

**Description:**

- Integration time constant of the velocity controller (PI control).




- Parameter can also be changed from Mode 0, Page 3
- If you specify 1000 ms, proportional control is selected.

## *Velocity Command Zero Adjustment* — *Vzero*

**Remote Operator Mode:** 3 **Page:** 3 **Default Value:** $$$$
**Function:** Tune **Setting Range:** +/- 16383

**Description:**

- Offset of the velocity command (adjustment).
- The value varies according to the adjustments done at shipment. You can change the setting by executing offset adjustment of the test mode (Page 2 and 3).


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## *Torque Command Zero Adjustment* — *Tzero*

**Remote Operator Mode:** 3 **Page:** 4 **Default Value:** $$$$

**Function:** Tune **Setting Range:** +/-16383

**Description:**

- Offset of the torque command (adjustment).
- The value varies according to the adjustments done at shipment. You can change the setting by executing offset adjustment of the test mode (Page 2 and 3).

## *Monitor Output Select #1* — *M1*

**Remote Operator Mode:** 4 **Page:** 0 **Default Value:** Vm2mV/min$^{-1}$

**Function:** **Setting Range:** 17 types

**Description:**

- This parameter allows you to specify a desired output from 17 types of data from the monitor 1 output (CN1-15 pin and check pin M1) as shown below.

| Indication | Contents | |
|---|---|---|
| Im 2V/IR | Current Monitor | 2 V/IR Peak |
| Ic 2V/IR | Current Command | 2 V/IR Peak |
| Vm 2mV/min-1 | Velocity Monitor | 2 mV/min$^{-1}$ |
| Vm 1mV/min-1 | Velocity Monitor | 1 mV/min$^{-1}$ |
| Vm 3mV/min-1 | Velocity Monitor | 3 mV/min$^{-1}$ |
| Vc 2mV/min-1 | Velocity Command | 2 mV/min$^{-1}$ |
| Vc 1mV/min-1 | Velocity Command | 1 mV/min$^{-1}$ |
| Vc 3mV/min-1 | Velocity Command | 3 mV/min$^{-1}$ |
| Per 50mV/P | Position Deviation | 50 mV/1 Pulse |
| Per 20mV/P | Position Deviation | 20 mV/1 Pulse |
| Per 10mV/P | Position Deviation | 10 mV/1 Pulse |
| Rm 0.3V/Full | Regenerative Load Factor | 0.3 V/Full |
| Im 0.5 V/IR | Current Monitor | Im0.5V/IR |
| Ic 0.5 V/IR | Current Command | Ic0.5V/IR |
| Vm 0.5 mV/min$^{-1}$ | Velocity Monitor | Vm0.5V/min$^{-1}$ |
| Vc 0.5 mV/min$^{-1}$ | Velocity Command | Vc0.5V/min$^{-1}$ |
| Per 5 mV/P | Position Deviation | Per5mV/P |

- IR is the “Rated Armature Current”.
- Full is the “allowable power of the built-in regenerative resistor”.


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## *Monitor Output Select #2* — *M2*

**Remote Operator Mode:** 4 **Page:** 1 **Default Value:** Ic2V/IR

**Function:** **Setting Range:** 17 Types

**Description:**

This parameter allows you to specify a desired output from 17 types of data for the monitor 2 output (CN1-16 pin and check pin M2) as shown above.

## *Gain Switching Select (older models only)* — *GAIN*

**Remote Operator Mode:** 4 **Page:** 2 **Default Value:** Fix

**Function:** **Setting Range:** 2 Choices

**Description:**

- Enables gain switching by an external input.

| Indication | Contents |
|---|---|
| Fix | Gain Switching Disabled |
| Select | Gain Switching Enabled |

- Choosing “Select” allows you to switch between Kp, Kvp, and Tvi from screen Mode 8 (use CN1-36 or CN1-35 pin for switching).


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## *Servo function choice (newer models only)* *Func*

**Remote Operator Mode:** 4 **Page:** 2 **Default Value:** Normal
**Function:** **Setting Range:** 4 Choices

**Description:**

- Enable for Gain Switch and automatic tuning.

| Indication | Contents |
|---|---|
| Normal | Gain Switching Disabled. Real time automatic tuning disabled |
| Gain_Sel. | Gain Switching Enabled. Real time automatic tuning disabled |
| Gain_Tun | Gain Switching Disabled. Real time automatic tuning enabled |
| Gsel&Gtun | Gain Switching Enabled. Real time automatic tuning enabled |

- Choosing options other than "Normal" allows you to switch between Kp, Kvp, and Tvi from screen Mode 8 (use CN1-36 or CN1-35 pin for switching).
- For Func = "Gain_Sel" with Gain Switch input = OFF

| **Description** | **Parameter** | Mode - Page |
|---|---|---|
| Position loop gain | Kp | 0-0 |
| Velocity loop proportional gain | Kvp | 0-2 |
| Velocity loop integral time constant | Tvi | 0-3 |
| Current command LPF | ILPF | 0-6 |

- For Func = "Gain_Sel" with Gain Switch input = ON

| **Description** | **Parameter** | Mode - Page |
|---|---|---|
| Position loop gain | Kp2 | 8-0 |
| Velocity loop proportional gain | Kvp2 | 8-2 |
| Velocity loop integral time constant | Tvi2 | 8-3 |
| Current command LPF | ILPF | 0-6 |

- For Func = "Gsel&Gtun" with Gain Switch input = OFF

| Description | Parameter | Mode - Page |
|---|---|---|
| Position loop gain | Kp | 0-0 |
| Velocity loop proportional gain | Kvp | Value of real time automatic tuning result |
| Velocity loop integral time constant | Tvi | Value of real time automatic tuning result |
| Current command LPF | ILPF | Value of real time automatic tuning result |

- For Func = "Gsel&Gtun" with Gain Switch input = ON

| **Description** | **Parameter** | Mode - Page |
|---|---|---|
| Position loop gain | Kp2 | 8-0 |
| Velocity loop proportional gain | Kvp2 | 8-2 |
| Velocity loop integral time constant | Tvi2 | 8-3 |
| Current command LPF | ILPF | 0-6 |


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## *Control Mode* — *TYPE*

**Remote Operator Mode:** 4 **Page:** 3 **Default Value:** $$$$

**Function:** **Setting Range:** 6 choices

**Description:**

- Allows you to choose a desired control mode (position, velocity, and torque).

| Indication | Contents |
|---|---|
| Position | Position Control Type |
| Velocity | Velocity Control Type |
| Torque | Torque Control Type |
| Velocity / Torque | Velocity-to-Torque "Switch-On-the-Fly" |
| Position / Torque | Position-to-Torque "Switch-On-the-Fly" |
| Position / Velocity | Position-to-Velocity "Switch-On-the-Fly" |

- You can specify a desired control mode from CN1-36 and CN1-35 pins. When Func3, Bit 7 is “0”, pin CN1-36 is enabled. When Bit 7 is “1”, pin CN1-35 is enabled.
- Parameter can also be changed from Mode 0, Page 3.

## *Encoder Type* — *ENKD*

**Remote Operator Mode:** 4 **Page:** 4 **Default Value:** $$$$

**Function:** **Setting Range:** 3 types

**Description:**

- Allows the selection of encoder type used.

| Indication | Contents |
|---|---|
| INC.E | Incremental Encoder with Reduced Wiring |
| ABS.E (1M) | Absolute Encoder (1 Mbps) |
| ABS.E (2M) | Absolute Encoder (2 Mbps) |


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## *ABS Sensor Format* *ABSF*

**Remote Operator Mode:** 4 **Page:** 5 **Default Value:** $$$$

**Function:** **Setting Range:** 11 Formats

**Description:**

- A desired format can be selected from the following.

2048 FMT
4096 FMT
8192 FMT
16384 FMT
32768 FMT
65536 FMT
131072 FMT
262144 FMT
524288 FMT
1048576 FMT
2097152 FMT

- You must turn “OFF” the control power before making the change.
- Your change is effective only after Func6, Bit 7 has been set a “1”.
- If the above operation (Func6, Bit 7 to “1”) is ignored, the parameter change is invalid, thus, does not take place.


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## *Motor Type* *MOT.*

**Remote Operator Mode:** 4 **Page:** 6 **Default Value:** $$$$

**Function:** **Setting Range:** A motor from the P1, P2, P3, P5, P6, and P8 series.

**Description:**

- Selects the motor used (in each series).
- Selectable motor types vary with the amplifier capacity.

## *Motor Configuration* *MOKD*

**Remote Operator Mode:** 4 **Page:** 7 **Default Value:** Rotary

**Function:** **Setting Range:** Rotary

**Description:**

- This parameter value can not be changed.

## *Power Supply Type* *PSKD*

**Remote Operator Mode:** 4 **Page:** 8 **Default Value:** AC 200V 1P

**Function:** **Setting Range:** AC 200V 3P
AC 200V 1P

**Description:**

- Selects the type of power supply for user connection.

| Setting | Description |
|---|---|
| AC 200V 3P | 200-240 VAC, 3 Phase |
| AC 200V 1P | 200-240 VAC, 1 Phase |


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## *Regenerative* — *RGKD*

**Remote Operator Mode:** 4 **Page:** 9 **Default Value:** Built in R

**Function:** **Setting Range:** Built in R
None/ Ext. R

**Description:**

- Selects regenerative resistor to use.

| Setting | Description |
|---|---|
| None/ Ext. R | Regenerative resistor is not connected, or external regenerative resistor is used. |
| Built in R | Built in regenerative resistor is used. |

- It is important that the resistor type be set correctly. Overload protection is adjusted based on this setting. Failure to correctly set this value can cause damage to the amplifier.

## *Position Loop Gain #2* — *Kp2*

**Remote Operator Mode:** 8 **Page:** 0 **Default Value:** 45 (30) rad/S

**Function:** **Setting Range:** 1 to 1000 rad/S

**Description:**

- Proportional gain of the position controller
- Enabled during gain switching


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## *Velocity Loop Proportional Gain #2* — *Kvp2*

**Remote Operator Mode:** 8 **Page:** 1 **Default Value:** 100 (70) Hz
**Function:** **Setting Range:** 10 to 3000 Hz

**Description:**

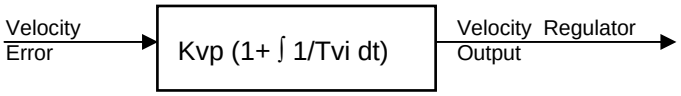
- Proportional gain of the velocity controller
- Enabled during gain switching

## *Velocity Loop Integral Time Constant #2* — *Tvi2*

**Remote Operator Mode:** 8 **Page:** 2 **Default Value:** 15 (20) ms
**Function:** **Setting Range:** 1 to 1000 ms

**Description:**

- Integration time constant of the velocity controller (proportional integral controller).





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## *Current Command with Automatic Notch Filter Tuning* — *Tn_F*

| | | | | | |
|---|---|---|---|---|---|
| **Remote Operator Mode:** | 8 | **Page:** | 3 | **Default Value:** | 100 % |
| **Function:** | | | | **Setting Range:** | 30 to (IP/IR) X 100 % |

**Description:**

- User setting value of current command when executing automatic notch filter tuning in test mode.
- Selecting lc=lst on Tune IBEF setting screen enables automatic notch tuning execution at current command of this setting value

## *Observer – Load Inertia Ratio* — *O_JL*

| | | | | | |
|---|---|---|---|---|---|
| **Remote Operator Mode:** | 8 | **Page:** | 4 | **Default Value:** | 100 % |
| **Function:** | | | | **Setting Range:** | 0 to 3000 % |

**Description:**

- This parameter estimates load torque used for real time automatic tuning processor
- O_JL (%) = load inertia JL / motor inertia JM * 100


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# Maintenance and Troubleshooting

## Chapter Overview

This chapter contains a maintenance and troubleshooting guide for installation of amplifiers and matching motors.


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# Maintenance

- Normally, the only maintenance required is the removal of superficial dust and dirt from the amplifier. To clean the amplifier, use low-pressure, oil-free compressed air.
- Periodically inspect all cables, verifying they are free from damage and ensuring that the connections to the amplifier are tight.
- Investigate any unusual vibrations or noises immediately.

# Troubleshooting

Upon the occurrence of an alarm, the 7-segment display on the amplifier will flash an alarm code. The alarm code or bit will also be set on the output pins on CN1-43, 44, 45, 46 and reported in the alarm trace mode of the Remote Operator and PY Software. Table 21 shows the alarm codes that may appear on a drive or monitoring device.

**Table 21: Amplifier Alarm Codes**

| 7-Segment | Abbreviation | Description |
|---|---|---|
| 1 | OC | Overcurrent |
| 2 | OL | Overload |
| 3 | AOH | Amplifier Overheating |
| 5 | OV | Overvoltage |
| 6 | OS | Overspeed |
| 7 | PE | Control Power Supply Error |
| 8 | DE | Detector Error – Encoder Error |
| 9 | MPE | Bus power (R, S, and T) Error |
| A | FP | Fail Phase - bus power (R, S, and T) is missing a phase |
| C | SE | Speed Control Error |
| D | OVF | Position Deviation Overflow |
| E | EXOH | External Regen Resistor Overheating |
| F | DSPE | DSP Error |
| H | RGOH | Internal Regen Resistor Overheating |
| J | RGOL | Resistor Overload |
| P | MEME | Memory Error |
| U | AEE | Absolute Encoder Error (Not available at this time) |
| No Light | CPUE | CPU Error |

The table below outlines possible causes and corrective actions for each alarm.


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| Power Element Error | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| OC | 1 | 0001 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board | • Replace the servo amplifier |
| Alarm occurs when the Start Ready Complete output (SRDY, CN1-41) turns ON, after turning ON the bus power (R, S, and T) | • Faulty PC board | • Replace the servo amplifier |
| Alarm occurs when Servo On input (SON, CN1-37) turns ON | • Faulty motor ground | • Check ground circuits<br>• Replace motor |
| | • Faulty Power Module<br>• Faulty current feedback circuit | • Replace the servo amplifier |
| | • Incorrect motor power wiring | • Check and correct motor wiring |
| Alarm occurs when the motor starts or stops | • Improper combination of motor and amplifier | • Use the Remote Operator to check and set parameter MOT. |


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| Overload | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| OL | 2 | 0010 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board | • Replace servo amplifier |
| Alarm occurs while the motor is in operation | • The motor is operating over the rated torque | • Review the load requirements and the motor specifications |
| | • The holding brake is not released | • Release the brake |
| The motor turns but has very little torque or the Alarm occurs after the motor is operated for a while | • Incorrect wiring of the motor power circuit<br>• Intermittent failure in motor power circuit | • Correct the wiring |
| | • Improper combination of motor and amplifier | • Use the Remote Operator to check and set parameter MOT. |
| Load conditions have been verified to be under rated conditions and the alarm occurs | • Faulty PC board | • Replace the servo amplifier |
| | • Faulty motor encoder | • Replace servo motor |

| Amplifier Overheating | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN-1 [46,45,44,43]** |
| AOH | 3 | 0011 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty temperature sensor on PC board | • Replace servo amplifier |
| Alarm occurs while the motor is in operation | • The ambient temperature of the servo amplifier is greater than 55C | • Take measures to lower the ambient temperature |
| | • Excess heat generated due to an amplifier failure | • Replace servo amplifier |


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**Overvoltage**

| Symbol | 7-Segment Display | Alarm code CN1- [46,45,44,43] |
|---|---|---|
| OV | 5 | 0101 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board | • Replace servo amplifier |
| Alarm occurs after the bus power (R, S, and T) supply is turned ON for a while | • The input power voltage is high (high-line)<br>• The input power waveform is distorted | • Lower the line voltage below the specification |
| Alarm occurs while the motor is in operation | • The load inertia is too large for the existing regeneration resistor | • Lower the load inertia<br>• Add or increase the size of the external regen resistor. |

**Overspeed**

| Symbol | 7-Segment Display | Alarm code CN1- [46,45,44,43] |
|---|---|---|
| OS | 6 | 0110 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board | • Replace servo amplifier |
| | • Faulty motor encoder | • Replace servo motor |
| Alarm occurs while the motor is in operation | • Improper velocity scale setting | • Reset the velocity scale |
| | • The velocity command is too high | • Reduce the command below the system specification |
| | • Incorrect encoder wiring | • Correct encoder wiring |
| | • Faulty encoder | • Replace servo motor |
| Alarm occurs when the motor starts | • Velocity overshoot is excessive | • Reset servo tuning<br>• Increase the acceleration time |


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| Control Power Supply Error | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| PE | 7 | 0111 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • The input power supply is below 170VAC | • Raise the line voltage to within the specification |
| | • The ±15V power is abnormal | • Replace servo amplifier |
| Alarm occurs while the motor is in operation | • Too large of an input power variation | • Bring input power within specification |

| Sensor Error | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| DE | 8 | 1000 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty Encoder | • Replace servo motor |
| | • Faulty PC board | • Replace servo amplifier |
| | • Incorrect or disconnected encoder wiring | • Correct encoder wiring |
| | • Incorrect parameter setting of encoder type | • Use the Remote Operator to check and set parameter ENKD |
| Alarm occurs after the motor has moved slightly | • Faulty encoder | • Replace servo motor |
| | • Incorrect or disconnected encoder wiring | • Correct encoder wiring |


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| Bus Power (R, S, and T) Supply Failure | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| MPE | 9 | 1001 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board | • Replace servo amplifier |
| Alarm occurs when the bus power (R, S, and T) supply is turned ON | • The bus power (R, S, and T) voltage is too low | • Bring input power within specification |
| | • The internal bridge rectifier or fuse is damaged | • Replace servo amplifier |
| Alarm occurs while the motor is in operation | • Too large of a input power variation | • Bring input power within specification |
| | • Faulty PC board | • Replace servo amplifier |

| Bus Power (R, S, and T) Phase Missing | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| FP | A | 1010 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board | • Replace servo amplifier |
| Alarm occurs when the bus power (R, S, and T) is turned ON | • The three phase power has a phase missing | • Bring input power within specification |
| | • Bus power (R, S, and T) connections are not tight | • Tighten terminals R, S, and, T on main terminal strip |


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| Velocity Control Error | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| SE | C | 1100 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board | • Replace servo amplifier |
| Alarm occurs with Servo ON | • The motor oscillates (vibrates) | • Perform servo tuning<br>• Replace servo amplifier<br>• Replace servo motor |
| Alarm occurs when a velocity command is entered | • Incorrect motor power wiring | • Correct motor power wiring |

| Deviation Overflow (Position) | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| OVF | d | 1101 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board | • Replace servo amplifier |
| | • Command pulses are being sent before the amplifier is ready | • Stop inputting command pulses and enter deviation clear |
| Alarm occurs during motor operation | • The maximum deviation value is set too low | • Review the deviation over value and position loop gain |
| | • The load inertia is too large | • Lower the load inertia |
| | • The holding brake is not released | • Release the brake |
| | • Incorrect encoder wiring | • Correct encoder wiring |
| | • High command pulse frequency, resulting in high acceleration rate | • Lower the frequency within specification<br>• Make the commanded velocity lower |


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| External (Regeneration Resistor) Overheating | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| EXOH | E | 0011 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board | • Replace servo amplifier |
| | • The H1 and H2 terminals are open | • Correct wiring |
| | • Faulty external regeneration resistor thermostat | • Replace external regeneration resistor |
| Alarm occurs during motor operation | • External regeneration resistor thermostat open | • Review working condition |
| | • Capacity of the external regeneration resistor is too small | • Review application requirements and regeneration resistor sizing. |

| DSP Error | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| DSPE | F | 1111 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board<br>• The 5V power supply is low<br>• The DSP is malfunctioning | • Replace servo amplifier |
| Alarm occurs during motor operation | • The 5V power supply is low<br>• The DSP is malfunctioning | • Replace servo amplifier |


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| Internal Regeneration Resistor Overheating | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| RGOH | H | 0101 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board | • Replace servo amplifier |
| | • Faulty Thermostat | • Replace servo amplifier |
| Alarm occurs during motor operation | • Capacity of the internal regeneration resistor is too small | • Review application requirements and regeneration resistor sizing |
| | • Faulty Thermostat | • Replace servo amplifier |

| Regeneration Error | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| RGOL | J | 0101 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board | • Replace servo amplifier |
| Alarm occurs after the bus power (R, S, and T) is turned ON | • Faulty regeneration transistor | • Replace servo amplifier |
| Alarm occurs during motor operation | • The regeneration capacity is exceeded | • Install an external regeneration resistor |
| | • The load inertia is too large | • Reduce the load inertia within specification<br>• Make the deceleration time longer<br>• If possible, lower the current limit |


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| Memory Error | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| MEME | P | 1111 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • Faulty PC board<br>• Memory IC failure | • Replace servo amplifier |
| | • Improper combination of motor and amplifier | • Use the Remote Operator to check and set parameter Func6, Bit 0 to "0" |

| Absolute Encoder Battery Alarm (not available at this time) | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| AEE | U | 1000 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Alarm occurs when the control power supply is turned ON | • The battery has less than 20 hours of operation remaining and the absolute encoder position is unreliable | • Replace battery |
| | • Faulty PC board | • Replace servo amplifier |

| CPU Error | | |
|---|---|---|
| **Symbol** | **7-Segment Display** | **Alarm code CN1- [46,45,44,43]** |
| CPUE | No Lights | 1111 |
| **Operating Condition** | **Cause** | **Corrective Action** |
| Light remains OFF after the control power is applied | • The CPU has failed<br>• The 5V power supply is low<br>• Faulty PC board | • Replace servo amplifier |
| Lights go off during motor operation | • The CPU has failed<br>• The 5V power supply is low | • Replace servo amplifier |


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# Specifications

## Chapter Overview

This chapter contains specifications for the system, amplifiers and motors that are not in the *Product Catalog and Business Policies*.

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Acceleration and Deceleration Time ..... 129
Dynamic Brake ..... 130
*Stopping Time* *130*
Miscellaneous Servo Motor Specifications ..... 132
*Direction of Rotation* *132*
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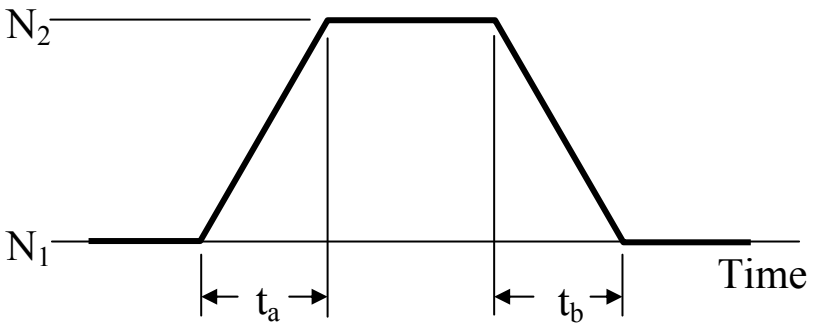
# Acceleration and Deceleration Time

The acceleration time ($t_a$) and deceleration time ($t_d$) of the motor under certain conditions are calculated by the following expressions. These expressions are for rated speed (or less). Ignore viscosity torque and friction torque(s) of the motor.

Acceleration time $$t_a := \left(J_M + J_L\right) \cdot \frac{(2\pi)}{60} \cdot \frac{N_2 - N_1}{T_P - T_L}$$

Deceleration Time $$t_d := \left(J_M + J_L\right) \cdot \frac{(2\pi)}{60} \cdot \frac{N_2 - N_1}{T_P + T_L}$$

| | |
|---|---|
| $t_a$ | Acceleration Time [sec] |
| $t_b$ | Deceleration Time [sec] |
| $N_1$ | Initial Speed [RPM] |
| $N_2$ | Final Speed [RPM] |
| $T_P$ | Maximum Stall Torque [Nm] |
| $T_L$ | Load Torque [Nm] |
| $J_M$ | Motor Inertia [kg $m^2$] |
| $J_L$ | Load Inertia [kg $m^2$] |





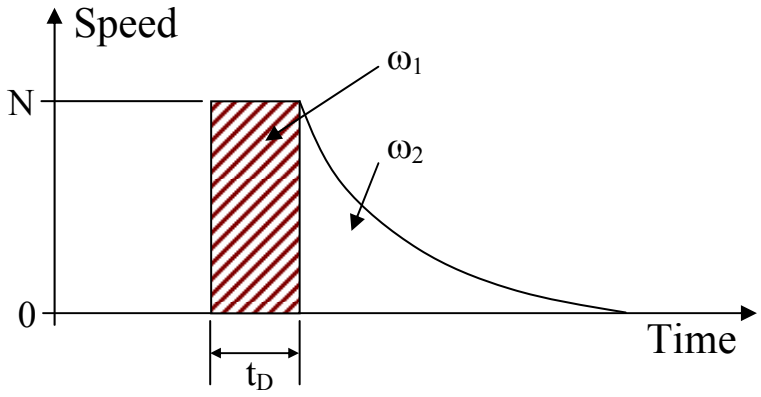
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# Dynamic Brake

The PY servo amplifier is designed with an internal dynamic brake for stopping. The brake is activated when an alarm is detected. The following explains the dynamic brake characteristics and allowable operating frequency.

**Stopping Time**




$$\omega_1 := \frac{2\pi \cdot N \cdot t_D}{60} \qquad \omega_2 := \left(J_M + J_L\right) \cdot \left(\alpha \cdot N + \beta \cdot N^3\right) \qquad \omega_3 := \left(\frac{J_M + J_L}{2 \cdot T_L}\right) \cdot \left(\frac{2 \cdot \pi \cdot N}{60}\right)^2$$

No Load Torque

$$\omega_{t1} := \omega_1 + \omega_2$$

With Load Torque

$$\omega_{t2} := \omega_1 + \frac{\omega_2 \cdot \omega_3}{\left(\omega_2 + \omega_3\right)}$$

| | |
|---|---|
| N | Motor speed [RPM] |
| $J_M$ | Motor inertia [kg $m^2$] |
| $J_L$ | Load inertia [kg $m^2$] |
| $T_L$ | Load torque, acting to slow the motor [N m] |
| $\omega_1$ | Distance traveled during processing delay (assume $T_L$=0) |
| $\omega_2$ | Distance travel while slowing from N to a stop (assume $T_L$=0) |
| $\omega_3$ | Reduction in distance traveled as a result of a load torque $T_L$ |
| $\omega_{t1}$ $\omega_{t2}$ | Total distance traveled [revolutions] |
| $\alpha$ | Motor Constant |
| $\beta$ | Motor Constant |


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| Drive Model | Motor Model | $t_D$ [sec] | Dynamic Brake Constants | | |
|---|---|---|---|---|---|
| | | | $\alpha$ | $\beta$ | $J_M$ [kg $m^2$] |
| PY2A015 | P30B04010D | 0.0100 | 25 | $12.2\times10^{-7}$ | $0.051\times10^{-4}$ |
| PY2A015 | P50N05020D | 0.0100 | 9.78 | $3.86\times10^{-7}$ | $0.173\times10^{-4}$ |
| PY2A030 | P30B06040D | 0.0100 | 4.32 | $6.8\times10^{-7}$ | $0.255\times10^{-4}$ |
| PY2A030 | P30B08075D | 0.0100 | 2.97 | $3.68\times10^{-7}$ | $0.635\times10^{-4}$ |
| PY2A050 | P50N08100D | 0.0100 | 2.99 | $0.30\times10^{-7}$ | $2.66\times10^{-4}$ |
| PY2A050 | P60B13150H | 0.0100 | 1.08 | $0.60\times10^{-7}$ | $8.30\times10^{-4}$ |
| PY2A050 | P20B10150D | 0.0240 | 2.19 | $1.05\times10^{-7}$ | $2.04\times10^{-4}$ |
| PY0A015 | P30B04010D | 0.0065 | 25 | $12.2\times10^{-7}$ | $0.051\times10^{-4}$ |
| PY0A015 | P50N05020D | 0.0065 | 9.78 | $3.86\times10^{-7}$ | $0.173\times10^{-4}$ |
| PY0A030 | P30B06040D | 0.0065 | 4.32 | $6.8\times10^{-7}$ | $0.255\times10^{-4}$ |
| PY0A030 | P30B08075D | 0.0065 | 2.97 | $3.68\times10^{-7}$ | $0.635\times10^{-4}$ |
| PY0A050 | P50N08100D | 0.0100 | 2.99 | $0.30\times10^{-7}$ | $2.66\times10^{-4}$ |
| PY0A050 | P60B13150H | 0.0100 | 1.08 | $0.60\times10^{-7}$ | $8.30\times10^{-4}$ |
| PY0A050 | P20B10150D | 0.0240 | 2.19 | $1.05\times10^{-7}$ | $2.04\times10^{-4}$ |
| PY0A100 | P20B10250D | 0.0240 | 2.87 | $0.26\times10^{-7}$ | $3.71\times10^{-4}$ |
| PY0A100 | P20B13300D | 0.0240 | 2.02 | $0.25\times10^{-7}$ | $7.14\times10^{-4}$ |
| PY0A150 | P20B13500D | 0.0240 | 1.54 | $0.07\times10^{-7}$ | $12.58\times10^{-4}$ |

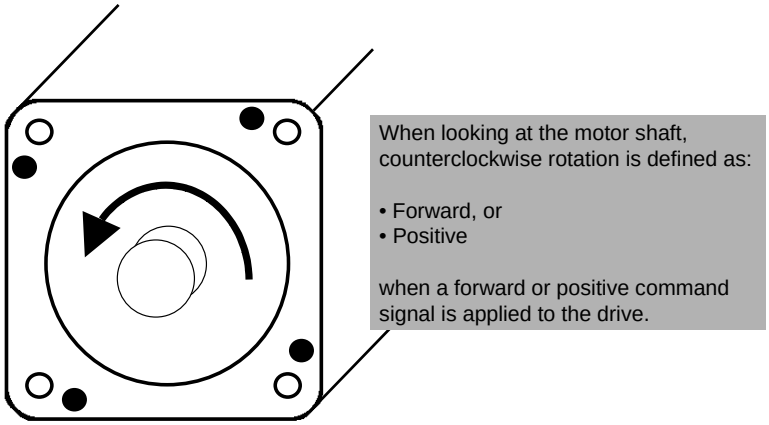

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# Miscellaneous Servo Motor Specifications

## Direction of Rotation

For the standard setting, the servomotor revolves counterclockwise, as viewed from the shaft when a positive velocity command or forward position (pulse) command is applied. By changing parameters with the Remote Operator, the direction of rotation with the same positive command can be reversed (Func5, Bit 1 for Velocity Command. Func5, Bit 2 for Position Command).




## Holding Brake Specification

The optional brake is for holding only and should not be used to stop the motor. Turn "ON" and "OFF" the brake using the holding brake signal output HBON, CN1-42. The specifications for the holding brake are in the table below.

**Table 22: Holding Brake Specifications**

| Motor Model | Static friction Torque [N m] | Release time varistor (diode) [mS] | Set Time [mS] |
|---|---|---|---|
| P60B13150H | 9.0 | 30 (140) | 100 |
| P50N05020D | 0.353 | 10 (100) | 15 |
| P50N08100D | 2.94 | 20 (200) | 30 |
| P30B04010D | 0.32 | 15 (100) | 25 |
| P30B06040D | 1.274 | 20 (120) | 30 |
| P30B08075D | 2.38 | 20 (200) | 40 |
| P20B10150D | 7.84 | 50 (200) | 60 |
| P20B10250D | 9.4 | 30 (140) | 100 |
| P20B13300D | 11.4 | 30 (140) | 100 |
| P20B13500D | 18.1 | 50 (150) | 120 |


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