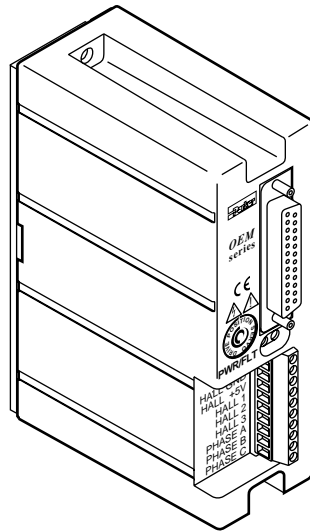


Compumotor

OEM770X Servo Controller/Drive User Guide



Compumotor Division
Parker Hannifin Corporation
p/n 88-018468-01 A



IMPORTANT

User Information



WARNING



OEM Series products are used to control electrical and mechanical components of motion control systems. You should test your motion system for safety under all potential conditions. Failure to do so can result in damage to equipment and/or serious injury to personnel.

OEM Series products and the information in this user guide are the proprietary property of Parker Hannifin Corporation or its licensors, and may not be copied, disclosed, or used for any purpose not expressly authorized by the owner thereof.

Since Parker Hannifin constantly strives to improve all of its products, we reserve the right to change this user guide and software and hardware mentioned therein at any time without notice.

In no event will the provider of the equipment be liable for any incidental, consequential, or special damages of any kind or nature whatsoever, including but not limited to lost profits arising from or in any way connected with the use of the equipment or this user guide.

© 2000, Parker Hannifin Corporation
All Rights Reserved

Motion Planner and Pocket Motion Planner are trademarks of Parker Hannifin Corporation.
Microsoft and MS-DOS are registered trademarks, and Windows, Visual Basic, and Visual C++ are trademarks of Microsoft Corporation.

Technical Assistance ⇨ *Contact your local automation technology center (ATC) or distributor, or ...*

North America and Asia:

Compumotor,
Division of Parker Hannifin
5500 Business Park Drive
Rohnert Park, CA 94928

Telephone: (800) 358-9070
or (707) 584-7558

Fax: (707) 584-3793

FaxBack: (800) 936-6939
or (707) 586-8586

e-mail: tech_help@cmotor.com

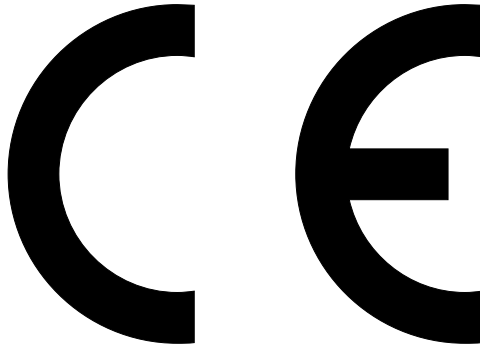
Internet: <http://www.compumotor.com>

Europe (non-German speaking):

Parker Digiplan
21 Balena Close
Poole, Dorset
England BH17 7DX
Telephone: +44 (0)1202 69 9000
Fax: +44 (0)1202 69 5750

Germany, Austria, Switzerland:

HAUSER Elektronik GmbH
Postfach: 77607-1720
Robert-Bosch-Str. 22
D-77656 Offenburg
Telephone: +49 (0)781 509-0
Fax: +49 (0)781 509-176



Product Type:
OEM770X Position Servo Controller/Drive

The above product is in compliance with the requirements of directives

- **72/23/EEC Low Voltage Directive**
- **93/68/EEC CE Marking Directive**

The OEM770X, when installed according to the procedures in the main body of this user guide, may not necessarily comply with the Low Voltage Directive (LVD) of the European Community. To install the OEM770X so that it complies with LVD, you must follow the additional procedures described in *Appendix A, LVD Installation Instructions*. If you do not follow these instructions, the LVD protection of the product may be impaired.

OEM770X drives are sold as complex components to professional assemblers. As components, they are not required to be compliant with Electromagnetic Compatibility Directive 89/336/EEC. However, information is offered in Compumotor's *EMC Installation Guide* on how to install the OEM770X in a manner most likely to minimize the effects of drive emissions and to maximize the immunity of drives from externally generated interference.

C O N T E N T S

PREFACE	6
1 INTRODUCTION.....	9
OEM770X Description	9
Operation & Block Diagram	9
Related Products	14
2 INSTALLATION	17
OEM770X Ship Kit	17
Installing Selectable Resistors and Jumper JU1	18
Resistor & Jumper Selection for Compumotor Motors	20
Resistor & Jumper Selection for Non-Compumotor Motors	20
Drive Mounting	22
Drive Dimensions	22
Panel Layout	23
Motor Mounting	26
Connecting a Motor to the Drive	29
Connecting Compumotor SM and NeoMetric Series Motors	30
Connecting Motors from Other Vendors	30
Connecting a Brushed DC Servo Motor	31
Shielded Motor Cables	31
Motor Grounding	31
OEM770X Inputs and Outputs	32
Clockwise and Counterclockwise – Definitions	32
General Purpose Inputs (Signal 1-Signal 5)	33
Output #1 (Signal 6) and Output #2 (Signal 8)	34
CW (Signal 12) & CCW (Signal 13) Limit Inputs	34
Dedicated Fault Output (Signal 9)	35
RS-232C—Tx (Signal 14), Rx (Signal 15), and Ground (Signal 7)	36
Enable Input (Signal 10)	36
Encoder Inputs +5V, A, B, Z, Gnd (Signals 16 - 23)	37
Current Monitor	38
Daisy Chaining	38
Connecting a Power Supply	40
Tuning	42
Tuning Procedure	45
Configuring an In Position Window	48
3 SPECIFICATIONS	49
Specifications: OEM770X Controller/Drive	50
Motor Specifications	52
Speed/Torque Curves	57
Motor Dimensions	59
Encoder Specifications	62
Hall Effect Specifications	62
Motor Wiring Information	63

4 SPECIAL INTERNAL CIRCUITS	65
Short Circuit Protection	65
Undervoltage	67
Overvoltage	68
Overtemperature	70
Response Circuit	71
Motor Inductance Affects Feedback	73
Selecting a Response Resistor	77
Current Foldback	80
Resistor Selection	85
How Long Will Foldback Protect Your System?	89
5 HALL EFFECT SENSORS	91
Hall Effect Sensors and Commutation	91
The Hall Effect	92
Hall Effect Sensors	93
Hall Effect Sensors Used Inside Brushless Motors	94
Windings in a Three Phase Brushless Motor	95
The Six Possible Hall States	96
Commutation Based on Hall States	99
Connecting Motors from Other Vendors	101
Improper Wiring Can Result in Poor Performance	101
Trial and Error Method	102
6 POWER SUPPLY SELECTION	103
How Much Power Does Your System Need?	104
Peak Power—A Calculation Method	104
Peak Power—A Graphical Method	110
Peak Power Curves	112
Friction, Gravity, and Different Move Profiles	116
Power Requirements—An Empirical Method	119
Average Power Calculations	121
Regeneration	121
Power Flow During Deceleration	122
Regeneration Curves	124
What Voltage Do You Need?	128
Power Supply Choices	130
Powering Multiple Axes	135
7 TROUBLESHOOTING	137
APPENDIX A: LVD INSTALLATION	151
APPENDIX B: SOFTWARE REFERENCE	155
INDEX	217

P R E F A C E

About This User Guide

You may not need to read this user guide from cover to cover! You can find essential information in the first three chapters—a product description in Chapter 1, installation instructions in Chapter 2, and specifications for the drive and motors in Chapter 3. This may be all you need to use the OEM770X.

Later chapters contain additional information about selected topics. Read them if you need a deeper understanding about these topics.

Special internal circuits, including an extended discussion of the current foldback circuit and the response circuit, are covered in Chapter 4. This chapter may interest you if you want to achieve optimum performance from the drive by adjusting the selectable resistors.

Hall effect sensors, and the way they affect commutation in brushless servo motors, are described in Chapter 5. If you use motors from manufacturers other than Compumotor, you may need this information to determine how to connect your motor to the drive.

Power supply selection is covered in Chapter 6. Read this chapter for information about calculating the power your system requires, how regeneration affects power supplies, and how you can specify a power supply for your system.

Troubleshooting procedures are covered in Chapter 7.

Warnings and Cautions

Warning and caution notes alert you to problems that may occur if you do not follow the instructions correctly. Situations that may cause bodily injury are presented as warnings. Situations that may cause system damage are presented as cautions.

A typical warning note is shown below.

WARNING

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

A typical caution note is shown below.

CAUTION

Do not turn on power unless the motor's Hall effect sensors, Hall +5, and Hall GND are connected to the drive. The motor may be destroyed by overheating if these connections are not made.

C H A P T E R 1

Introduction

OEM770X Description

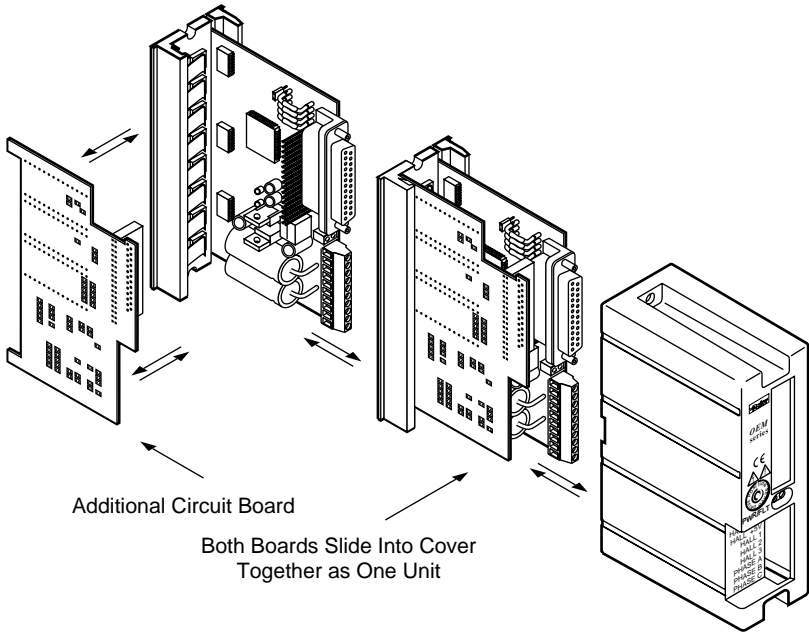
The OEM770X is a torque servo drive designed to operate standard 3 phase brushless DC servo motors equipped with Hall effect sensors, or equivalent feedback signals. It can also operate brushed DC servo motors. It is a high-performance module around which the Original Equipment Manufacturer (OEM) can design a motion control system. The drive offers a basic set of features designed to meet the needs of most customers. It is compatible with standard industry servo controllers, and is intended to be used in positioning applications. It uses three-state current control for efficient drive performance and cooler motor operation.

The OEM770X is small and convenient to use. It installs with only two screws (the screws also provide grounding and captivate the cover). Its right angle screw terminal allows side-by-side mounting, and its small footprint maximizes cabinet space. The snap-on molded cover is removable for drive configuration, and helps provide a barrier against environmental contamination. The drive is the same size as a 3U Eurorack card. Its standard 25 pin D-connector is compatible with universally available connectors.

The drive is designed for manufacturability and reliability. It uses surface mount components and a custom designed ASIC to conserve space, reduce cost, and improve reliability. More than 90% of the components are auto inserted, which reduces assembly time and cost, and further improves reliability.

Operation & Block Diagram

A Compumotor product called the OEM770T Torque Drive is the “building block” in a family of servo drives. It has an internal slot where an additional circuit board can be inserted to make a different product.



Additional Circuit Board Can Mount Internally

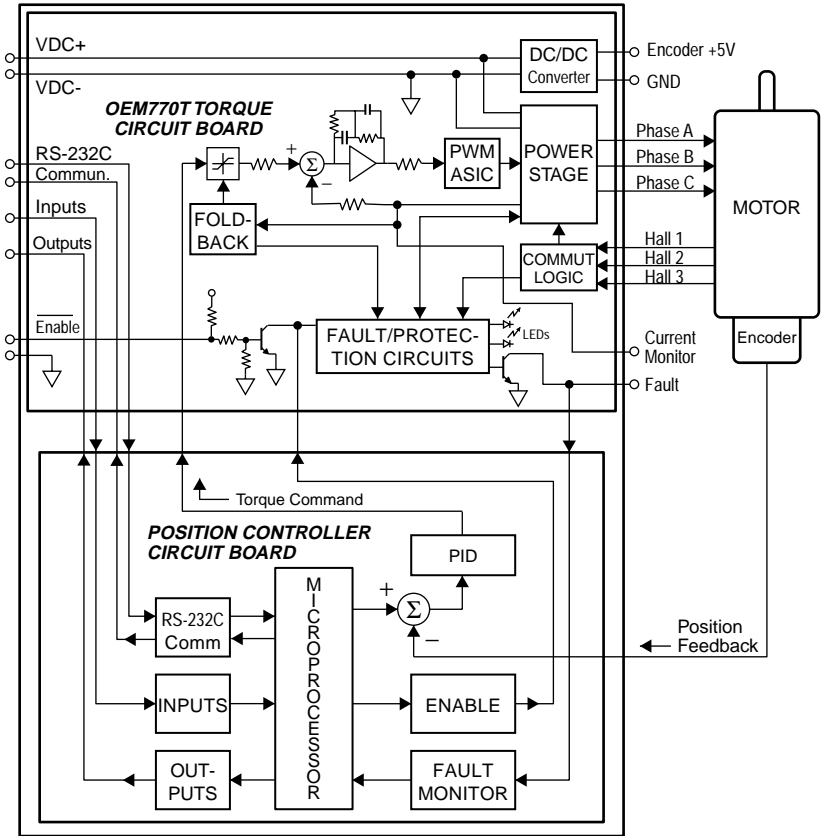
The additional circuit board is inserted at the factory, at the time of manufacture. Externally, the new product looks just like the OEM770T, except that the label is a different color.

OEM770X POSITION CONTROLLER/DRIVE

The OEM770X Controller/Drive consists of the OEM770T with a position controller circuit board.

The OEM770X requires a single external power supply. The drive accepts 24VDC to 75VDC for its power input. Its internal DC-to-DC converter produces +5V to power Hall effect sensors and encoder electronics, and all internal voltages used for the drive's circuits.

The block diagram for the OEM770X is shown in the next drawing.



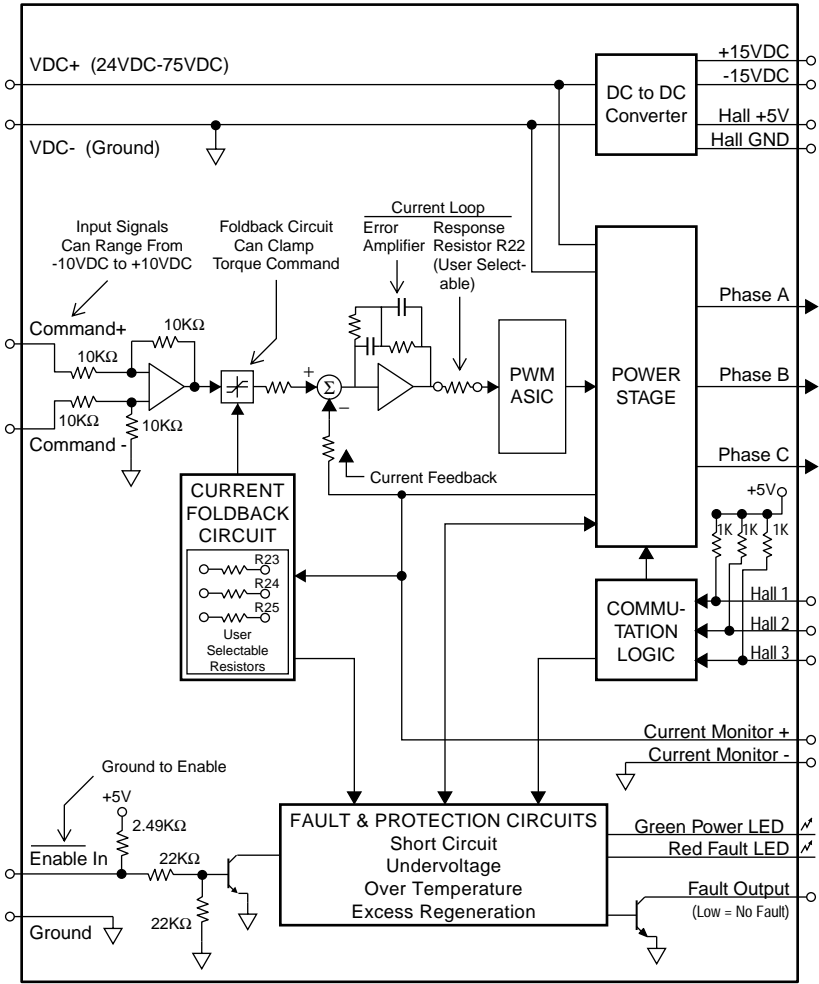
OEM770X Position Controller/Drive — Block Diagram

Inputs, outputs, and RS-232C communications are internally routed to the position controller board, where they interface with a microprocessor. The microprocessor generates a position command. It can also enable or disable the torque board.

The position controller board receives feedback about actual position from an encoder, and compares commanded position with actual position. It generates a torque command to correct any position errors. The torque command (which is an analog voltage) then goes to the torque board as a *command input* signal, passes through the foldback circuit, and proceeds through the remainder of the torque board's circuits.

The detailed block diagram for the torque board is shown in the next drawing.

1 Introduction • OEM770X



Block Diagram — OEM770T Torque Servo Drive

Input to the torque board is a voltage signal called *command input*. It can range from -10VDC to +10VDC. Output current is scaled so that each volt of command input corresponds to 1.2A of output current. For example, a command input of 5V results in a 6A output current. The maximum command input of 10V results in the full 12A output current.

When the command input signal enters the board, it is amplified, sent through a foldback circuit (which may or may not be active) and an inverter,

and summed with a current feedback signal that is proportional to the actual output current.

An error signal—the difference between commanded and actual output current—goes through an error amplifier. The amplifier's output controls a pulse width modulation (PWM) circuit. If actual current is too low, the PWM circuit will send longer pulses to the power stage. These pulses keep the stage turned on longer, which results in more output current. If actual current is too high, the PWM circuit sends shorter pulses, resulting in less current.

A *response resistor* affects the signal level that goes into the PWM circuit. The user can choose a value for this resistor that produces the best current loop gain and system dynamics for a particular motor.

The power stage has three outputs—each connects to a particular motor coil. The drive gets inputs from the motor's Hall effect sensors, and determines which of six possible positions the rotor is in. It then uses a six-state commutation technique to send current into one coil and out of another (the third coil receives no current). The current creates a torque on the rotor, and the rotor turns to the next position. The drive reads the new position from the Hall sensors, and switches current to a different combination of coils. The rotor turns further, and the process repeats. (The drive can also be configured to commutate brushed servo motors.)

The drive has several fault and protection circuits. These monitor temperature, regeneration, undervoltage, and short circuits. They can shut down the drive if limits are exceeded. LEDs indicate power and fault status.

A foldback circuit monitors motor current, and protects the motor from overheating due to prolonged high currents. The user can install resistors to set levels for peak current, foldback current, and time constant. When the circuit invokes foldback, it clamps the command input signal at a voltage that reduces motor current to the preset level. After a period of time, the circuit may release its clamp on the command input signal, and normal operations can continue.

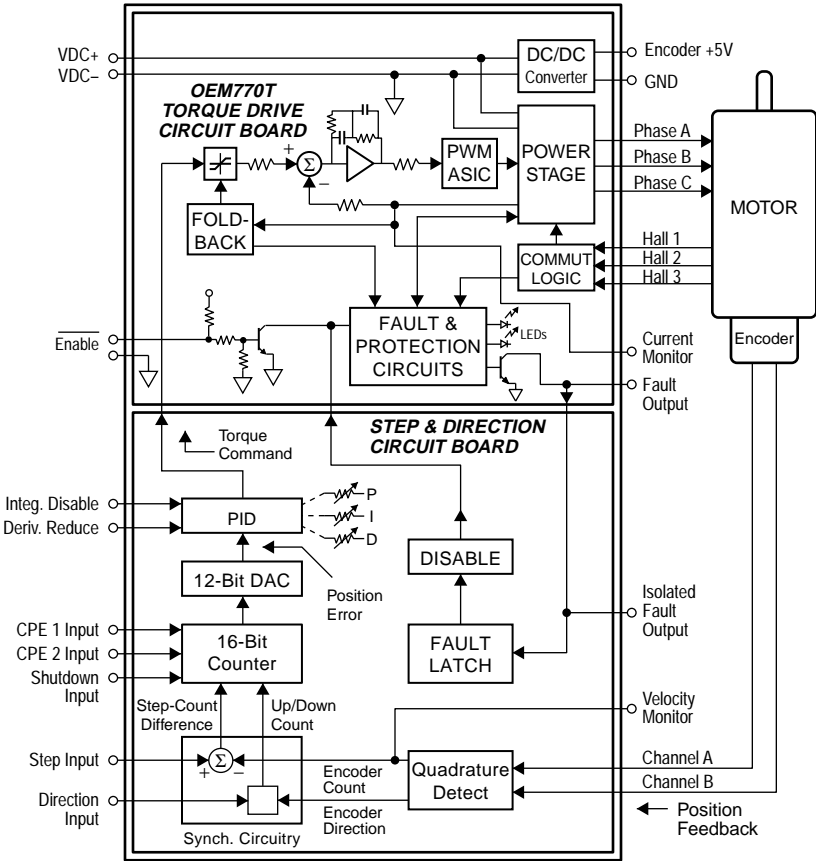
The drive has several other inputs and outputs. An enable input must be grounded to enable the drive. A fault output is held low if there are no faults. A current monitor output provides a voltage scaled to represent the actual output current. It can range from -10V to +10V, with one volt corresponding to 1.2 amps of output current.

Related Products

In addition to the OEM770X and OEM770T, the other products described below comprise the family of Compumotor OEM Servo Products.

OEM770SD STEP & DIRECTION SERVO DRIVE

The OEM770SD Step & Direction Servo Drive consists of the OEM770T with a position controller circuit board added.



Block Diagram – OEM770SD Step & Direction Servo Drive

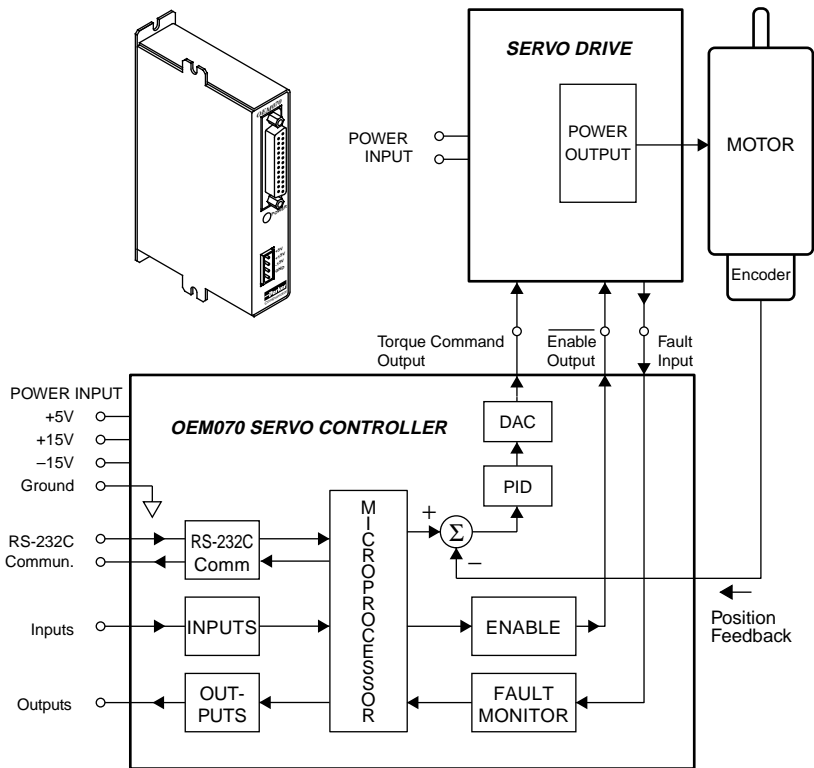
The controller accepts step and direction position commands from an indexer. It uses encoder signals for feedback. Its internal PID position control loop generates an analog command output voltage that is sent to the torque board.

Indexers intended for use with step motor systems can operate the OEM770SD. It emulates a stepper drive, but can achieve servo system levels of high speed performance and thermal efficiency.

OEM070 SERVO CONTROLLER

The OEM070 Servo Controller is a compact, stand-alone controller designed to operate with analog servo drives.

The OEM070 contains the same position controller board used in the OEM770X. The board is packaged by itself in a minimum depth, small footprint housing. It controls motor torque or velocity with a $\pm 10V$ command output signal. Through its I/O and RS-232C ports, the OEM070 can interface with external devices such as incremental encoders, switches, computers, and programmable control units.



OEM070 Servo Controller – Block Diagram

SM and NeoMetric Series Servo Motors

Compumotor offers SM Series and NeoMetric Series servo motors designed to operate with OEM Series servo drives. Each motor is equipped with Hall effect outputs and an encoder.