Instructions for Installation and Operation

PACESETTER™
ADJUSTABLE SPEED DRIVE

Model 2996 with Direction Switch
Model 2997 without Direction Switch
NEMA 1/IP-40 Enclosure

SPECIFICATIONS

Input Volts	115 VAC ±10% Single Phase, 50/60Hz
Input Current	9.6 Amps AC
Output Volts	0 – 230 VAC, Three Phase
Output Current, per Phase	2.4 Amps RMS
Maximum Motor HP (kW)	½ HP (0.37 kW)

BODINE®
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QUALITY IN MOTION®

Part No. 07401050E

This manual contains the basic information needed to install and operate Bodine Pacesetter™ 115V NEMA 1 series inverters, models 2996 and 2997. This manual does not profess to cover all details or variations in equipment, nor to provide for every possible contingency associated with installation, operation, or maintenance. No warranty of fitness for purpose is expressed or implied. Should further information be desired or should particular problems arise which are not covered sufficiently for the user's purpose, the matter should be referred to the Bodine Electric Company.

IMPORTANT

Read this manual completely and carefully. Pay special attention to all warnings, cautions, and safety rules. Failure to follow the instructions could produce safety hazards that could injure personnel or damage the control, motor, or other equipment. If you have any doubts about how to connect the control or motor, refer to the detailed sections of this manual.

QUICK REFERENCE

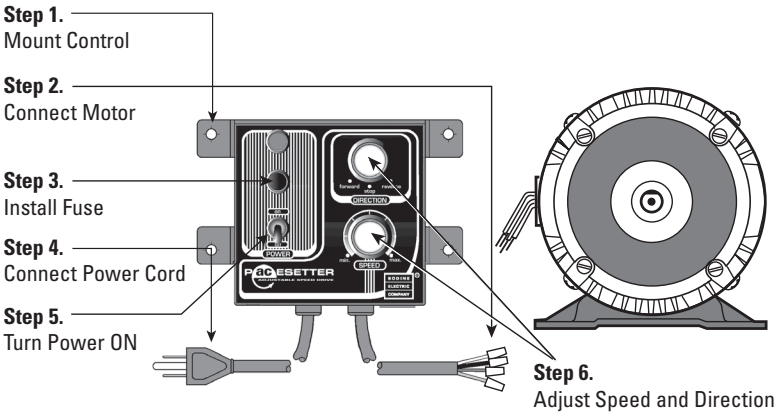

FIGURE 1 – Summary of installation and operation, for reference only and not be used as a replacement for the detailed instructions within this manual.

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FIGURES

PRODUCT SPECIFICATIONS

ABOUT THIS PRODUCT–Bodine's Pacesetter™ NEMA 1 series inverter is designed to provide variable speed control of standard three-phase AC induction motors. Adjustable linear acceleration and deceleration are provided, making the drive suitable for soft start applications. The output voltage is a sinewave coded PWM operating at 16 kHz, which provides high motor torque, high efficiency, and low noise. The full featured drive is easy to install and operate. Simple trimpot adjustments eliminate the computer-like programming required on other drives. However, for most applications, no adjustments are necessary.

Table 1 – Electrical Ratings

Input Volts	115 VAC ±10%, Single Phase, 50/60Hz
Input Current	9.6 Amps AC
Output Volts	0 – 230 VAC, Three Phase
Output Current, per Phase	2.4 Amps RMS
Maximum Motor HP (kW)	½ HP (0.37 kW)

Table 2 – General Performance Specifications

Parameter	Specification	Factory Setting
Maximum Load	150% Current Overload for 2 Min.	—
Switching Frequency at Motor	16 kHz	—
Signal Following Input Voltage	0 - 5 VDC	—
Signal Following Input Resolution	8 bits	—
Minimum Speed Trimpot Range	0 - 40% of frequency setting	10
Output Frequency Setting	50 Hz, 60 Hz, 100 Hz or 120 Hz	60
Maximum Speed Trimpot Range	70 - 110% of frequency setting	100
Speed Range	50:1	—
Acceleration Trimpot Range	0.3 - 20 seconds	1.0
Deceleration Trimpot Range	0.3 - 20 seconds	1.0
Boost Trimpot Range (50Hz only) (Volts/Hz)	0 - 30%	5
Slip Compensation Trimpot Range	0 - 3 Volts/Hz/Amp	1.5
Current Limit Trimpot Range	1.5 - 4.5 Amps AC	3.8
Speed Regulation (0 to Full Load, 30:1 Speed Range)	2.5% of Base Speed	—
Operating Temperature Range	0 to +40°C	—
Overload Protector Trip Time (Stalled Motor)	6 seconds	—
Bus Overvoltage Trip Point	400 VDC (283 VAC Line Volts)	—
Bus Undervoltage Trip Point	260 VDC (184 VAC Line Volts)	—

IMPORTANT SAFETY PRECAUTIONS

Models 2996 and 2997 have been evaluated by Underwriters Laboratories for conformance to UL standard 508 and CSA standard C22.2 No. 14 and bear the UL Recognized Component mark.

The AC Drive is a power electronic device. For safety reasons, please read through this operations manual in detail and observe those paragraphs with the safety alert symbol.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION

CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage.

⚠ WARNING

- *Do not touch printed circuit board (PCB) right after turning off power. Wait until power light turns off.*
- *Do not attempt to wire circuitry while power is on.*
- *Do not attempt to examine components and signals on the PCB while the inverter is operating.*
- *Do not attempt to disassemble or modify internal circuitry, wiring, or components of the inverter.*
- *Inverter must be properly grounded.*

INSTALLATION

This control should only be installed by a qualified person familiar with its operation and associated hazards. The National Electrical Code (NEC), local electrical and safety codes, and when applicable, the Occupational Safety and Health Act (OSHA) should be observed to reduce hazards to personnel and property.

Step 1. Examine Before Installation

Check the items you received against your purchase order. The model number is printed as part of the serial number on an adhesive label on the outside bottom surface of the inverter enclosure. Carefully examine the control for shipping damage. Parts errors should be reported to Bodine. Shipping damage claims should be made to the freight carrier.

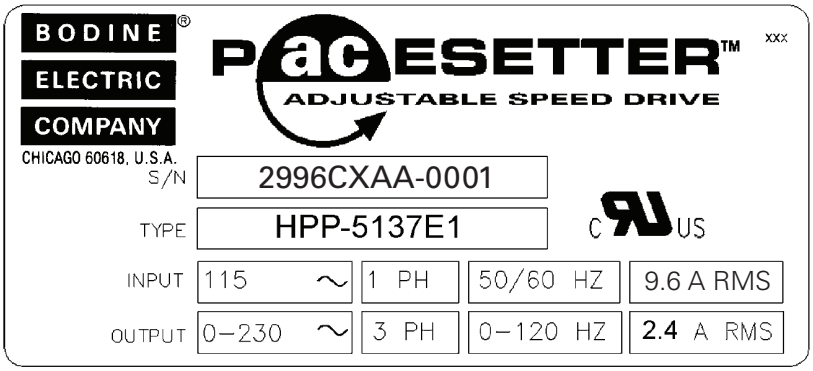


Figure 2 – The model number is the first four digits of the serial number (S/N) on the control's nameplate.

⚠ CAUTION

Do not connect the AC inverter to the power supply if there is any sign of damage. Notify the carrier and your distributor immediately.

Step 2. Choose a Suitable Location

The installation site directly impacts the functionality and lifespan of the inverter.

- Avoid areas where surrounding air temperature exceeds 40°C (for example, direct sunlight or near heating equipment or inside a panel without a cooling fan).
- Avoid locations where the front panel dial and switch may be bumped and accidentally turned on/off or damaged.
- Avoid humid environments.
- Avoid environments with corrosive gas.
- Avoid locations near radioactive matter or flammable material.
- Avoid locations near equipment that generate electromagnetic interference (for example, soldering or power machinery).
- Avoid mounting the inverter to a surface that vibrates.

Step 3 – Mount the Control

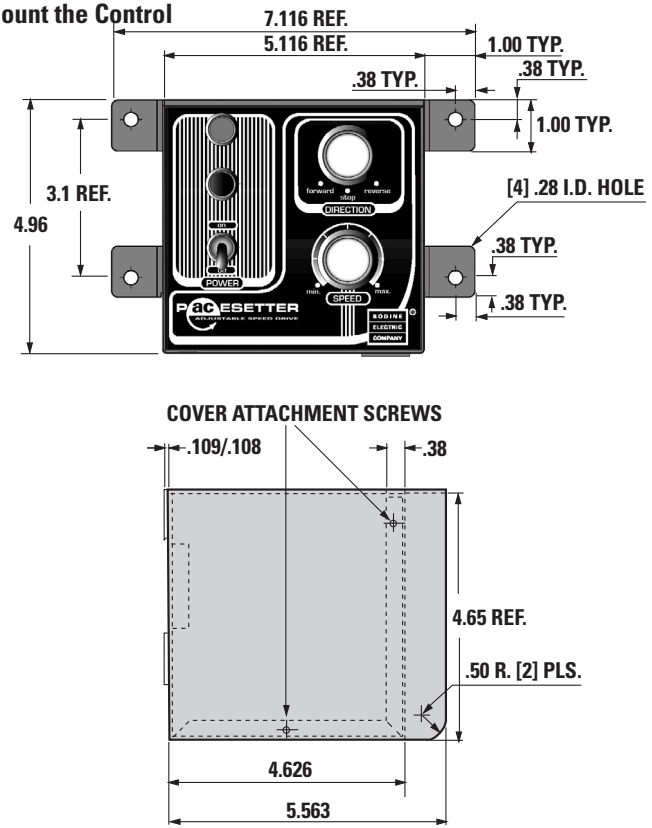


Figure 3–Mounting dimensions, front and side view

CONNECTION

CAUTION

- *The PCB inside the inverter enclosure is vulnerable to static electrical charges. Avoid contact with the PCB.*
- *Choose an appropriate power source with correct voltage settings for the specification of the AC inverter.*
- *Do not use a separate device between control and motor to switch motor ON or OFF during operation.*

Step 4 – Preliminary Setup

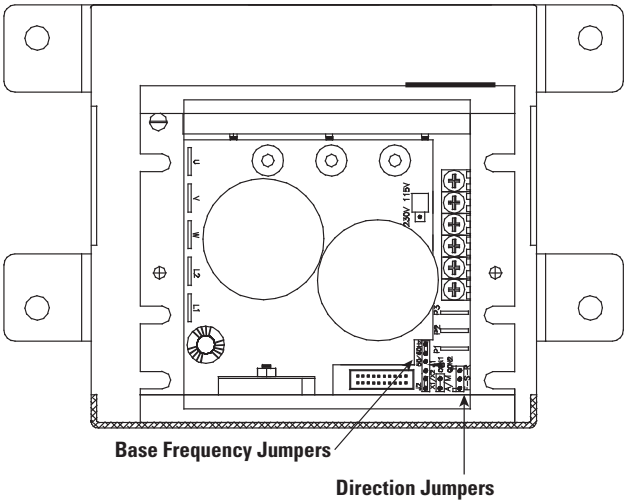


Figure 4–Inside of control, showing location of jumpers

BASE FREQUENCY JUMPER—Models 2996 and 2997 are factory set for 60 Hz output, but can be configured for 50 Hz, 100 Hz, or 120 Hz output by changing the two jumpers on the lower printed circuit board as shown in Fig. 5. When the control is set for 50 Hz or 100 Hz operation, the DECEL/B trimpot will automatically change to adjustable boost.

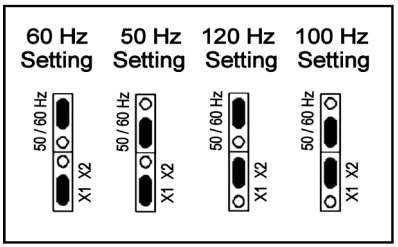


Figure 5–The different ways of setting the base frequency jumper

Note: The base frequency is the motor frequency and is on the motor nameplate.

When set for one of the over speed modes of 100 Hz or 120 Hz, the motor will produce full rated torque up to 50 Hz or 60 Hz respectively. Above 50/60 Hz, torque will linearly reduce to 50% at 100/120 Hz.

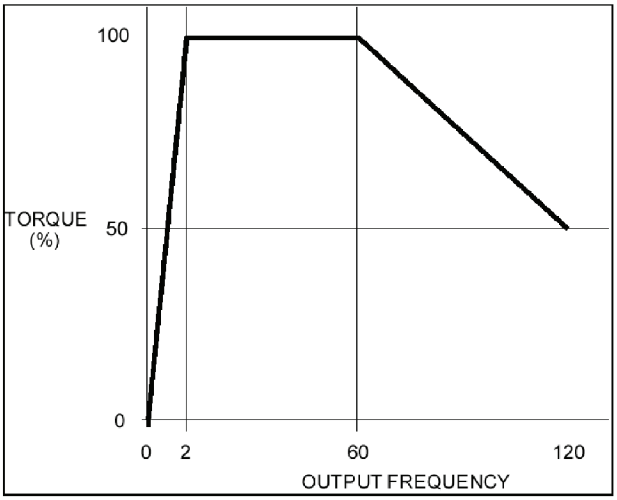


Figure 6 - Graph showing reduction in motor torque at frequencies above 60 Hz.

DIRECTION JUMPER – The direction select jumper in Model 2996 is factory wired to the direction select switch on the front panel of the control. The direction select jumper in Model 2997 is factory set in the "forward" position as shown in Figure 7. To change the direction of the motor without changing the connection of the motor leads, remove the direction select jumper and reinsert in the "reverse" position. See Step 5 – "Connect the Motor" for a definition of "forward" and "reverse."

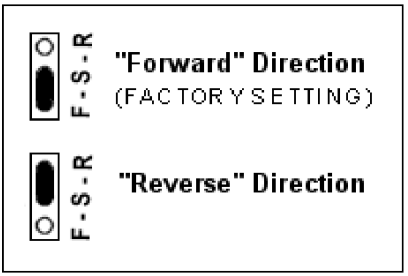


Figure 7– Different ways to set the direction jumper (Model 2997)

Step 5 – Connect the Motor

Connect a 230 VAC three-phase squirrel-cage induction motor with appropriate ratings for the inverter to the three wires at the end of the 36" long cord on the control. Remove the wire nuts from the end of the four leads on the end of the cord. Since the controls are capable of changing motor direction electronically, it doesn't really matter which motor wires go to which terminal. However, if it is desired for the motor to rotate a specific direction when wired a certain way, then refer to the connection diagrams for Bodine inverter-duty motors in Figures 9 and 10 on the next page. If the motor doesn't rotate in the desired direction as connected, with reference to the "forward" and "reverse" settings of the direction switch on Model 2996, then swap any two of the three motor wires. Note that these connection diagrams apply to Bodine motors only.

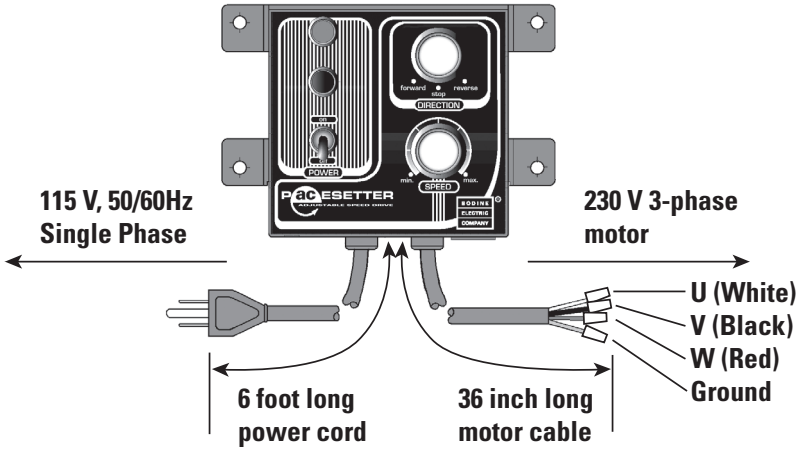


Figure 8–Electrical connections for Models 2996 and 2997

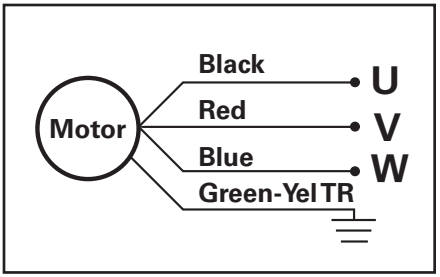


Figure 9–Connection diagram for Bodine 230V inverter-duty motors

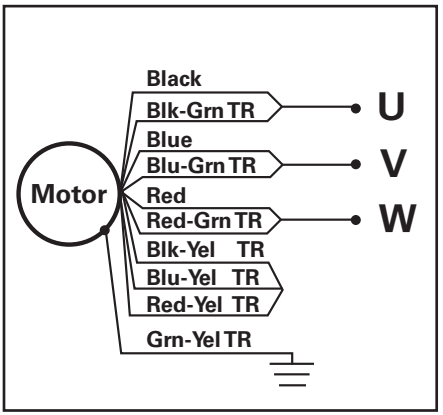


Figure 10–Connection diagram for Bodine 230/460V inverter-duty motors wired for 230V operation

Table 3–Direction of Bodine motor driveshaft rotation, viewing end of driveshaft, when connected per the diagrams at the left and with control set for "forward" direction.

Bodine Motor Type	Direction
30R2BEPP	CCW
30R4BEPP	CCW
30R2BEPP-D3	CW
30R4BEPP-D3	CW
30R2BEPP-D4	CCW
30R4BEPP-3N	CCW
34R6BEPP-Z2	CCW
34R6BEPP-Z3	CCW
34R6BEPP-Z4	CW
34R4BFPP-E1	CCW
34R4BFPP-E2	CW
34R4BFPP-E3	CCW
34R4BFPP-E4	CW
34R6BFPP	CW
34R6BFYP	CW
42R6BFPP	CCW
42R6BFPP-GB	CW
42R6BFPP-F1	CW
42R6BFPP-F2	CCW
42R6BFPP-F3	CW
42R6BFPP-5N	CCW
42R6BFPP-5H	CCW
48R5BFYP	CCW

Step 6 – Install Line Fuse

The control has a fuseholder on the front panel. The fuse is not installed by the factory, but is packaged separately in a bag. Twist off the fuseholder cap and insert the supplied 15A fuse. Then replace the fuseholder cap.

Step 7 – Connect to AC Power

The control has a 6' long cord with a standard 115 VAC power plug. After all other electrical connections have been made, insert the power plug into a standard 115 VAC power receptacle.

OPERATION

Step 8 – Check System Before Starting

⚠ WARNING

- *Recheck all connections.*
- *Do not remove the cover of the inverter when the power is ON to avoid injury caused by electrical shock.*
- *Do not attempt to wire circuitry while power is on.*

CAUTION

- *Do not attempt to make or break connections between motor and inverter when the power supply is turned on, or the inverter may be damaged due to a surge peak.*
- *Check that motor is securely mounted.*
- *Test motor unloaded first to verify proper setup.*
- *Check all rotating members. Be sure keys, pulleys, etc. are securely fastened and safety guards are in place.*
- *Check for proper mounting and alignment of products, and verify safe loading on shafts and gears.*
- *The inverter can be easily operated from a low-speed to a high-speed. Reconfirm the operating speed range of the motor and the machinery you are controlling.*

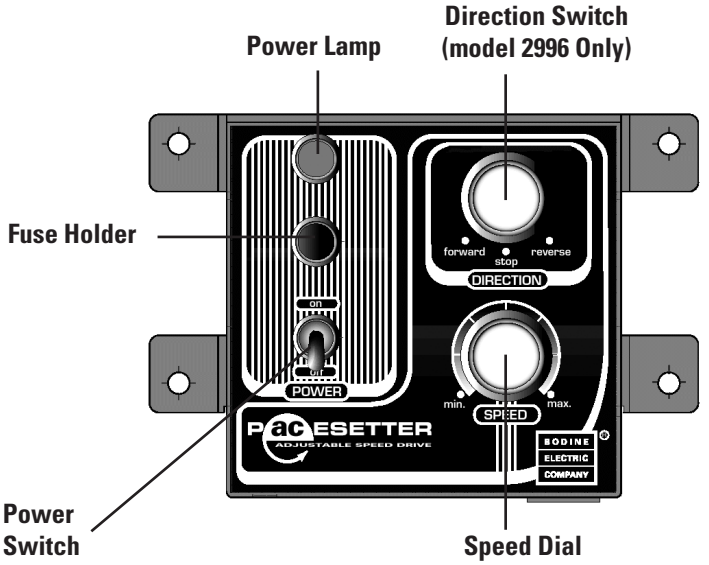


FIGURE 11 – Control panel layout

Step 9 – Operate the Inverter

The Pacesetter™ NEMA 1 series inverter is operated using the switch(es) and speed dial on the front panel of the control. See Figure 11 for panel layout.

1) Turn the AC power ON using the toggle switch. The power lamp will illuminate.
2) Model 2996 has a direction switch and model 2997 does not. If using a model 2996, turn the direction switch to either the "forward" or "reverse" position.
3) Adjust speed by turning the knob of the speed potentiometer. Turning the pot fully CCW will produce the minimum output frequency, as set by the MIN trim pot inside the control (factory setting is 10 Hz). Turning the pot fully CW will produce the maximum output frequency, as set by the max speed jumper and the MAX trim pot inside the control (factory setting is 60 Hz).
4) To stop the motor momentarily, turn the direction switch to the "stop" position.
5) To change direction of the motor, turn the direction switch to the "stop" position, wait until the motor comes to a complete stop, and then turn the direction switch to either "forward" or "reverse" position.
6) To stop the motor for long periods of time, turn the AC power off using the toggle switch.
7) If the motor does not start promptly and run smoothly, refer to the "TROUBLESHOOTING" section.

Step 10 – Adjust Trim Pots (Optional)

These controls contain trim pots that have been factory adjusted for most applications. Some applications may require readjustment of the trim pots in order to tailor the control to exact requirements.

⚠ WARNING

Do not adjust trim pots with main power on if possible. If adjustments are made with power on, insulated adjustment tools must be used and safety glasses must be worn. High voltage exists in this control. Electrocution and/or fire hazard can result if caution is not exercised.

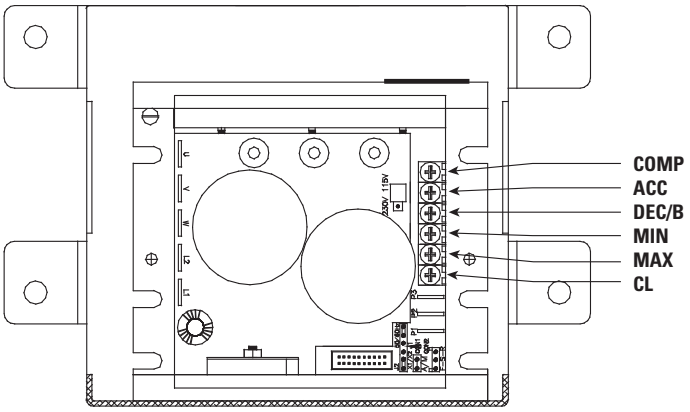


Figure 12 - Location of trim pots inside enclosure

MIN: Minimum Speed

The MIN trim pot is used to set the minimum output frequency of the drive, which sets the minimum motor speed. The minimum speed is factory set to 10 Hz at a base frequency of 60 Hz.

Fully counterclockwise sets the MIN trim pot at 0% frequency. For a higher minimum setting rotate the MIN trim pot clockwise. The maximum (fully clockwise setting) possible for the MIN trim pot is 40% of the base frequency.

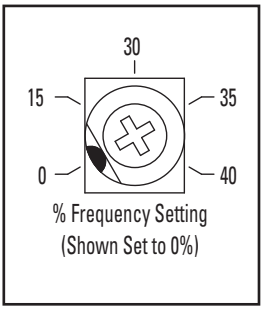


Figure 13 - Minimum speed trim pot (MIN) range

MAX: Maximum Speed

The MAX trim pot is used to set the maximum output frequency of the drive, which sets the maximum motor speed. The maximum speed is factory set to 100% base frequency setting.

For a higher maximum setting, rotate the MAX trim pot clockwise. For a lower maximum setting, rotate the MAX trim pot counterclockwise.

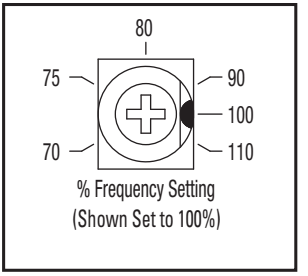


Figure 14 - Maximum speed trim pot (MAX) range

ACC: Acceleration

Sets the amount of time for the motor to accelerate from zero speed to full speed. The ACC Trim pot is factory set to 1.5 seconds. For longer acceleration time, rotate the ACC Trim pot clockwise. For more rapid acceleration, rotate the ACC Trim pot counterclockwise.

Note: When the control is set for 50 Hz operation, the ACC trim pot will automatically change to adjustable acceleration and deceleration.

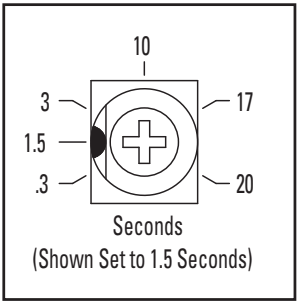


Figure 15 - Acceleration trim pot (ACC) range

DEC/B: Deceleration (with 60 Hz or 120 Hz configuration)

Sets the amount of time for the motor to decelerate from full speed to zero speed. The DEC/B Trim pot is factory set to 1.5 seconds. For longer deceleration time, rotate the DEC/B Trim pot clockwise. For more rapid deceleration, rotate the DEC/B Trim pot counterclockwise.

BOOST: (DEC/B)

When the drive is set for 50 Hz Motor Operation (Jumper J1 installed in the "50 Hz" position), the DEC/B Trim pot automatically becomes the adjustable BOOST Trim pot.

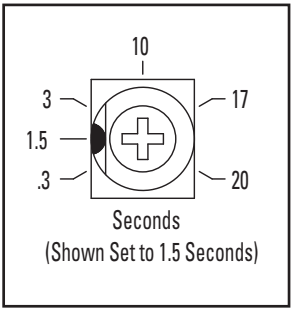


Figure 16 - Deceleration trim pot (DEC/B) Range

Most 60 Hz motors conforming to NEMA standards can operate from a preset Volts/Hz curve. 50 Hz motors, however, generally differ widely in their characteristics. Therefore, it is necessary to have adjustable Boost to obtain maximum motor performance.

To increase the boost, rotate the BOOST Trim pot clockwise. To decrease the boost, rotate the BOOST Trim pot counterclockwise.

In order for the 50 Hz motor to run properly, the boost must be adjusted. If the application does not require full torque below 10 Hz, the Boost (DEC/B) Trim pot can be conservatively set at 5 Volts/Hz (9 o'clock position).

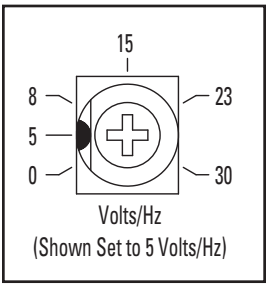


Figure 17 - BOOST trim pot (DEC/B) range

Note: In 50 Hz motor operation, the deceleration time is automatically set to the same as the Acceleration Trim pot (ACC) setting.

CAUTION

To avoid motor winding overheating and failure, do not over boost motor.

The Boost (DEC/B)Trim pot may be adjusted as follows:

1. Wire an AC RMS ammeter in series with one motor phase.
2. Run the motor unloaded at approximately 4 Hz (or 120 RPM).
   Note: An unloaded motor with excessive boost will draw more current than a partially loaded motor.
3. Increase the boost until the ammeter reaches the nameplate rated current (Amps AC).
4. Using the Main Speed Potentiometer, slowly adjust the motor speed over a 0 – 15 Hz (0 – 450 RPM) range. If the motor current exceeds the nameplate rating, decrease the boost setting.

Motor Overload (I^2t) with RMS Current Limit (CL)*
Sets the current limit (overload), which limits the maximum current to the motor, prevents motor burnout, and eliminates nuisance trips. The CL Trim pot is factory set to 160% of the drive rating. To increase the current limit, rotate the CL Trim pot clockwise. To decrease the current limit, rotate the CL Trim pot counterclockwise.

*UL approved as an electronic overload protector for motors.

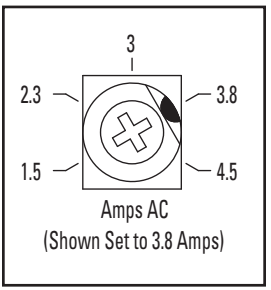


Figure 18 - Current Limit trim pot (CL) range

In order to ensure that the motor is properly protected with the I^2t feature, it is required that the CL Trim pot be set for 160% of the motor nameplate rating. This is accomplished as follows:

Note: This adjustment must be made within 6 seconds or the I^2t Trip will occur.

1. Wire an AC RMS ammeter in series with one motor phase.
2. Set the CL Trim pot fully counterclockwise.
3. Adjust the speed setting to 30% of full speed.
4. Lock the motor shaft and adjust the CL Trim pot to 160% of the motor nameplate rating.

Example: A 1/2 HP motor has a full load current rating of 1.8 Amps. Set the CL Trim pot to 1.8x160% = 2.9 Amps.

Slip Compensation (COMP)

Sets the amount of Volts/Hz to maintain set motor speed under varying loads. The COMP Trim pot is factory set to 1.5 Volts/Hz, which provides excellent speed regulation for most motors. To increase the slip compensation, rotate the COMP Trim pot clockwise. To decrease the slip compensation, rotate the COMP Trim pot counterclockwise.

The slip compensation may be adjusted as follows:

1. Wire an AC RMS ammeter in series with one motor phase.
2. Run the motor and set the unloaded speed to approximately 50% (900 RPM on 4-pole 1500/1725 RPM motors).
3. Using a tachometer, record the unloaded speed.
4. Load the motor to the nameplate rated current (Amps AC).
5. Adjust the COMP trim pot until the loaded RPM is equal to the unloaded RPM.
6. The motor is now compensated to provide constant speed under varying loads.

TROUBLESHOOTING

WARNING

Do not remove the cover of the inverter when the power is ON to avoid injury caused by electrical shock.

This control does not require maintenance under normal conditions. If you encounter a problem, read all instructions provided with this control and double-check the wiring. If problems persist, contact your source of purchase and describe the problem in detail. Performing unauthorized repairs will void the Warranty.

GENERAL EVALUATION–Knowing the circumstances under which the problem occurred can help to identify the root cause of the problem.

Has the system ever operated properly? If the control was just installed and doesn't work right, then it is likely that something wasn't done correctly in the installation. However, if the system has been working for an extended period of time and just recently stopped working, then this would indicate that the control was initially installed properly but something has somehow changed.

Is the problem continuous or intermittent? If the problem always occurs and never goes away, then it would indicate something inherently wrong in the connections or a defective component. On the other hand, if the system operates properly most of the time and only occasionally does something wrong, then this might indicate loose connections or electrical noise

Table 4–General problem evaluation method

interference.

ABNORMALITY	CHECK POINT	COUNTERMEASURE
Motor does not run	Is main power lamp illuminated?	• Check that power source is switched on. • Reconfirm the power voltage level.
	Is a problem indicated by the LED status indicator?	• See Table 5 for interpretation (page 21).
	Is there a direction command?	• Check that the direction switch is set at either Forward or Reverse.
	Is the main speed pot damaged?	• Examine the speed pot and if needed, replace it.
Motor runs, but in wrong direction	Is wiring to the motor correct?	• Swap any two of the three motor wires. • Change direction jumper (Model 2997) • Change direction switch (Model 2996)
Motor runs, but speed can't be adjusted	Is the main speed pot damaged?	• Examine the speed pot and if needed, replace it.
	Is the loading too heavy?	• Reduce loading
Motor runs, but speed is too high or too low	Are the MAX and MIN trim pot settings correct?	• Check MAX and MIN trim pot setting.
Motor runs, but with abnormal speed variations	Is the loading too heavy?	• Increase inverter and motor capacity
	Is the loading variation too large?	• Reduce loading variation
	Is input power steady and stable?	• Install AC reactor on power supply input.

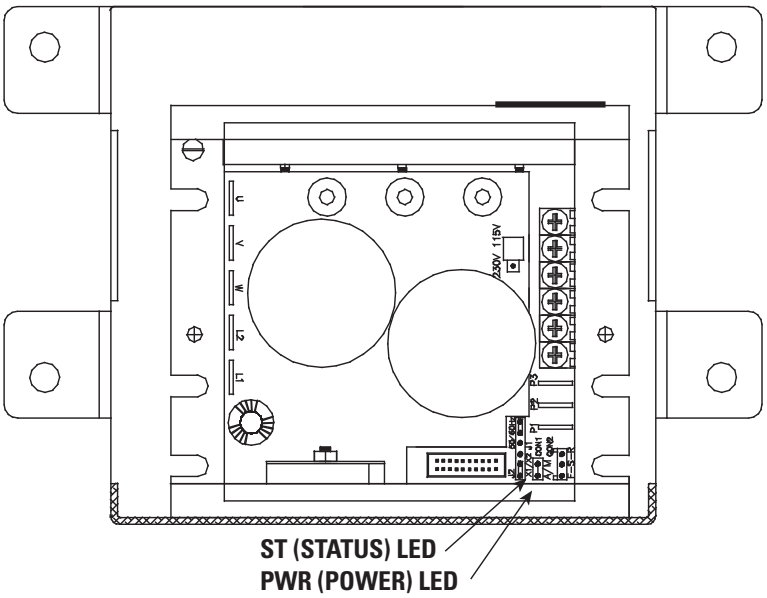


Figure 19 – Location of LED Status Indicators inside the enclosure

LED STATUS INDICATORS – Models 2996 and 2997 contain two LED status indicators on the printed circuit board inside the enclosure. One LED is a green Power On indicator (PWR) that indicates the presence of the bus voltage and the operation of the main control logic power supply.

The other LED is a tricolor lamp (ST) that indicates a fault or abnormal condition. The information provided can be used to diagnose an installation problem, such as incorrect input voltage, overload condition and control circuit miswiring. It also provides a "normal" signal that informs the user that all control and microprocessor operating parameters are proper. The meaning of the different colors and flash frequencies are explained in Table 5.

TABLE 5 – Drive Operating Condition & Status LED Indicator

Drive Operating Condition	Flash Rate[1] and LED Color
Normal Operation	Slow Flash Green
Overload (120% – 160% Full Load)	Steady Red[2]
I^2t (Drive Timed Out)	Quick Flash Red
Short Circuit	Slow Flash Red
Undervoltage	Quick Flash Red / Yellow[3]
Overvoltage	Slow Flash Red / Yellow[3]
Stop	Steady Yellow

Notes:

1. Slow Flash = 1 second on and 1 second off.
   Quick Flash = 0.25 second on and 0.25 second off.
2. In Manual Start Mode, when the Overload is removed, before the I^2t times out and trips the drive, the "ST" LED will flash green.
3. In Manual Start Mode, when the Undervoltage or Overvoltagecondition is corrected, the "ST" LED will flash Red / Yellow / Green.

NOTES

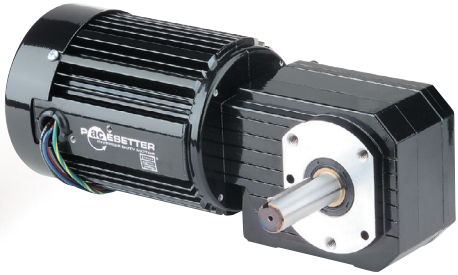
BODINE LIMITED WARRANTY

The Bodine Electric Company warrants all products it manufactures to be free of defects in workmanship and materials when applied in accordance with nameplate specifications. Bodine motors and gearmotors purchased with and used only with appropriately applied Bodine controls are covered by this warranty for a period of 24 months from the date of purchase or 30 months from date of manufacture, whichever comes first. Bodine motors and gearmotors used with non-Bodine controls and Bodine controls used with non-Bodine motors and gearmotors are covered by a 12 month warranty period. The Bodine Electric Company will repair, replace, or refund at its option, any of its products which has been found to be defective and within the warranty period, provided that the product is shipped freight prepaid, with previous authorization, to Bodine or to a Bodine Authorized Service Center. Bodine is not responsible for removal, installation, or any other incidental expenses incurred in shipping the products to or from Bodine. This warranty is in lieu of any other expressed or implied warranty – including, but not limited to, any implied warranties of merchantability and/or fitness for a particular use. Bodine's liability under this warranty shall be limited to repair or replacement of the Bodine product and Bodine shall not be liable, under any circumstances, for any consequential, incidental or indirect damages or expenses associated with the warranted products. Proof of purchase of motor or gearmotor and matching control as a system must be provided with any claim.

Control Type:_____ **Serial No.**_____

Date of Purchase:_____ **Place of Purchase:**_____

Bodine offers over 1,000 standard gearmotors, motors and system-matched speed controls.



Visit www.bodine-electric.com for all your motion control needs.

Bodine offers the widest selection of variable-speed AC, permanent magnet DC and brushless DC fractional horsepower gearmotors and motors in the industry. For complete specifications, 3D CAD drawings, or to order online, visit bodine-electric.com.

BODINE® ELECTRIC COMPANY

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