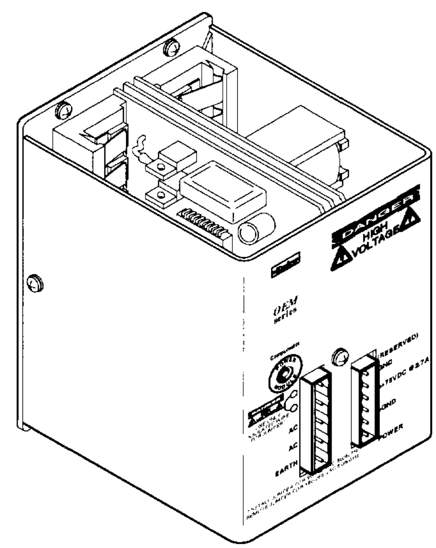
Compumotor

OEM300 Power Module User Guide



Compumotor Division
Parker Hannifin Corporation
p/n 88-013513-01 C

Important User Information

Installation & Operation of Compumotor Equipment

It is important that Compumotor motion control equipment is installed and operated in such a way that all applicable safety requirements are met. It is your responsibility as a user to ensure that you identify the relevant standards and comply with them. Failure to do so may result in damage to equipment and personal injury. In particular, you should review the contents of the user guide carefully before installing or operating the equipment.

Under no circumstances will the suppliers of the equipment be liable for any incidental, consequential, or special damages of any kind whatsoever, including but not limited to lost profits arising from or in any way associated with the use of the equipment or this user guide.

Safety Warning

High-performance motion control equipment is capable of producing rapid movement and very high forces. Unexpected motion may occur especially during the development of controller programs. KEEP CLEAR of any machinery driven by stepper or servo motors and never touch them while they are in operation.

High voltages exist within enclosed units, on rack system backplanes, and on transformer terminals. KEEP CLEAR of these areas when power is applied to the equipment.

Parker Compumotor constantly strives to improve all of its products. We reserve the right to modify equipment and user guides without prior notice. No part of this user guide may be reproduced in any form without prior consent from Parker Compumotor.

Compumotor

For assistance in the United States, contact:
Compumotor Division of Parker Hannifin
5500 Business Park Drive
Rohnert Park, CA 94928
Telephone: (800) 358-9070
Fax: (707) 584-8015

For assistance in Europe, contact:
Parker Digiplan
21 Balena Close
Poole, Dorset
England BH17 7DX
Telephone: 0202-690911
Fax: 0202-600820

Parker

88-013513-01 C

OEM300 Power Module User Guide

Revision C Change Summary

The following is a summary of the primary technical changes to this user guide since the last version was released. This user guide, p/n 88-013513-01 **C** (released on January 3, 1995), supersedes 88-013513-01 **B**.

JUMPER SELECTABLE AC INPUT VOLTAGE RANGE (PG. 11)

The OEM300 Power Module AC power input circuitry is no longer auto-ranging. A jumper on the AC power connector will now configure the OEM300 for 120VAC or 240VAC operation, as follows:

120VAC Operation – Jumper must be installed

240VAC Operation – Jumper must be removed

The OEM300 ships from the factory pre-configured for 120VAC operation, with a jumper installed on the connector. You must remove the jumper if you operate the OEM300 at 240VAC.

SYSTEM SIZING (PG. 45)

Chapter ⑥ explains how to determine how many step motor drives you can connect to one OEM300. A reference has been added to *Chapter ⑥* that says similar information about servo motor drives can be found in Compumotor's *OEM670T Torque Servo Drive User Guide.*

CONTENTS

PREFACE

MAYBE YOU SHOULDN'T READ THIS MANUAL!

Perhaps you are wondering, "How hard can it be to operate this Power Module? Why do I need a manual? Can't I just hook up AC power, plug in some output cables, and power up my system?"

You may be right! If you have experience designing motion control systems, then perhaps the only information you need can be found in *Chapter ② Installation & Operation.* You may already know how to cool power supplies. You will have calculated the power your system requires, and you will connect the right number of drives to the Power Module. You will know about the hazards of load regeneration, and improper equipment grounding. And, you will probably take the proper steps to ensure electrical noise is not a problem in your system. So, if you are confident in your preparations, go ahead and plug away! And best of luck with the OEM300!

The rest of the information in this manual gives details about the issues mentioned above. Special benefits of using the OEM300 are also discussed, such as the protective circuits that guard equipment from damage by short circuits, load regeneration, or high temperatures. A troubleshooting section will help you locate problems. So, browse through the manual; you might find other topics of interest, too!

FOR THOSE WHO NEVER READ MANUALS

At least look at the next illustration. We have attempted to put all the critical information you need in this drawing. It is also shown on the back cover. Use it for quick reference. Consult the rest of the manual for detailed information.

OEM300 POWER MODULE

The OEM300 is *NOT* a general purpose power supply. Use it only with Compumotor OEM Series Microstepping or Servo Drives.

> ***WARNING***
> **NO USER SERVICEABLE PARTS INSIDE**
> The OEM300 contains potentially lethal voltages! Do not attempt to repair it. Return the OEM300 to Compumotor for repairs.

HEATSINK

Attach Power Module's heatplate to a heatsink or heat sinking surface

HEATPLATE COOLING

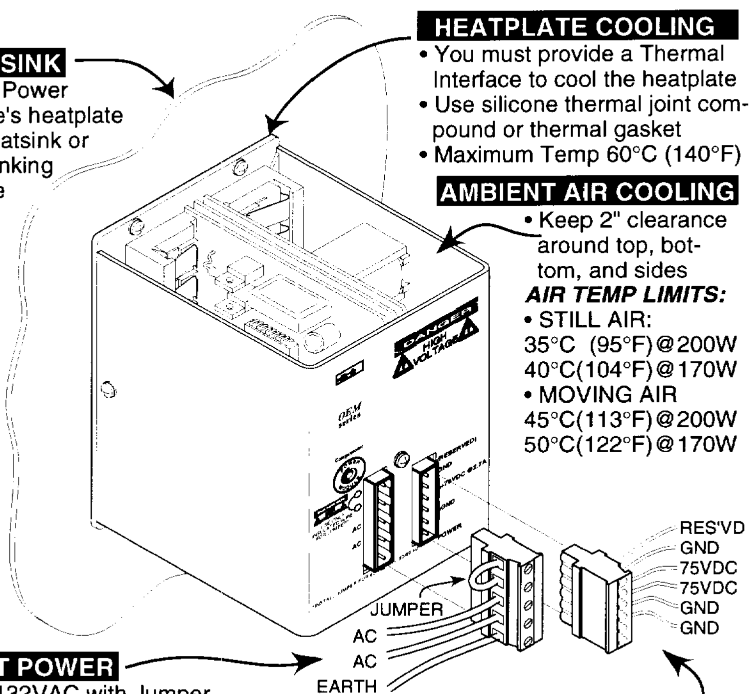
- You must provide a Thermal Interface to cool the heatplate
- Use silicone thermal joint compound or thermal gasket
- Maximum Temp 60°C (140°F)

AMBIENT AIR COOLING

- Keep 2" clearance around top, bottom, and sides

AIR TEMP LIMITS:

- STILL AIR:
  35°C (95°F)@200W
  40°C(104°F)@170W
- MOVING AIR
  45°C(113°F)@200W
  50°C(122°F)@170W



INPUT POWER

- 90-132VAC with Jumper Installed
- 180-265VAC with Jumper Removed
- **DO NOT USE** 132-180VAC

INPUT CONNECTOR:

- 5 Pin Removable Connector
- 16 AWG Recommended

> ***You must connect the EARTH terminal to EARTH GROUND!***
> (Chassis, cover, EARTH, GND pins are connected internally)

OUTPUT POWER

- 75VDC ± 5%
- 2.7A/200W Continuous
- 4.0A/300W Peak
  (30 sec., 10% Duty Cycle at Peak)
- Two 75VDC pins, internally connected

OUTPUT CONNECTOR:

- 6 Pin Removable Connector
- Use16 AWG if < 10 ft., 14 AWG if > 10 ft.

> ***DO NOT CONNECT MULTIPLE OEM300s IN PARALLEL! They will not share the load.***

PROTECTIVE CIRCUITS

- SHORT CIRCUIT PROTECTION — Latched
- POWER DUMP — Turns on at 85VDC
- OVER-TEMPERATURE — Unit shuts down @ 60°C; Latched; Cool to 30°C
- OVERVOLTAGE — Shuts down output after 0.5 sec overvoltage; Latched

Warnings & 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.

WARNING

NO USER SERVICEABLE PARTS INSIDE THE OEM300!

The OEM300 contains potentially lethal voltages. Do not attempt to repair it. Return it to Compumotor for any repairs.

Situations that may cause system damage are presented as cautions.

CAUTION

Do not use AC input voltage in the range of 132-180VAC. AC voltage in this range can cause excessive voltages to be generated within the OEM300, and may damage the unit.

CHAPTER ①

Introduction

DESIGN INTENTIONS

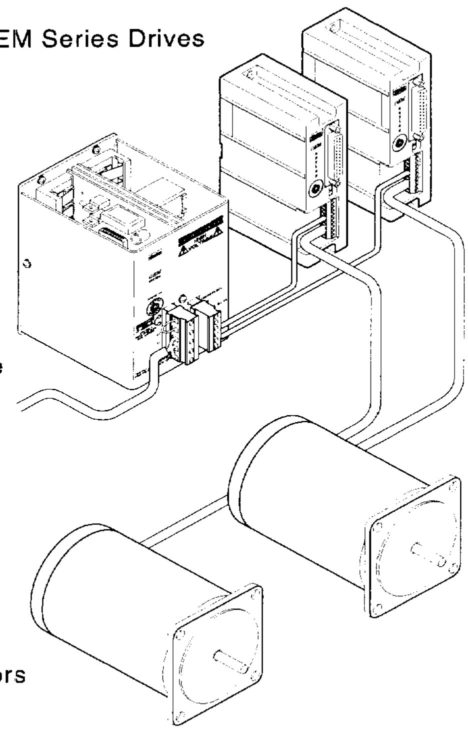
COMPUMOTOR'S OEM SERIES: A FAMILY OF MOTION CONTROL PRODUCTS

The OEM Series is a collection of high performance motion control modules. The product line consists of stepper and servo drives, indexers, motors, and the OEM300 Power Module. The products are intended to be used as embedded systems around which the Original Equipment Manufacturer (OEM) can design a motion control system.

THE ORIGINAL EQUIPMENT MANUFACTURER DECIDES HOW TO USE OEM PRODUCTS

The products have a basic set of features that the OEM can configure to meet varied needs. The products are not shipped as ready-to-use units. Compumotor assumes that the OEM system designer will make design and engineering decisions to properly use the equipment.

THIS MANUAL PROVIDES INFORMATION NECESSARY TO MAKE ENGINEERING AND DESIGN DECISIONS ABOUT PROPER USE OF THE OEM300 POWER MODULE.



OEM Series Products — A Typical System

OEM300 POWER MODULE FEATURES

The OEM300 Power Module is optimized to provide power to Compumotor's OEM Series of microstepping drives and servo products. It contains a dual range power supply that can operate at 120VAC or 240VAC, at 50/60 Hz.

The voltage output of the OEM300 is fixed at 75VDC. It can produce 2.7A continuous and 4.0A peak, and provides power for drives and motors.

The OEM300 will power two OEM650 Drives, each running a Compumotor 83-135 step motor. It can power as many as five OEM650 Drives, each running 57-40 step motors. It can power OEM670 Servo Drives running servo motors as large as 1/2 horsepower (373 watts). The total number of servo drives is limited by the total power demand.

The Power Module is compact. It occupies the space of two OEM drives, and mounts similarly to the drives. Its small footprint conserves space in equipment cabinets.

To remove excess heat from within, the OEM300 uses a heat-plate technique and convection cooling.

PROTECTIVE CIRCUITS

Several circuits in the OEM300 automatically provide protection for the Power Module and the equipment it powers.

- ❑ **OVER-TEMPERATURE** The Power Module monitors the temperature of its heatplate, and will automatically shut down if the heatplate temperature exceeds 60°C (140°F). To restart the Power Module: turn off AC power, cool the Power Module below 30°C (86°F), and cycle AC power.
- ❑ **SHORT CIRCUIT PROTECTION** The Power Module monitors current going to the drive, and will shut down its output if it detects a short circuit in the drive. Cycle AC power to resume normal operations.
- ❑ **INTERNAL POWER DUMP** The Power Module has an internal power dump circuit. This circuit can dissipate excess energy during load regeneration conditions.
- ❑ **OVERVOLTAGE** The Power Module will shut down if there is excessive voltage at its output terminals.

For more information about these circuits, refer to *Chapter ④ Protective Circuits in the OEM300.*

SPECIAL DESIGN ISSUES

You can use the Power Module in many different ways. To use it effectively, however, you must solve several design issues. Two of the most important are:

COOLING THE OEM300 POWER MODULE

The OEM300 Power Module dissipates some power as internal heat. This excess heat must be removed from the Power Module. When you design your system, keep in mind three things you can do to remove heat.

- ❑ **COOL THE HEATPLATE**—Make sure heat can pass through the Power Module's heatplate and into a suitable heat sinking surface.
- ❑ **PROVIDE SPACE AROUND THE POWER MODULE**—Allow convection to transfer heat to the ambient air.
- ❑ **KEEP AMBIENT AIR WITHIN ITS TEMPERATURE LIMITS**—Otherwise, it will not adequately cool the Power Module.

For more information about cooling the Power Module, refer to *Chapter ⑤ Heat & Thermal Management Issues.*

HOW MANY DRIVES CAN THE OEM300 OPERATE?

The OEM300 can deliver power to many different combinations of OEM Series products. You can save money if you analyze your system, determine how much power each drive needs, and then connect the right number of drives to use the full power capability of the OEM300.

For information on calculating power required by different motors and drives, see *Chapter ⑥ Calculating How Many Drives & Motors The OEM300 Can Operate.*

CHAPTER ②

Installation & Operation

BEFORE YOU BEGIN

This chapter tells you how to test, install, and operate your OEM300 Power Module. Before you begin installation, we assume you have addressed and solved the following design issues.

❑ **HEATSINK** You have chosen a heatsink, or a suitable heat sinking surface. You have selected a way to make good thermal contact between the heatsink and the Power Module's heatplate.

❑ **COOLING** You have decided on a method for ventilating the Power Module, and keeping ambient air temperatures within specified limits.

❑ **NUMBER OF DRIVES** You have calculated the power required by your system, and have decided how many drives you can connect to each Power Module.

If you need more information about heatsinks and cooling, refer to *Chapter ⑤ Heat & Thermal Management Issues.* For information on how many drives you can connect to the Power Module, refer to *Chapter ⑥ Calculating How Many Drives & Motors the OEM300 Can Operate.*

NOTE: The OEM300 is not a general-purpose power supply, nor is it a laboratory bench supply. It was designed specifically for use with OEM Series drives—it is unsuitable for other purposes.

CAUTION
The OEM300 Power Module should only be used with OEM Series drives. Do not connect it to any other products or equipment.

OEM300 SHIP KIT

Inspect the OEM300 upon receipt for obvious damage to its shipping container. Report any damage to the shipping company. Parker Compumotor cannot be held responsible for damage incurred in shipment. You should receive one or more OEM300 Power Modules, depending upon what you ordered. Compare your order with the units shipped.

Component	Part Number
OEM300 Power Module	OEM300
5 Pin Connector	43-014298-01
6 Pin Connector	43-006606-01
Accessories	
OEM300 User Guide	88-013513-01

User guides are not sent with each product. They are available upon request. Please order user guides as needed.

BENCH TEST

OEM300 Power Modules are tested at the factory before they are shipped. Ordinarily, there is no need to perform a bench test on the Power Module before you install it in your system. If you want to test the Power Module, you can perform the tests listed below.

CAUTION

If you operate the OEM300 without adequate cooling, it may be damaged. Mount the OEM300 to a heatsink. Make sure there is good thermal contact between the Power Module's heatplate and the heatsink. Do not block the openings in the cover. Allow adequate air movement so that convection can cool the Power Module. Remove AC power to the Power Module when you complete your tests.

To test a Power Module:

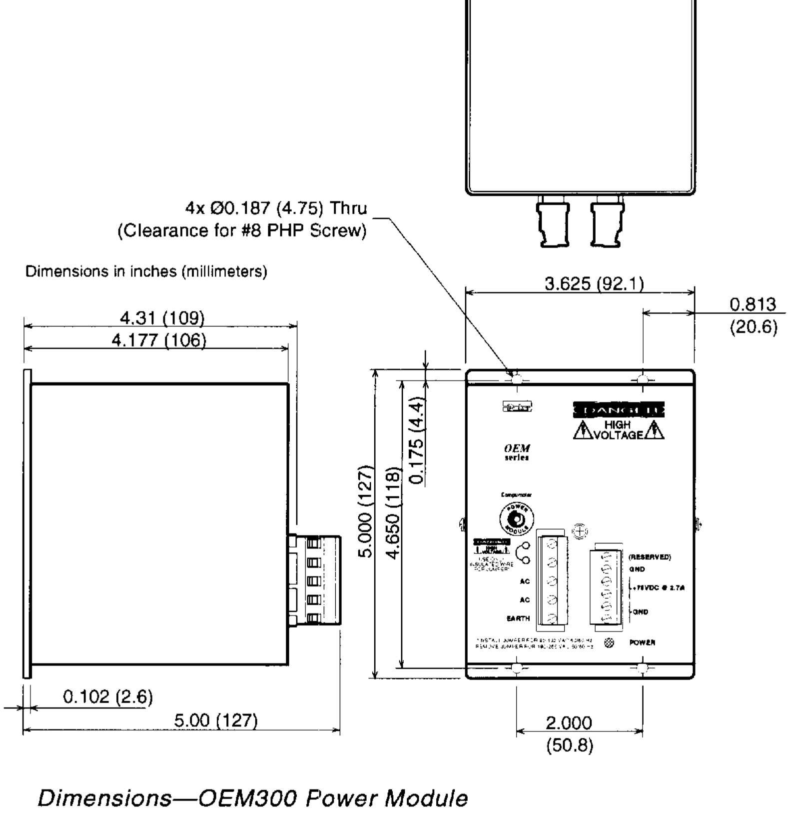
1. Connect AC power to the OEM300 (120VAC with jumper installed; or 220VAC with jumper removed).
2. LED: the green LED should be illuminated. This indicates that the 75VDC power supply in the Power Module is operating correctly.

3. Use a voltmeter to measure the voltage at the 75VDC output terminals. It should be 75VDC ± 5%.

INSTALLATION

MOUNTING

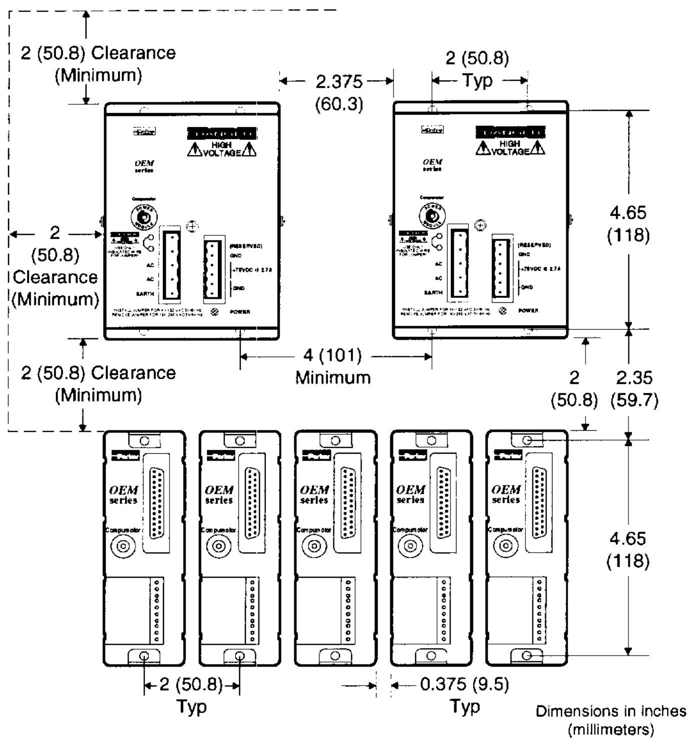
The OEM300 Power Module is designed to minimize panel area, or footprint, in an equipment cabinet. Dimensions are shown in the drawing below.



Dimensions—OEM300 Power Module

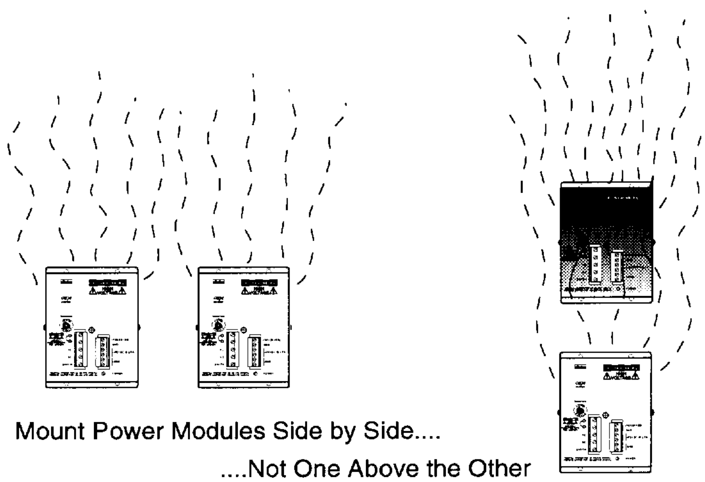
Panel Layout and Minimum Spacing

Do not obstruct the openings in the top and bottom of the OEM300. Provide space for air circulation between the Power Module and other equipment. The figure below shows the minimum spacing required.



Panel Layout—OEM300 Power Modules with OEM Series Drives

If you are using several OEM300s in an equipment cabinet, mount them side by side. This configuration provides good heat dissipation. Do not mount units above each other in a vertical configuration—heat rises from the lower units to the upper units, which may cause excessive heat buildup in the upper units. This is shown in the next drawing.

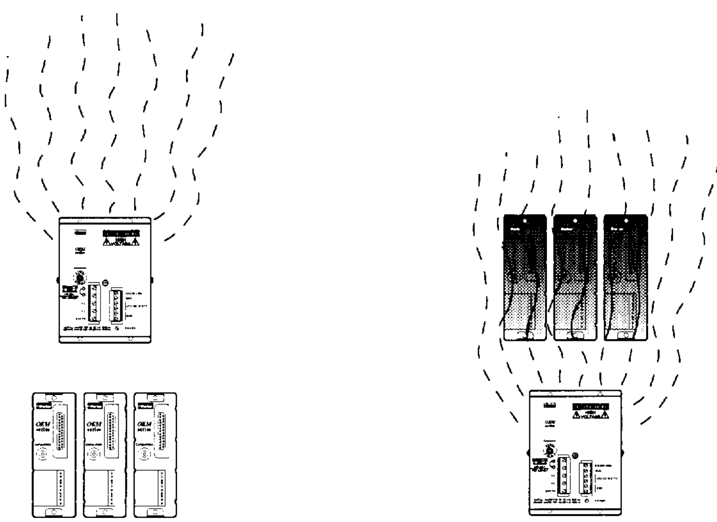


Mount Power Modules Side by Side....

....Not One Above the Other

Side by Side Mounting is Preferred

When you position equipment and components, place those that produce the most heat above those that are cooler. The figure below illustrates this.



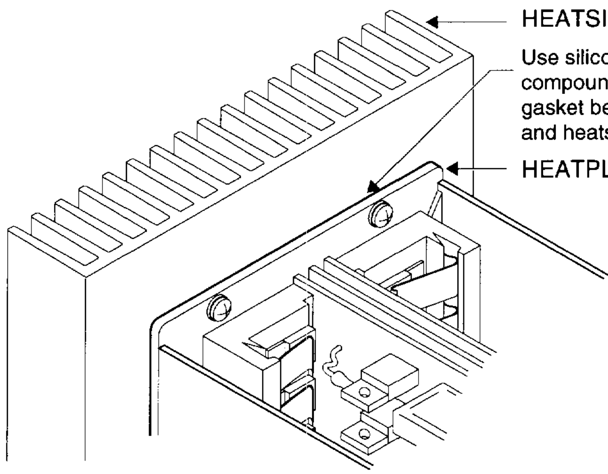
Mount Heat Sensitive Equipment
Below the Power Module....

....Not Above It

Heat Sensitive Equipment—Preferred Mounting

Attachment to Heatsink

You ***must*** attach the heatplate of the Power Module to a heatsink or suitable heat sinking surface. The heatplate is the pathway through which you can remove much of the excess heat generated by the Power Module.



Attaching Heatplate to Heatsink

When you attach the Power Module to a heatsink, observe the following guidelines:

- ❑ Use silicone thermal joint compound or a thermal gasket to ensure good thermal contact between the heatsink and the Power Module's heatplate.
- ❑ Make sure there are no voids or air pockets between the heatsink and heatplate.
- ❑ Verify that the heatsink is not warped (a warped surface will not make a good thermal interface).

CAUTION

You ***must*** attach the heatplate of the Power Module to a heatsink or suitable heat sinking surface. Use silicone thermal joint compound or a thermal gasket to provide a good thermal interface.

For more information about choosing a heatsink, refer to *Chapter ⑤ Heat & Thermal Management Issues.*

Ventilation

The OEM300 depends on ventilation to remove much of its excess heat. Mount the Power Module so that air can circulate around it. Follow the guidelines for minimum spacing that were shown earlier in this section. Make sure the openings in the top and bottom of the cover are not blocked.

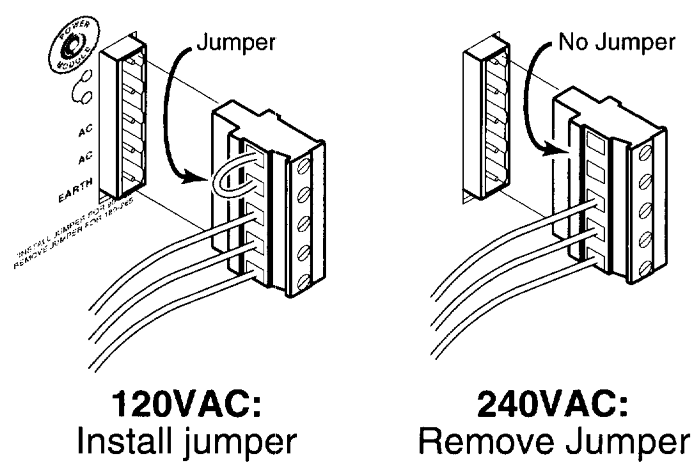
If you have high ambient temperature conditions, or heat-producing equipment near the OEM300, you may need to provide a fan for air circulation and cooling. For more information about ventilation, refer to *Chapter ⑤ Heat & Thermal Management Issues.*

AC POWER CONNECTION

Use AC input power in the range of 90-132VAC or 180-265VAC to operate the OEM300, and configure the jumper wire on the power connector to match your input voltage.

Voltage in the intermediate range (132-180VAC) ***MUST NOT*** BE USED!

There are two terminals on the 5-pin AC input connector that require the installation or removal of a jumper wire, depending upon the input voltage you use. The following illustration shows how to configure the jumper for your voltage.



AC Input Connector–Jumper Configurations

120VAC Operations

The OEM300 is shipped from the factory configured for input voltage in the 90-132VAC range, with the jumper in place on the connector. Leave the jumper in place if you operate in this range. Operating without a jumper will cause poor system performance.

Line voltage is present on the jumper. For safety reasons, use only insulated wire for the jumper.

WARNING

High voltage is present on the jumper. Use insulated wire for safety.

240VAC Operations

If you use input power in the 180-265VAC range, remove the jumper. Do not operate the OEM300 in the 180-265VAC range with the jumper in place. Doing so can produce high internal voltages which could cause severe system damage.

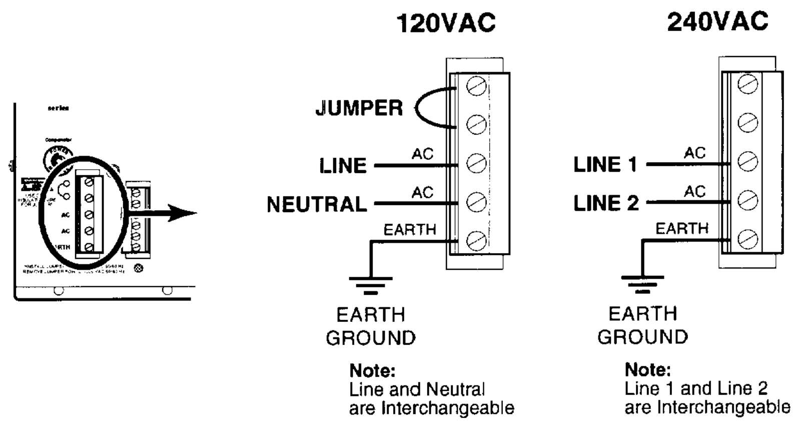
CAUTION

Do not use a jumper when using AC input voltage in the 180-265VAC range. If a jumper is in place, input voltage in this range will cause the OEM300 to generate high internal voltages which could result in system damage.

AC input information is summarized below:

Input Voltage:	90VAC-132VAC	Jumper installed
	180VAC-265VAC	Jumper removed
	Forbidden Range:	132VAC-180VAC
Wire Size:	16 AWG (1.5 mm^2) minimum	
Input Connector:	5-pin removable connector (Phoenix P/N GMVSTBR 2.5/5-ST)	

The following illustration shows the AC input connector properly configured for both voltage ranges.



AC Input Connections

CAUTION

Do not use AC input voltage in the range of 132-180VAC. AC voltage in this range can cause excessive voltages to be generated within the OEM300, and may damage the unit.

DC OUTPUT CONNECTION

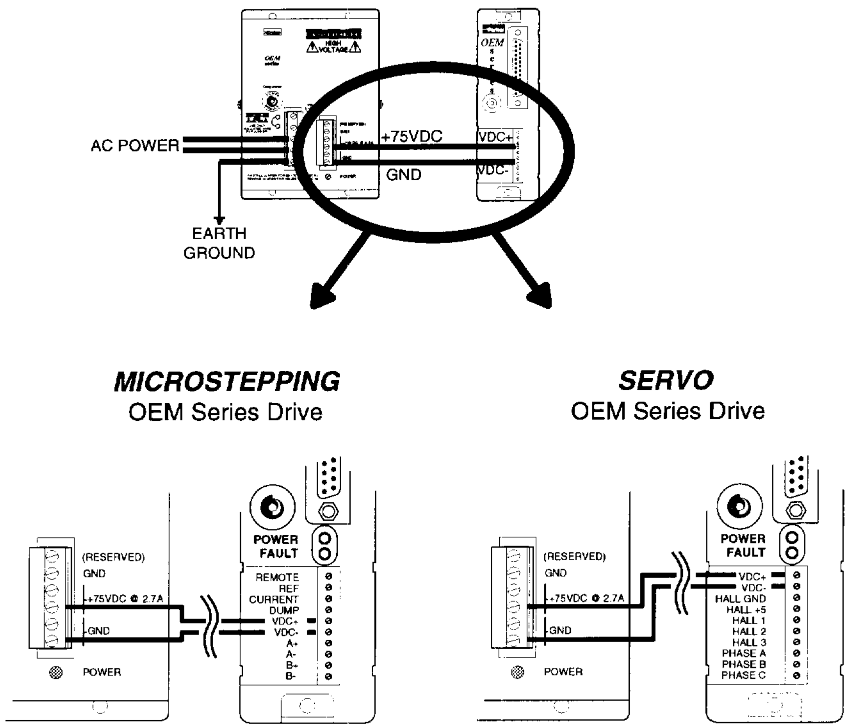
For convenience, multiple pins are provided for 75VDC and for GROUND (GND). The two 75VDC pins are identical—use either one, or use both, whichever your needs require. Similarly, the three GROUND pins are identical—use as many as you need.

Output Pins:	+75VDC	Two provided
	GROUND	Three provided
	RESERVED	One provided; Do not use

Output Connector: 6-Pin Removable connector (Phoenix P/N MVSTBR 1.5/6-ST)

Wire Size: 16 AWG (1.5 mm^2) if less than 10 ft. (3m)
14 AWG (2.5 mm^2) if more than 10 ft. (3m)

The following drawing illustrates typical power cabling for various OEM Series drives.

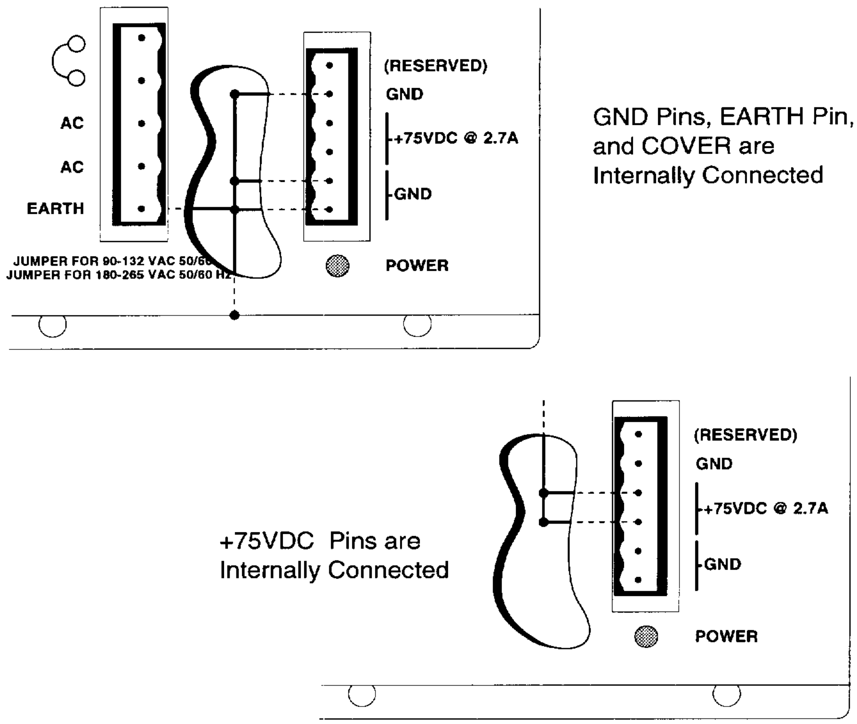


Power Connections to Various Drives

OUTPUT POWER CABLE LENGTH

Make the output power cables as short as possible. Voltage drops occur in cables over 3 feet long, and cause a reduction in power delivered to the drive. To minimize cable length, mount the OEM300 close to the drive.

The next drawing shows that the 75VDC output pins are connected together internally. It also shows the internal connections of the ground pins and cover.



Internal Connections

GROUNDING FOR SAFETY

Inside the OEM300, the 75VDC output grounds are connected to each other, to the AC input ground (which is labeled EARTH), and to the cover of the OEM300. For safety considerations, connect the EARTH terminal of the Power Module to an external EARTH GROUND.

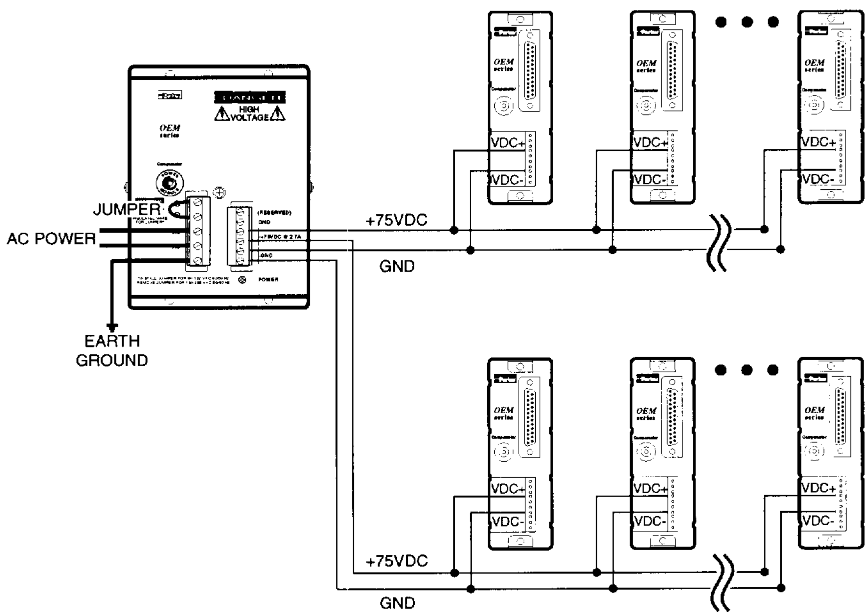
Do not create ground loops when you connect cables to your system.

How Many Drives Can Be Connected to One OEM300?

The OEM300 can deliver power to many different combinations of drives, indexers, and the motors they operate. Determine the power demanded by your application, and verify that the OEM300 will supply the amount of power needed. You may need multiple OEM300 Power Modules; or, you may be able to use fewer Power Modules than anticipated. For details on how to calculate the power output required of the OEM300, refer to *Chapter ⑥ Calculating the Number of Drives & Motors the OEM300 Can Operate.*

Connecting Multiple Drives to the OEM300

Consult the following figure for guidelines on how to connect more than one drive to the OEM300. You can make a single power bus or you can use the extra pins in the DC output connector to make a second power bus.



Power Cabling Options

You can connect OEM650 Microstepping Drives and OEM670 Servo Drives to the same OEM300 Power Module.

Using More than One OEM300 Power Module

The OEM300 is not designed for current sharing. Each unit is designed as a standalone Power Module. Do not attempt to connect multiple OEM300s together in parallel. Instead, connect drives directly to individual Power Modules.

CAUTION

Do not connect multiple OEM300 Power Modules in parallel. Connect drives directly to individual Power Modules.

Electrical Noise Control

The OEM300 Power Module contains a switching power supply. Internally, it rapidly switches several high voltage components on and off. This rapid switching creates electrical noise, which is a standard characteristic of switching power supplies.

You may need to reduce electrical noise, depending on your application and the sensitivity of the equipment in your system. The following information is provided to help with your noise reduction efforts. For additional information about controlling electrical noise, consult the technical reference section in Compumotor's catalog.

Switching Frequencies

Primary Switching Frequency:	118 kHz ± 9 kHz
AC Line Switching Frequency:	48-72 Hz, plus harmonics

(AC line frequency varies by country)

Input Filter

Internally, the OEM300 has an AC input filter. This filter reduces the electrical noise that is conducted from the Power Module to the AC power line. If you need to further reduce the noise sent out over the AC lines, you can install an external filter at the point where AC power is connected to the Power Module. A variety of filters are commercially available from many different vendors.

Output Filter

We recommend that no external filters be placed between the output of the OEM300 Power Module and any equipment connected to it.

The OEM300 Power Module should be connected directly to Compumotor OEM Series drives. It is designed to respond rapidly to power demands from drives and their loads. Any external filters, such as EMI filters or extra capacitors, may seriously impede the response and performance of the Power Module.

Output Cables

Noise can be coupled from the output cables to sensitive equipment by means of electromagnetic radiation. This type of noise problem is known as *Electro Magnetic Interference*, or *EMI*.

If you need to reduce EMI emanating from the power cables, use shielded power cables and properly ground the shield. You can achieve additional reductions in EMI if you run cables in conduit or steel pipe. Cables should be as short as possible. Keep cables away from sensitive equipment.

If you run separate wires for power cables (POS and GND, or + and -), both wires should be parallel, immediately adjacent to each other, and twisted together. This will minimize circuit inductance and radiated noise.

Proper Application of the OEM300

In extreme cases and unusual applications, sensitive equipment can be highly susceptible to electrical noise problems. In situations like this, a switching power supply might be the wrong type of power supply to use.

If your system cannot tolerate the amount of electrical noise generated by the OEM300, and noise reduction techniques fail to reduce noise to tolerable levels, then you may need to consider using a linear power supply, such as the Compumotor DC 4. Linear supplies are virtually noise free, and give excellent results in noise-sensitive applications. Unfortunately, in comparison to switching supplies, linear supplies are large, heavy, and dissipate more power. They also suffer from poor output regulation, which may affect the high-speed performance of your system.

OPERATION

The OEM300 Power Module is intended to be hardwired within your system. Therefore, it does not have an ON/OFF switch, AC input cables, or DC output cables. You should provide a means for turning the OEM300 on and off, connecting input AC power, and delivering DC output power to your drives.

During operation, a green LED on the front panel is illuminated to indicate the 75VDC section is functioning.

CHAPTER ③

OEM300 Specifications

WARNING
NO USER-SERVICEABLE PARTS INSIDE THE OEM300!
The OEM300 contains potentially lethal voltages. Do not attempt to repair it.
Return it to Compumotor for any repairs.

AC INPUT SPECIFICATIONS

INPUT VOLTAGE

Low Range: Jumper installed	90VAC to 132VAC
High Range: Jumper removed	180VAC to 265VAC
Forbidden Range:	132VAC to 180VAC

WARNING
High voltage is present on the jumper. Use insulated wire for safety.

CAUTION
Do not use AC input voltage in the range 132-180VAC.
Voltage in this range can cause excessive voltages to be generated within the OEM300, and may damage the unit.

INPUT FILTER

The Power Module has a line filter at the AC input that minimizes noise energy sent out to the power line.

INRUSH CURRENT

The Power Module has an initial power up current limiter.

Input Limit:	40A Maximum Inrush Current

DC OUTPUT SPECIFICATIONS

OUTPUT VOLTAGE

75VDC ± 5%	(Fixed—Not Adjustable)

OUTPUT CURRENT

2.7A at 75VDC	Continuous Current
4.0A at 75VDC	Peak Current

OUTPUT POWER

200W	Continuous
300W	Peak
	30 seconds maximum at peak
	10% duty cycle at maximum
	(Example: 30 seconds at 300W, followed by a minimum of 270 seconds at 200W or less.)

OUTPUT GROUNDS

Output grounds are internally connected to each other, to the AC input ground (labeled EARTH), and to the cover of the OEM300.

VOLTAGE REGULATION

± 5% maximum

EFFICIENCY

The Power Module has a minimum of 80% efficiency at full output load.

Over-Temperature Protection

The Power Module will shut down if its heatplate reaches a temperature of 60°C (140°F). This is a *LATCHED* condition. To resume normal operations, turn off AC power, cool the Power Module below 30°C (86°F), and then turn on AC power.

Power Dump

The OEM300 has a power dump circuit that can dissipate excess energy from load regeneration conditions.

THRESHOLD VOLTAGE: 85VDC ± 3VDC

ENERGY DISSIPATION: Consult Power Dump section in *Chapter ④ Protective Circuits*

AVERAGE POWER DISSIPATION RATE: 8 Watts

PEAK POWER DISSIPATION RATE: 722.5 Watts

EQUIVALENT ENERGY: Two 83-135 motors, each turning loads with 10:1 Rotor Inertia at 50 rps, simultaneously decelerate to a full stop in 0.3 sec.

Short Circuit Protection

The Power Module shuts down the 75VDC output if there is a short circuit in output cables or drives. This is a *LATCHED* condition. Cycle AC power to resume normal operations.

Short Circuit Current	Response Time
9 Amps	Immediate (output shuts down)
6 Amps	Responds in 3 seconds

Overvoltage Protection

The Power Module has an output overvoltage protection circuit. It shuts down the Power Module if the power dump stays on continuously for more than one-half second. This is a *LATCHED* condition. Correct the problem, then cycle AC power to resume normal operations.

OPERATING TEMPERATURES

Maximum Ambient: Still Air

35°C (95°F)	With a 200W Load
40°C (104°F)	With a 170W Load

Maximum Ambient: Moving Air

45°C (113°F)	With a 200W Load
50°C (122°F)	With a 170W Load

Maximum Heatplate Temperature

60°C (140°F)

Minimum Ambient Temperature

0°C (32°F)

CHAPTER ④

Protective Circuits in the OEM300

Extreme conditions can damage power supplies. The OEM300 Power Module contains several circuits that will protect it from threatening conditions, such as short circuits in drives, excessive heat buildup in equipment cabinets, or energy regenerated by high inertial loads.

The OEM300's protective circuits are built-in and work automatically. You do not need to do anything to turn them on; in fact, you *cannot* alter them in any way. Because they are automatic, they can cause unexpected results if you do not understand how they work.

For example, if there is a short circuit in a drive connected to the Power Module, the Power Module will shut down. If you are unaware of the short circuit protection feature, you might think the shutdown is caused by a defective Power Module and waste time trying to fix it. If you know about the protective circuitry, however, you can find the root cause of the problem—the short circuit in the drive—more quickly. You can proceed straight to locating and fixing the short circuit, and getting your system running again.

The following information about the protective circuits will help you understand how they work, when they take effect, and the results they produce. This will aid your troubleshooting efforts, and help you locate the cause of unexpected behavior.

SHORT CIRCUIT PROTECTION

The OEM300 continuously monitors output current at the 75VDC terminals. If it detects a rapid current rise to excessive levels, it interprets the current rise as a short circuit fault in the drive. It shuts off power to the 75VDC output terminals. Internally, the 75VDC power supply section of the Power Module continues to function, and the green LED remains illuminated.

If the OEM300 detects a short circuit current in excess of 9 amps, it will shut down the output immediately . It will monitor a 6 amp current and shut down the output if the current lasts longer than 3 seconds. This is summarized in the table below:

Current Level	Response Time of Protection	
9 amps	Respond:	Immediately
6 amps	Respond:	In 3 seconds
4—6 amps	No Response:	Beyond specified operating range
2.7—4 amps	No Response:	Intermittent operating range
0—2.7 amps	No Response:	Continuous range

When the 75VDC output is shut down, the shutdown is a *LATCHED* condition (the 75VDC output will remain off until power is cycled). To *CYCLE POWER*, turn off the AC power to the OEM300, wait approximately 30 seconds (the green LED will turn off), then turn on AC power.

The output is latched in the OFF condition for safety reasons. Short circuit protection guards people from injury and equipment from damage.

IMPORTANT TROUBLESHOOTING NOTE: You may be confused if your system unexpectedly stops, the voltage at the 75VDC terminals is Ø Volts, but the LED is illuminated. There is probably a short circuit fault in your equipment. Remember, the LED will remain illuminated, even when the 75VDC output is shut down due to a short circuit fault. Find and fix the problem in your equipment, then cycle power to the OEM300 and restart your system.

Other possible causes:

① Excessive load regeneration—see the Power Dump description below.

② Overvoltage—see the description below.

OVER-TEMPERATURE PROTECTION

The OEM300 has a circuit that protects it from damage due to over-temperature conditions. This circuit monitors the temperature of the Power Module's heatplate. A temperature rise above 60°C (140°F) will trigger a thermal switch; when this happens, the protection circuit shuts down the Power Module, and turns off the green LED. This is a latched condition. Before the Power Module can operate again, its heatplate must cool below approximately 30°C (86°F) and AC power must be cycled.

The Power Module will cool faster if you turn off AC power while it cools. If AC power is on, several bleeder resistors will continue to dissipate their heat into the heatplate and keep it warm, even though the Power Module is off. It will cool much faster with the power off. Therefore, design your system so that, if an over-temperature shutdown occurs, AC power is turned off while the Power Module cools down.

TRIP TEMPERATURE

65°C ± 5°C (149°F ± 9°F)

DESIGN TIP: Use 60°C (140°F) as the maximum heatplate temperature allowed for continuous operation of the Power Module. Because of the manufacturing tolerance on the thermal switch, different OEM300 units will shut down at different temperatures in the 60°C to 70°C range (140°F to 158°F). For predictability, use 60°C (140°F) as the shutdown temperature.

HYSTERESIS

The thermal switch used by the over-temperature protection circuit has built-in thermal hysteresis. The switch will open at 65°C ± 5° (149°F ± 9°F), and shut down power to the OEM300. It will not close until it has cooled to approximately 30°C (86°F). This means that the OEM300 will not operate again until it has had adequate time to cool.

TROUBLESHOOTING NOTE: If the OEM300 shuts down because of excessive heatplate temperature, the heatplate must cool below 30°C (86°F) before the unit can be restarted. Turn off AC power while the OEM300 cools.

POWER DUMP

During normal use, a motor consumes power from a power supply. During deceleration or a free-wheeling shutdown, however, the motor becomes a generator and produces energy. This energy *must* go somewhere! It travels through the cables and drive, and back to the power supply, where it enters the supply through the output terminals. This phenomenon is called *regeneration*.

The energy produced by regeneration is proportional to the kinetic energy of the moving parts of the motor and its load. For some configurations of motors and loads, the energy can be quite high, and has the potential to damage any connected drives and power supplies. The OEM300 has a circuit that protects drives connected to it from excessive load regeneration. The protective circuit is called a *power dump*.

The power dump works by sensing the voltage at the 75VDC output terminals. A voltage rise above a threshold value, approximately 85VDC, indicates the OEM300 is receiving too much regenerated energy. The power dump circuitry closes an internal switch and diverts the extra energy through a large power resistor. The energy is dissipated as heat in the resistor, and voltage at the output terminals falls.

When the voltage falls to approximately 82VDC, the power dump turns off. If energy is still being regenerated, voltage at the output terminals will start to rise. When the voltage reaches 85VDC, the power dump turns on, and the whole process begins again. To dissipate the entire amount of regenerated energy, the power dump will switch on and off, over and over again, until the voltage no longer rises above 85VDC.

The resistor in the power dump can absorb a maximum of 400 joules of energy within a short period of time. And, after the resistor converts the energy to heat, it needs time to transfer the heat to the ambient air before it can absorb more energy. Therefore, there is a repetition rate, or period, that determines how frequently energy can be dumped into the power resistor. The maximum *average* power dissipation rate during this period is 8 watts.

For example, suppose 400 joules is dissipated in the power dump in one second. How long must we wait before we can repeat the regeneration event? Average power dissipation must be 8 watts or less during the total regeneration event (dump on plus time waiting). We find the repetition rate by dividing 400 joules by 8 watts—this gives us 50 seconds. (Remember, 1 watt is equal to 1 joule per second. So, 400 joules/8 watts = 50 seconds.) We must wait 49 seconds before regenerating again (1 second *ON* plus 49 seconds *OFF* = 50 seconds).

Another factor to consider in power dump performance is the *peak* power dissipation rate—722.5 watts. If your system sends power to the power dump at a rate higher than 722.5 watts, the power dump cannot dissipate the power fast enough to lower the voltage at the output terminals. It will stay on continuously. After one-half second, the overvoltage circuit will shut down the output of the OEM300. (See the next section for an explanation of the overvoltage protection circuit.)

For example, suppose a moving system of motors contains 200 joules that must be dissipated in the power dump. How quickly can it decelerate without overwhelming the power dump? If energy is dissipated at the peak rate of 722.5 watts, we find that the deceleration time is 200 joules/722.5 watts, or 0.3 seconds. The repetition rate will be 200 joules/8 watts, or 25 seconds. Power dump information is summarized below.

POWER DUMP CHARACTERISTICS			
POWER DISSIPATION RATE:		Peak = 722.5 Watts	
		Average = 8 Watts	
PEAK ENERGY ABSORBED: (*x.xx* Joules within *y.yy* seconds)			
Amount (Joules)	***Absorbed in...(sec)***	***Time Off (sec)***	***Repetition Rate (sec)***
400 Joules	5.0 sec	45.000 sec	50.000 sec
400	2.5	47.500	50.000
400	1.0	49.000	50.000
400	0.554	49.446	50.000
361.25	0.5	44.656	45.156
144.5	0.2	17.863	18.063
72.25	0.1	8.931	9.031
36.125	0.05	4.466	4.516
THRESHOLD VOLTAGE:		On = 85 VDC	
		Off = 82 VDC	

The numbers in the table show the energy that can safely be absorbed in the OEM300's power dump. When a motor regenerates energy, much of the energy is dissipated as heat in the motor and drive. Therefore, total energy contained in the moving parts of the motor and load can be higher than the numbers shown in the table. After motor and drive losses, the energy left over will be sent into the power dump—this is the energy that is listed in the table above.

(For a discussion of motor and drive losses, see the section *Where Power is Used in a Motion Control System*, in *Chapter ⑥ Calculating How Many Drives & Motors the OEM300 Can Operate.*)

The power dump in the OEM300 is designed to dissipate as much regenerated energy as would occur in a worst-case situation where two 83-135 motors each operate loads with 10:1 rotor inertia. Under these conditions, when regeneration occurs, the power dump will turn on and dissipate the excess energy.

EXAMPLE: A single OEM83-135-MO motor turns a load that has ten times the motor's rotor inertia. Speed of the system is 50 rps. The kinetic energy in the moving parts of the system can be calculated as follows:

$$\text{Kinetic Energy} = (1/2)J\omega^2$$

$$= (1/2)\{(1 + 10)(1.87\ \text{kg}\cdot\text{cm}^2)(10^{-4})\}(2\pi\cdot 50)^2$$

$$= 101.5\ \text{joules}$$

Where:

J = inertia, in $kg\cdot cm^2$

$1.87\ kg\cdot cm^2$ is the motor's rotor inertia. It can be found in the OEM650 User Guide.

10^{-4} is a conversion factor, to convert from $kg\cdot cm^2$ to $kg\cdot m^2$, units which are compatible with joules.

ω = velocity, in radians/sec ($\omega = 2\pi\cdot rps$)

Kinetic energy in this system is 101.5 joules. Kinetic energy in a similar system with two motors would be approximately 200 joules, which can be absorbed in 0.3 sec.
(200J/722.5W ≈ 0.3 sec. *See previous page*.)

Compumotor's OEM650 Microstepping Drive also has a power dump circuit. To use it, you must connect an external power resistor to the drive. However, the threshold voltage for the power dump in the OEM300 is much lower than the threshold in the OEM650. The OEM300's power dump will always turn on first. Therefore, there is usually no need to use the power dump in the drive, as long as your system's stored energy can be safely dissipated in the OEM300's power dump.

However, if you design a system that has enough stored energy to overwhelm the power dump in the OEM300, you may want to use the drive's power dump to protect the drive. Regenerating this much energy should be avoided, however. It is beyond the specified energy dissipation limits, and can damage the OEM300.

OVERVOLTAGE PROTECTION

An overvoltage protection circuit guards your drives and equipment from excessively high voltages produced by a damaged OEM300. It also protects your system from excessive regeneration.

If a damaged element within the Power Module causes it to produce an output voltage in excess of 85VDC, the power dump threshold voltage is exceeded, and the power dump turns on. The overvoltage circuit monitors the power dump. If the power dump stays on for more than one-half second, the overvoltage circuit will shut down the output terminals.

The overvoltage circuit also monitors the power dump when load regeneration occurs. In this case, if the power dump stays on longer than one-half second, excessive regeneration is occurring. To protect the OEM300, the overvoltage circuit will shut down the output terminals.

TROUBLESHOOTING NOTE: There are no separate indicators to distinguish between an excessive regeneration fault, a damaged Power Module, or a short circuit fault. Any of these conditions will shut down your system; and, the green LED will remain illuminated.

When you attempt to restart your equipment, you should be able to isolate the cause. If the problem is due to a short circuit fault in connected equipment, the Power Module will shut down instantly when it is turned on. If the problem is due to a damaged Power Module, it will run for 1/2 second and shut down, even with no load regeneration. If the problem is due to excessive regeneration, the Power Module will power your system until load regeneration occurs; then it will shut down. These conditions are summarized below.

Power Module Shuts Down....	Probable Cause
....instantly when turned on	Short circuit fault in drive
....after running 1/2 second	Damaged OEM300
....when regeneration occurs	Excessive regeneration

CHAPTER ⑤

Heat & Thermal Management Issues

HEAT MUST BE REMOVED FROM THE OEM300

The OEM300 will operate over a broad range of ambient temperatures. As it delivers power to connected equipment, it also produces heat internally. During load conditions where the OEM300 is supplying its maximum output power, internally generated heat can be as much as 35 watts. In the small space enclosed by the Power Module, 35 watts is a significant amount of heat! To keep the Power Module within its operating temperature limits, you must use two methods to remove this heat: heatplate cooling and convection cooling.

HEATPLATE COOLING

The OEM300 uses a HEATPLATE technique to provide a heat dissipation path. The heatplate is the entire back surface of the OEM300; it is the unpainted metal plate you see when you look at the back of the Power Module.

Internally, many of the components that produce the most heat are thermally bonded to the heatplate. The heat they produce can be removed through the heatplate pathway. This means that if you can cool the heatplate, these components will stay cool, too.

To cool the heatplate, you must mount it to a thermal mass, such as a heatsink or a heat sinking surface. Make sure that the surface of the heatsink is clean and flat (not warped). There should be good contact between the heatplate and heatsink, with no voids or empty spaces between them. Use silicone thermal joint compound or a thermal gasket to ensure good heat transfer across the thermal interface.

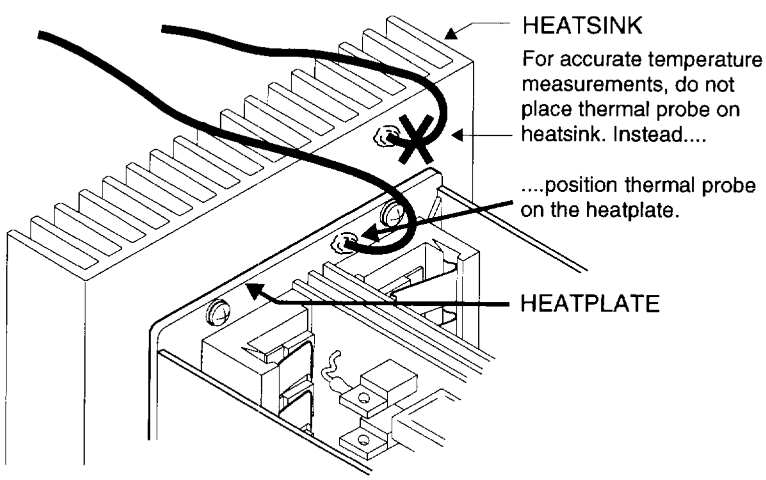
CAUTION

The heatplate must be mounted to a heatsink or proper heat sinking surface. Ensure good contact between the heatplate and the mounting surface. Use silicone thermal joint compound or a thermal gasket to ensure heat transfer from the heatplate to the mounting surface.

Heatplate Temperature Limit

Maximum Heatplate Temperature: 60°C (140°F)

To check the heatplate temperature in your system, take measurements after the system has run long enough to reach steady temperatures. As the next drawing shows, place your thermal probe directly on the heatplate, not the heatsink to which it is attached.



Measuring Heatplate Temperature

Do not assume that the heatplate and heatsink are at the same temperature. If the thermal interface between them is not good, heat may not transfer from the heatplate to the heatsink. If heat is not leaving the heatplate, its temperature can become very high, while just a few inches away the heatsink is much cooler.

In this situation, if you place a thermal probe on the heatsink, you might read an acceptable temperature. This could lead you to think your system is within limits, but it is not. Therefore, make sure you place the probe on the heatplate. This will give you the most accurate temperature information about your system.

HEATSINK CALCULATIONS

To cool the heatplate of the OEM300, mount the Power Module to a heatsink. Or, you may prefer to mount the Power Module directly to a heat sinking surface, such as the metal wall of an equipment cabinet.

Your heatsink or heat sinking surface should satisfy this equation:

$$R_{th_{SA}} \leq \frac{60^\circ C - T_A}{20W}$$

where:

T_A is the ambient temperature

$R_{th_{SA}}$ is your heatsink's thermal resistance to ambient conditions, in °C/W

20W in this equation is the amount of heat the Power Module will dissipate through its heatplate, when it operates at its maximum continuous output power. This is a worst-case condition. If your application uses less power, the Power Module will dissipate less heat. In this case, you can use a number smaller than 20W in the equation above.

HEATSINK PROBLEMS

Several problems with heatsinks can cause poor heat transfer.

Warped Heatsink

Many heatsinks are made from aluminum extrusions. During the extrusion process, the aluminum is hot. When it cools, it sometimes warps. A warped heatsink will not make good contact with the Power Module. Heat transfer may be inadequate. Ensure that your heatsink is flat.

Voids in Thermal Interface

The heatsink should be in full contact with the Power Module's heatplate. Use silicone thermal joint compound or a thermal gasket to ensure full contact. Make sure that there are no air pockets, empty spaces, or voids in the thermal grease. Voids can severely reduce the amount of surface area available for heat transfer.

Paint

Paint on a heat sinking surface can cause poor thermal transfer. If you attach the Power Module to the wall of an equipment cabinet, make sure that any paint has been removed from the area where the Power Module attaches to the wall.

Thermal Contact Only Around Fasteners

Flexible or non-rigid heat sinking surfaces, such as equipment cabinet walls, are prone to a particular problem. The pressure of the bolts or screws that attach the Power Module to the wall can cause the wall to warp slightly. There may be thermal contact in the circular area immediately surrounding the bolt, but nowhere else. If you use the wall of an equipment cabinet for a heat sinking surface, make sure there is good thermal contact everywhere between the heatplate and your surface, not just around the bolts.

CONVECTION COOLING

Several heat producing components inside the OEM300 are not attached to the heatplate. They must dissipate their heat to the surrounding air. The open top and bottom of the OEM300 allow air to circulate and carry heat away from these components.

If the openings are blocked, air cannot circulate through the Power Module. Heated air is not replaced by cooler air; instead, the air is motionless, and heat builds up around the hot components.

Mount the OEM300 properly to ensure adequate air circulation, and to keep temperatures within acceptable limits. Refer to *Chapter ② Installation & Operation* for information on recommended mounting patterns, spacing between the Power Module and adjacent equipment, and other issues. Make sure the open top and bottom of the OEM300 are not obstructed.

CAUTION

Do not obstruct the openings in the top and bottom of the OEM300. Ensure adequate space for air circulation between the OEM300 and other equipment.

Ambient Air Temperature Limits

The ambient air temperature must remain below these limits to adequately cool internal components:

Still Air:	35°C	(95°F)	with a 200W load
	40°C	(104°F)	with a 170W load
Moving Air:	45°C	(113°F)	with a 200W load
	50°C	(122°F)	with a 170W load

To measure ambient air temperature, position your thermal probe below the OEM300, approximately one inch away from it. Make measurements after your system has run long enough to reach a stable operating temperature.

Providing Additional Ventilation

If you have heat-producing equipment near the OEM300, you may need to provide additional ventilation to keep the ambient air temperature within limits. Additional ventilation can be provided by vent holes in the equipment cabinet, a fan to move air in the cabinet, a combination of fans and ventilation ducts, or some other method.

Simply by moving air past the OEM300, you can raise the maximum ambient temperature limit by 10°C (18°F), from 35°C to 45°C for a 200 watt load, or from 40°C to 50°C for a 170 watt load. (95°F to 113°F at 200W, or 104°F to 122°F at 170W.)

You may wish to include a fan in your system, to take advantage of this extended temperature range. The fan should be rated at approximately 20 cfm (cubic feet/minute) or more. It should be 5 to 10 inches away from the OEM300, and positioned so that it blows air from the bottom up through the OEM300.

EXAMPLE: Suppose you want to power a 170 watt system with an OEM300, and you need to place your equipment in a sealed equipment cabinet. You mount the Power Module in a cabinet that has no fan or ventilation holes. After you power up your system and let it run long enough to reach stable temperatures, you check the temperature in the still air near the OEM300. You find it is 45°C (113°F), which is higher than the 40°C (104°F) recommended limit for still air.

So, you install a fan in the cabinet, and verify that it circulates air through the Power Module. Once again you measure the air temperature near the OEM300, and find that it is still 45°C (113°F). But, because the air is moving, the ambient air temperature is now within recommended limits. You can still use a sealed cabinet without ventilation holes!

OVER-TEMPERATURE PROTECTION

The OEM300 has a circuit that protects the Power Module from damage due to over-temperature conditions. This circuit shuts down the Power Module if the heatplate temperature rises above 60°C (140°F).

For more information about the over-temperature circuit, refer to *Chapter ④ Protective Circuits in the OEM300.*

CHAPTER ⑥

Calculating How Many Drives & Motors The OEM300 Can Operate

You can use the OEM300 Power Module to power Compumotor's OEM Series servo motor drives (OEM670T, OEM670X, OEM670SD, etc.) and OEM Series step motor drives (OEM650, OEM650X, OEM350, OEM350X, etc.). This chapter will explain how to determine the number of *step motor* drives you can connect to the OEM300.

For a similar discussion about *servo motor* drives, see *Chapter ⑥ Power Supply Selection* in the *OEM670T User Guide* (part number 88-013599-01). The section of that chapter called *Peak Power Curves for OEM Series Motors* may be particularly useful for using the OEM300 Power Module with OEM670 drives.

GENERAL GUIDELINES – STEP MOTOR SYSTEMS

The OEM300 Power Module can deliver power to many different combinations of drives, indexers, and the motors they run. How many drives can one Power Module operate? The answer depends on several factors

- ❑ The size of each motor in the system.
- ❑ The work each motor must do—what its move profile looks like.
- ❑ The time when each move profile occurs.

There are three methods you can use to determine how many drives to connect to one OEM300.

- ❑ WORST-CASE METHOD: If you want all your motors to be able to simultaneously produce full power, connect the number of motors specified in the Worst-Case Table below.
- ❑ CALCULATION METHOD: Based on figures for peak and average power requirements, calculate the number of drives to connect.
- ❑ MEASUREMENT METHOD: Make a prototype of your system, and directly measure the power requirements.

For the simplest and most conservative way to proceed, use the worst-case numbers. However, in almost every application, you can operate more drives than these numbers suggest. Use the information in the other sections below to see if you can save money by operating additional drives with each Power Module.

The following sections use Compumotor OEM Series motors as examples. If you are using other motors, obtain information about the relevant motor specifications (copper losses, core losses, peak shaft power, etc.), and follow the same type of procedure as explained below.

NOTE: The techniques presented in this chapter apply to step motor systems. For information on how to determine the number of servo drives you can connect to an OEM300, consult your servo drive user's manual.

WORST-CASE METHOD

A system of drives and motors places the greatest demand on a power supply when each motor produces the maximum shaft power it can deliver, and all motors turn at the same time. For the power supply, this is the "worst-case" situation. There are no other times when the power supply must provide this much power.

The table below lists the maximum number of drives that can be connected to the OEM300 Power Module in the worst-case situation—each drive operating a motor at maximum shaft power; all motors turning simultaneously.

WORST-CASE NUMBER OF DRIVES

MOTOR SIZE			NUMBER OF DRIVES
SIZE 23	OEM57-40-MO	1/2 Stack	5
	OEM57-51-MO	1 Stack	4
	OEM57-83-MO	2 Stack	3
SIZE 34	OEM83-62-MO	1 Stack	3
	OEM83-93-MO	2 Stack	2
	OEM83-135-MO	3 Stack	2

CALCULATION METHOD

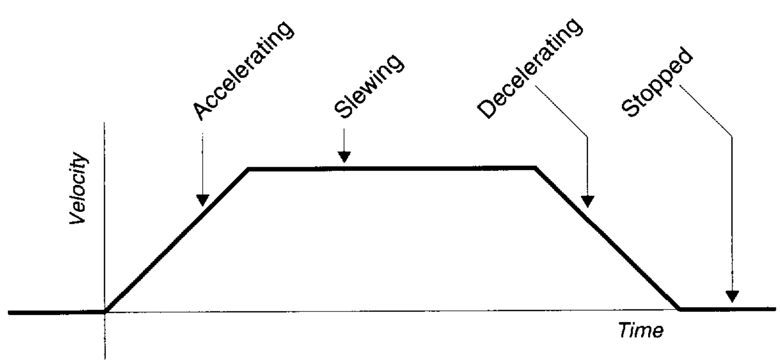
In most applications, the worst-case situation described above never occurs. Conditions where all motors in a system produce maximum shaft power, all at the same time, are extremely rare. Instead, it is more common for the motors to use power at different levels: one may be accelerating, another stopped, and others moving at constant velocity or decelerating.

If you consider the move profiles of all motors in your system, and evaluate the amount of peak and average power the motors require, you will probably find that you can operate more drives and motors from one OEM300 than the worst-case numbers suggest. Details on how to perform these calculations are given below.

WHERE POWER IS USED IN A MOTION CONTROL SYSTEM

A motor can be in one of four states: stopped, accelerating, slewing, or decelerating. The power supply must satisfy the motor's power requirements, which are very different during each of these states.

A sketch of a typical move profile is shown below.



Typical Move Profile

In the following sections, we will see how the drive and motor use the power they get from the power supply. Then, we will examine the amount of power required by the drive and motor during each part of a move.

Copper Losses and Drive Losses

Two types of power losses always exist, whether a motor is in motion or stopped—copper losses and drive losses. Their values remain approximately constant, regardless of the speed at which the motor turns. If the motor is not moving, these are the only losses present.

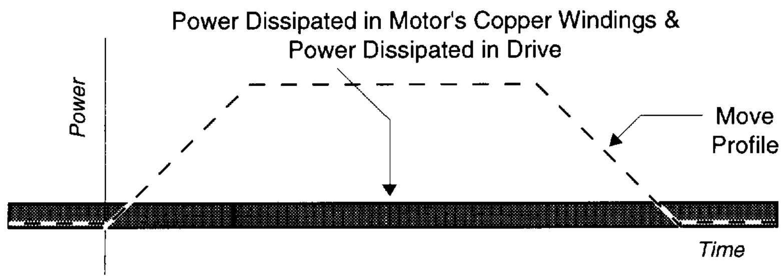
Copper losses are caused by resistance to current flow in the copper windings of the motor. A step motor that is stopped has a current flowing in it to maintain holding torque; approximately the same amount of current flows when the motor is in motion.

The copper losses are calculated as I^2R—the square of the current in the windings, multiplied by the resistance of the windings. Since the current stays the same, whether the motor is moving or stopped, the copper losses are constant. They are usually small, approximately 10 to 15 Watts, because the resistance of the windings is low.

Drive losses occur during normal operation of the drive. The drive receives power from the power supply, and sends most of that power to the motor. Some of the power, however, is lost as heat in the drive when resistors and other components heat up.

Power dissipated as heat in the drive constitutes the drive losses. These are usually small, approximately equal to the copper losses. They are proportional to the current the drive delivers. Since this current is fairly constant, drive losses are also constant—they do not change when motor speed changes.

Copper losses and drive losses are shown in the drawing below. Notice that these losses are constant, whether the motor is moving or stopped.



Copper Losses and Drives Losses

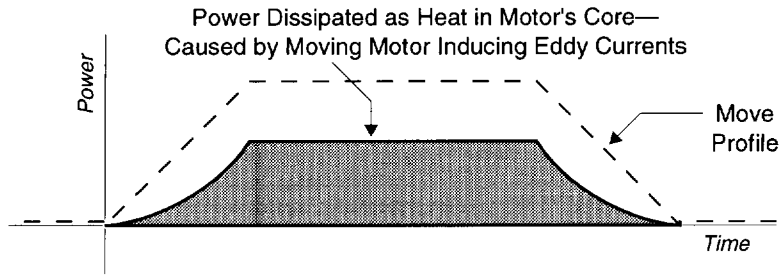
The following table lists the values for drive losses and copper losses.

COPPER LOSSES and DRIVE LOSSES				
OEM SERIES MOTORS		Copper Loss(W)	Drive Loss(W)	TOTAL (COPPER + DRIVE)
SIZE 23	OEM57-40-MO	9	9	18
	OEM57-51-MO	11	11	22
	OEM57-83-MO	9	13	22
SIZE 34	OEM83-62-MO	13	15	28
	OEM83-93-MO	14	20	34
	OEM83-135-MO	15	27	42

Core Losses Caused by Motion

When the motor is in motion, some power is lost because of the movement of the motor. The moving magnetic fields in the motor will induce eddy currents in the motor's iron core; these eddy currents cause heating in the core. The power supply delivers the power that ends up as heat in the motor's core.

The power losses caused by eddy current induction are called *core losses* (they are also known as *iron losses*). Core losses are shown in the drawing below.

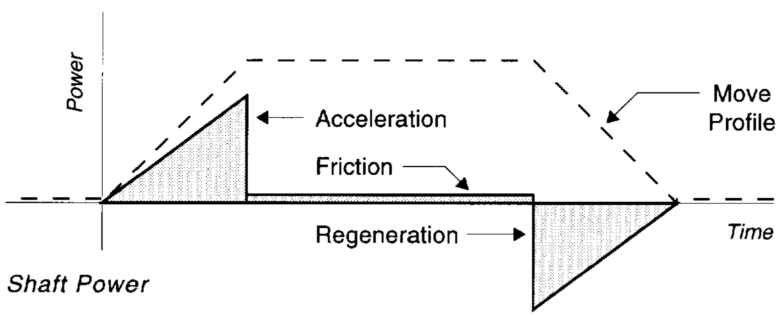


Core Losses

Core losses are proportional to v^2, the square of the motor's velocity. Notice that they can change rapidly during acceleration or deceleration, and are constant when the motor is slewing

Shaft Power During Acceleration, Slew, and Deceleration

To accelerate a load, the motor's shaft produces torque. The power required to accelerate the load is called shaft power (since torque multiplied by velocity equals power). During slew, a system with little friction will not require shaft power. If there is friction in the system, the motor must produce shaft power to overcome the friction. Shaft power is shown in the drawing below.



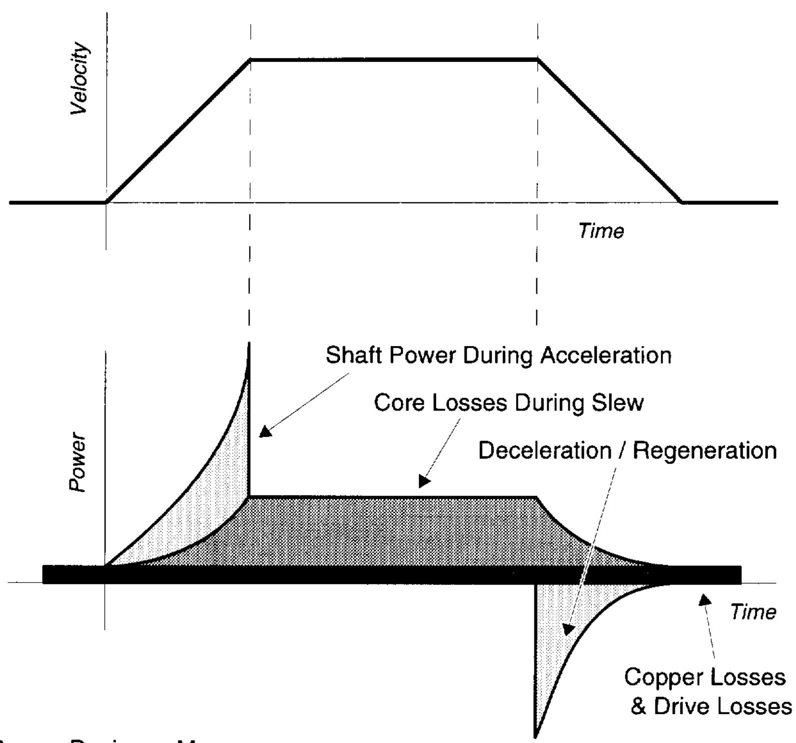
Shaft Power

Notice that shaft power rises at a constant rate during acceleration, and, if friction is negligible, will be close to zero during slew.

During deceleration, shaft power is negative. This means that the drive is not delivering power to the motor. In fact, the opposite happens: the motor delivers power to the drive and power supply. This is called regeneration.

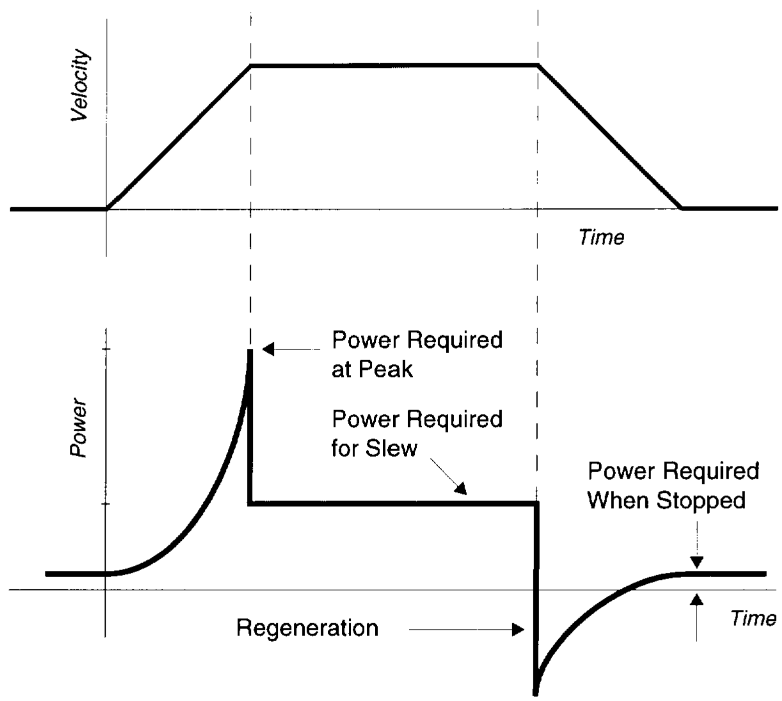
POWER REQUIREMENTS DURING A TYPICAL MOVE

If we make a graph of all the places power is used, as we have done in the next drawing, we can see where power goes during a move.



Power During a Move

And, if we add up the values for the various losses, shaft power, regeneration, etc., we get a graph of the power that the power supply must deliver. This is shown in the next drawing.



Power Required During a Move

Using the drawings above, we can discuss the power required during each part of a move profile.

Stopped

When the motor is not moving, power is dissipated in copper losses and drive losses. The power supply must deliver power to replace these losses.

Accelerating

During acceleration, the motor develops shaft power. Because the motor is moving, core losses start to dissipate power, and play a larger role as speed increases. Copper losses and drive losses are still present. The power supply must deliver enough power for all these purposes.

In most applications, the period of time peak power is actually required is very brief—often just a few thousandths of a second. There is usually enough stored energy in the power supply's capacitors to meet this brief power demand.

Slewing

When the motor is slewing, the load moves at a constant speed. Demand placed on the power supply drops sharply, because shaft power is no longer required to accelerate the load. During slew, the power supply must replace losses caused by core losses; it must supply shaft power to overcome friction in the load; and, it must replace power dissipated in copper losses and in the drive itself.

Decelerating

During deceleration, the motor becomes a generator, and produces regenerated energy. The motor sends regenerated energy onto the power bus; this energy will be used to replace core losses, copper losses, and drive losses. If there is still excess energy, the power supply must be able to absorb this energy.

CALCULATING THE POWER REQUIRED

To calculate the power your system will require from the power supply, you need to know three numbers: power required at peak, power required for slew, and power required when the motor is stopped. The table below lists the power required by each OEM Series step motor.

POWER REQUIREMENTS — OEM SERIES MOTORS

MOTOR SIZE		STOP (W)	SLEW (W)	PEAK (W)
SIZE 23	OEM57-40-MO	18	46	74
	OEM57-51-MO	22	54	101
	OEM57-83-MO	22	48	110
SIZE 34	OEM83-62-MO	28	67	115
	OEM83-93-MO	34	75	160
	OEM83-135-MO	42	89	189

These figures are for motors that are operating at maximum power. If your motors operate at less than maximum power, the figures for peak and slew power will be lower.

To determine the power that the OEM300 must deliver to your system at any given time, first determine where each motor is in its move profile—stopped, accelerating, slewing, or decelerating. Use the numbers from the table above to approximate the number of Watts each motor requires at that time. Add up the Watts required by each motor to obtain the total power demand.

The OEM300 can provide 200W on a continuous basis, and 300W peak for up to 30 seconds (with a 10% duty cycle). Identify the periods when your system requires the most power, and compare the power required with the amount of power the OEM300 can deliver.

Remember, there is a reservoir of additional power stored in the capacitors of the OEM300. If the peak power demand during acceleration of some motors briefly exceeds 300W, the OEM300 may still be able to deliver enough power, provided that the period of peak demand is short enough.

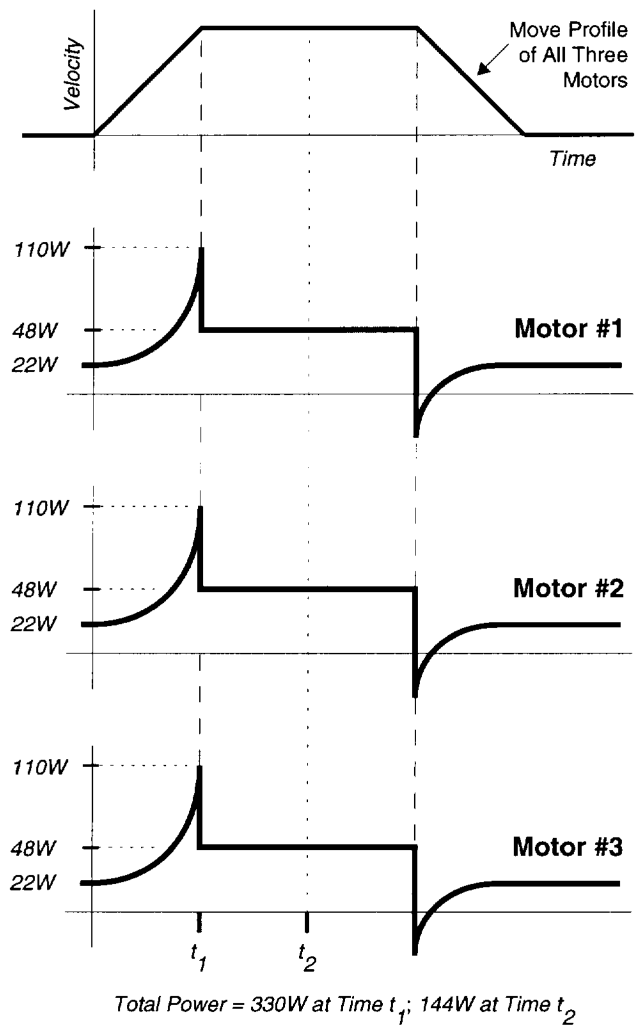
A Design Example

To illustrate the calculation method, we will determine how many OEM650 drives can be connected to one OEM300 Power Module, when each drive runs an OEM57-83 motor (a 23 frame size 2-stack step motor).

Because the number of drives that can be connected depends on the motors' move profiles, we will look at two situations. The first example has move profiles that occur simultaneously. The second example has move profiles that occur at different times.

Simultaneous Moves

The drawing below shows the move profile and power requirements in a system where three motors simultaneously accelerate until they reach maximum power, then move at constant velocity. We assume there is no friction in the system.



Simultaneous Move Profiles

At time t_1, each motor requires peak power. From the table listing power requirements for OEM Series motors, we find a value of 110W at peak for the OEM57-83 motor. Next, we add together the power required by each motor:

Motor #1	110W
Motor #2	110W
Motor #3	110W
TOTAL	330W

We find the total power required at time t_1 is 330W.

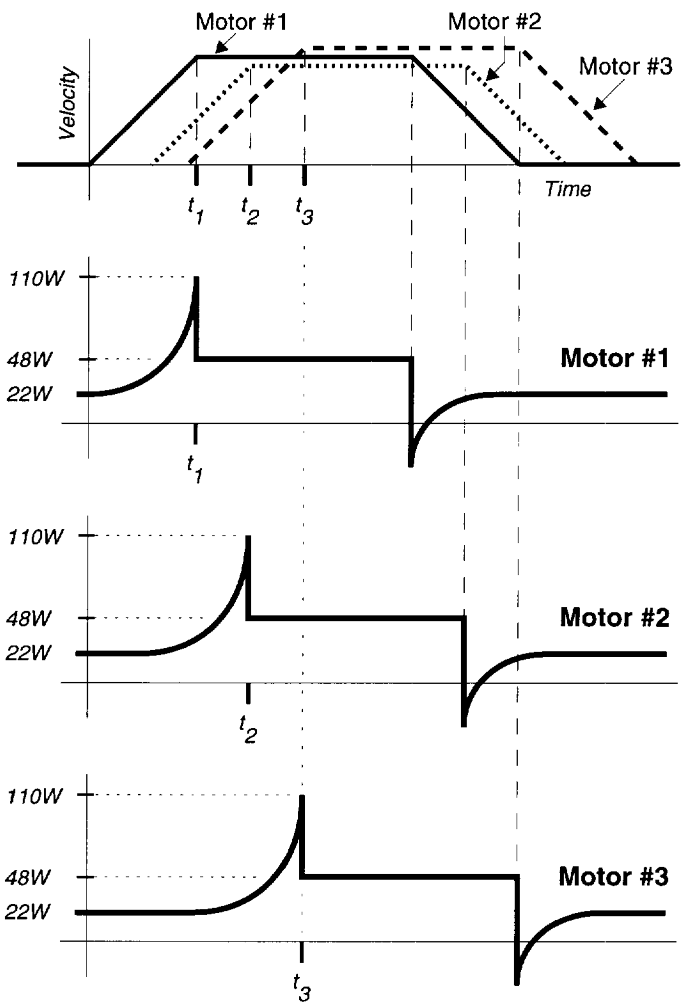
The OEM300 is specified as a 300W power supply. Can it provide 330W? Yes, because the duration of time that 330W is required is very brief; the OEM300 will use extra power stored in its capacitors to meet this demand.

Notice that every motor's peak power requirements occur at the same time. Because of this, we can only run three motors of this size. This is the same number that is listed in the worst-case table for OEM57-83 motors. The method discussed in this section was used to find the numbers in the worst-case table.

At time t_2, each motor is slewing and requires only 48W. The total power required to operate the system at this time is 144W. This means that most of the time this system operates, less than half of the capability of the Power Module is being used. The next section shows how to use the full capabilities of the Power Module, and operate additional drives.

Independent Moves

In this example, we consider the same three motors as in the previous example. This time, however, the move profiles are staggered, so that the peak power requirements of each motor occur at different times. Move profiles and power requirements for each motor are shown in the next drawing. (We assume there is no friction during slew.)



Total Power = 206W at Time t_3

Independent Move Profiles

In this system, when Motor #1 reaches its peak power at time t_1, Motor #2 is beginning to accelerate, and Motor #3 is stopped. At time t_3, Motor #3 accelerates to its peak power, and Motors #1 and #2 are slewing.

The peak power required by this system occurs at time t_3. Motors #1 and #2 each require 48W while slewing . Motor #3 requires 110W during its moment of peak power. (These numbers can be found in the Power Requirements table.)

We add each motor's power requirements:

Motor #1	48W
Motor #2	48W
Motor #3	110W
TOTAL	206W

The total power the three motors and drives require at time t_3 is 206W.

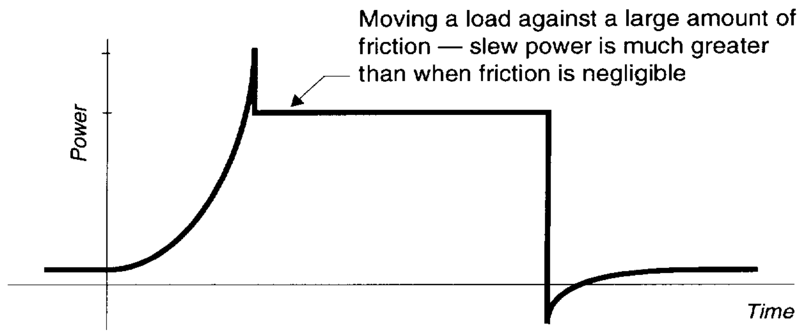
By staggering the move profiles, we have substantially reduced the peak power requirements of the total system. A fourth motor and drive could be added. The OEM300 would easily have the capability to provide the necessary power, no matter when the fourth motor's peak power demand occurred.

Even more drives and motors can be added. If the moves are organized so that some motors are stopped while others are running, the peak demand will be reduced. (Remember that a stopped motor still requires power—in this example, 22W). The peak demand will also be reduced if some motors operate at a level that requires less than full peak or full slew power.

Unusual Power Requirements

So far, the explanation of the calculation method has assumed that the power required during slew is substantially less than that required at peak acceleration. This is not always the case.

For example, the following drawing shows a graph of the power required by a motor while it moves a load against a large amount of friction.



Unusual Power Requirements

The demand for power rises as the load accelerates, and stays near the peak level while the load moves at constant velocity.

A motor lifting a load against gravity would have a similar graph for its power requirements.

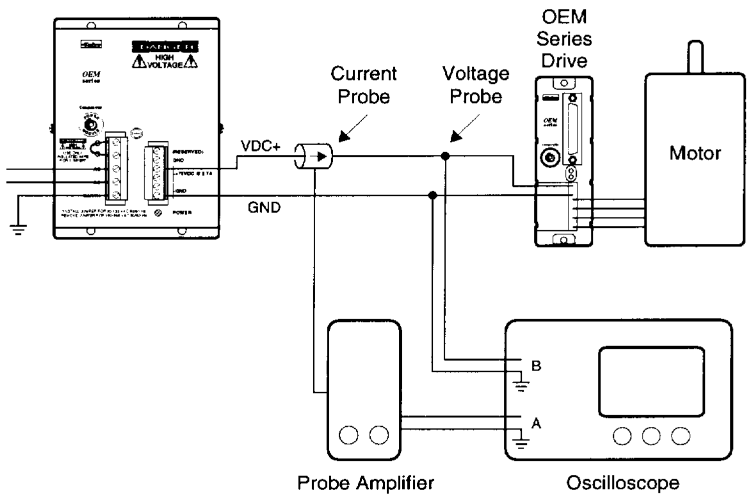
If your system has unusual power requirements, you must make appropriate adjustments to the figures given earlier for power required by OEM Series motors. Or, use the measurement method discussed in the next section, and determine the actual current requirements.

MEASUREMENT METHOD

The measurement method empirically measures actual current flowing from a power supply to each drive. To use the measurement method, you must first make a working prototype of your system, and measure the current required by each drive as the motors operate. You can then compare the total current required with that available from the OEM300.

For your prototype system, use a large temporary power supply, capable of providing enough current for all drives in your system at 75VDC. Once you determine the current requirements, you will replace the temporary power supply with one or more OEM300 Power Modules.

Use a DC current probe to measure the current going from the power supply to each drive. (Currents going from the drive to the motor are not relevant in this procedure; you do not need to measure them.)



Setup for Current Measurement

You need to find two values: the total peak current demand; and the duration, or duty cycle, of that total peak demand. The total current demand will probably be changing continuously.

One way to locate the peak demand periods and find their duty cycles is to connect the current probes to a storage oscilloscope. For any given time, you can then add up the demand from each drive to obtain the total demand. You can also measure the duration of the peak demand, find how frequently it occurs, and calculate its duty cycle.

The OEM300 is rated to deliver current at these levels:

	RATED CURRENT
2.7A	Continuous
4.0A	Peak (30 sec; 10% duty)

Current levels that activate the OEM300's short circuit protection are shown in the next table.

SHORT CIRCUIT PROTECTION	
Current Level:	Shutdown Within....
6A	3 seconds
9A	Immediate

With the results of your current probe measurements, and the current levels listed above, determine how many drives you can connect to each OEM300. Try to keep the current produced by the OEM300 within the rated levels.

What happens when your system operates on the borderline, and occasionally requires more than 4 Amps of current? The answer depends on the duration and level of the excess current demand. If asked to deliver excess current, the OEM300 will do so for brief periods. Voltage will stay very near the rated voltage of 75VDC.

However, there are two possible consequences if the OEM300 operates outside its specified range. The first is related to over-temperature protection. If the OEM300 continually provides current in excess of 4.0 Amps, it may become excessively hot. The OEM300 will not be damaged, but when its heatplate temperature exceeds 60°C, the over-temperature protection circuit will shut down the output of the OEM300.

The second potential problem is related to the short circuit protection feature. The OEM300 will produce currents above 4.0 Amps, to satisfy brief demands; but, if it produces 6.0 Amps, the short circuit protection feature will shut down the output within seconds. If the current reaches 9.0 Amps, however briefly, the OEM300 will shut down immediately.

Operating the OEM300 beyond its specified range can cause unpredictable results. Therefore, to achieve optimum performance from the Power Module, connect the appropriate number of drives.

CHAPTER 7

Troubleshooting

WARNING
NO USER SERVICEABLE PARTS INSIDE THE OEM300!
The OEM300 contains potentially lethal voltages. Do not attempt to repair it.
Return it to Compumotor for any repairs.

POSSIBLE PROBLEMS

The first section below gives troubleshooting information for an OEM300 that does not have drives connected to it. Use the information in the second section to help you diagnose problems in a system with motors, drives and an OEM300.

NO DRIVE IS CONNECTED; OEM300 WILL NOT TURN ON

With AC power connected to the OEM300, the LED and 75VDC output should be as follows:

NORMAL OPERATION WITH AC POWER CONNECTED	
LED:	Should be Illuminated
75VDC OUTPUT:	Should Measure 75VDC ± 5%

If the above conditions are not true, there are three possible problems:

PROBLEM	SOLUTION
No AC power	Check AC at OEM300 AC Input
Thermal Shutdown	Cool OEM300 below 30°C (86°F); Cycle AC Power
Defective OEM300	Return OEM300 to Compumotor

DRIVE IS CONNECTED; OEM300 WILL NOT POWER DRIVE

Check to see if the LED is illuminated. If it is not, use the information in the first table below. If it is illuminated, use the information in the second table.

LED is OFF — OEM300 Does Not Power Drive

PROBLEM	SYMPTOM	SOLUTION
No AC Power	System will not turn on.	Use an AC voltmeter to verify presence of AC power at AC input of OEM300.
Wrong Jumper Configuration	System will not turn on, or will not stay on.	120VAC: Install jumper 240VAC: Remove jumper
Thermal Shutdown due to Over-Temperature	System ran properly, but shut down unexpectedly when heatplate exceeded 60°C (140°F). LED is off. OEM300 will not restart.	Cool OEM300 below 30°C (86°F). Cycle AC power. Restart OEM300.
Damaged OEM300	OEM300 will not turn on, even though AC power is present at input, and heatplate temp is below 30°C (86°F).	Return OEM300 to Compumotor.

LED is ON — OEM300 Does Not Power Drive

PROBLEM	SYMPTOM	SOLUTION
Short Circuit in Cables or Drive	When system is turned on, OEM300 shuts down immediately. LED stays on.	Solve short circuit problem in connected equipment. Cycle AC power to restart system.
Overvoltage or Damaged OEM300	When turned on with motor not moving, system runs for approx. 1/2 second, then OEM300 shuts down. LED stays on.	Return OEM300 to Compumotor.
Excessive Regeneration	When turned on, system runs until regeneration occurs. OEM300 shuts down during regeneration. LED stays on.	Adjust move profile or load characteristics to keep regeneration within specifications. Cycle AC power and restart system.
Drive is not connected	OEM300 is on. 75VDC output measures 75VDC. LED is on. But drive is off.	Check cable connections. Use a voltmeter to verify 75VDC is present at drive input.
Wrong Jumper Configuration	Motor operates poorly, or does not run at all.	120VAC: Install jumper 240VAC: Remove jumper

RETURNING THE OEM300 TO COMPUMOTOR

If your OEM300 has failed, you must return it for replacement or repair. If you return your OEM300 for repairs or upgrades, use the following steps:

1. Get the serial number and the model number of the defective unit(s), and a purchase order number to cover repair costs in the event Parker Compumotor determines the unit is out of warranty.

2. Before you ship the unit to Parker Compumotor, have someone from your organization with a technical understanding of the OEM300 and its application include answers to the following questions:

- What is the extent of the failure/reason for return?
- How long did it operate?
- How many units are still working?
- How many units failed?
- What was happening when the unit failed (i.e., installing the unit, cycling power, starting other equipment, etc.)?
- How was the product configured (in detail)?
- What, if any, cables were connected, and how?
- With what equipment is the unit connected?
- What was the application?
- What was the system sizing (speed, acceleration, duty cycle, inertia, torque, friction, etc.)?
- What was the system environment (temperature, enclosure, spacing, unit orientation, contaminants, etc.)?
- What upgrades are required (hardware, user guide)?

3 . Call Parker Compumotor's Applications Engineering Department at 800-358-9070 for a Return Material Authorization (RMA) number. Returned products cannot be accepted without an RMA number.

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

INDEX

G

H

I

J

L

M

N

O

P

OEM300 POWER MODULE

The OEM300 is *NOT* a general purpose power supply. Use it only with Compumotor OEM Series Microstepping or Servo Drives.

> ***WARNING***
> **NO USER SERVICEABLE PARTS INSIDE**
> The OEM300 contains potentially lethal voltages! Do not attempt to repair it. Return the OEM300 to Compumotor for repairs.

HEATSINK

Attach Power Module's heatplate to a heatsink or heat sinking surface

HEATPLATE COOLING

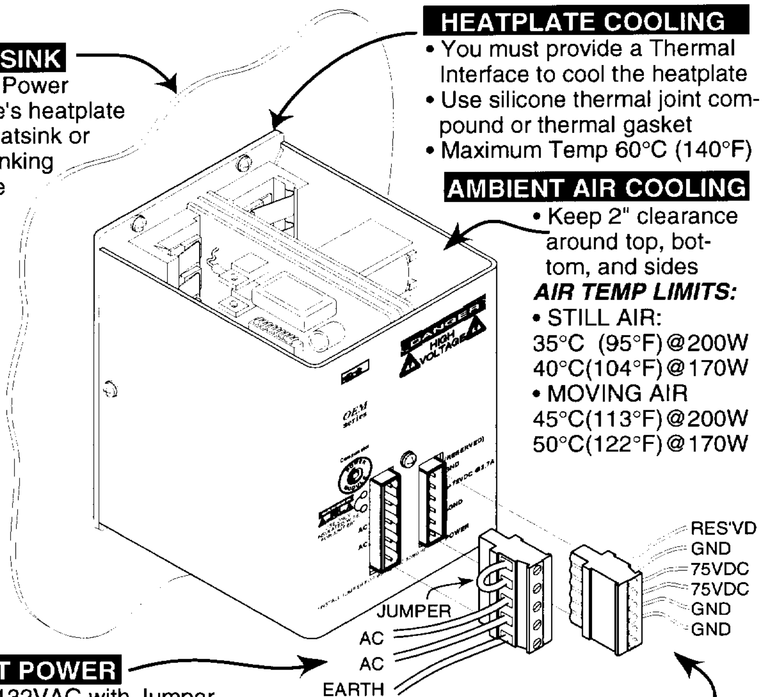
- You must provide a Thermal Interface to cool the heatplate
- Use silicone thermal joint compound or thermal gasket
- Maximum Temp 60°C (140°F)

AMBIENT AIR COOLING

- Keep 2" clearance around top, bottom, and sides

AIR TEMP LIMITS:

- STILL AIR:
  35°C (95°F)@200W
  40°C(104°F)@170W
- MOVING AIR
  45°C(113°F)@200W
  50°C(122°F)@170W



INPUT POWER

- 90-132VAC with Jumper Installed
- 180-265VAC with Jumper Removed
- **DO NOT USE** 132-180VAC

INPUT CONNECTOR:

- 5 Pin Removable Connector
- 16 AWG Recommended

> ***You must connect the EARTH terminal to EARTH GROUND!***
> (Chassis, cover, EARTH, GND pins are connected internally)

OUTPUT POWER

- 75VDC ± 5%
- 2.7A/200W Continuous
- 4.0A/300W Peak
  (30 sec., 10% Duty Cycle at Peak)
- Two 75VDC pins, internally connected

OUTPUT CONNECTOR:

- 6 Pin Removable Connector
- Use16 AWG if < 10 ft., 14 AWG if > 10 ft.

> ***DO NOT CONNECT MULTIPLE OEM300s IN PARALLEL! They will not share the load.***

PROTECTIVE CIRCUITS

- SHORT CIRCUIT PROTECTION — Latched
- POWER DUMP — Turns on at 85VDC
- OVER-TEMPERATURE — Unit shuts down @ 60°C; Latched; Cool to 30°C
- OVERVOLTAGE — Shuts down output after 0.5 sec overvoltage; Latched