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Instructions for Installation and Operation

Pac ESETTER™ ADJUSTABLE SPEED DRIVE

High Performance Drives for 3-Phase AC Induction Motors

115V MODELS



- Model 2701, 1/4 HP
- Model 2703, 1/2 HP

BODINE
ELECTRIC
COMPANY
CHICAGO 90010, U.S.A.

QUALITY
IN
MOTION

P/N 074 01023A (BW)

QUICK REFERENCE

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 which 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.

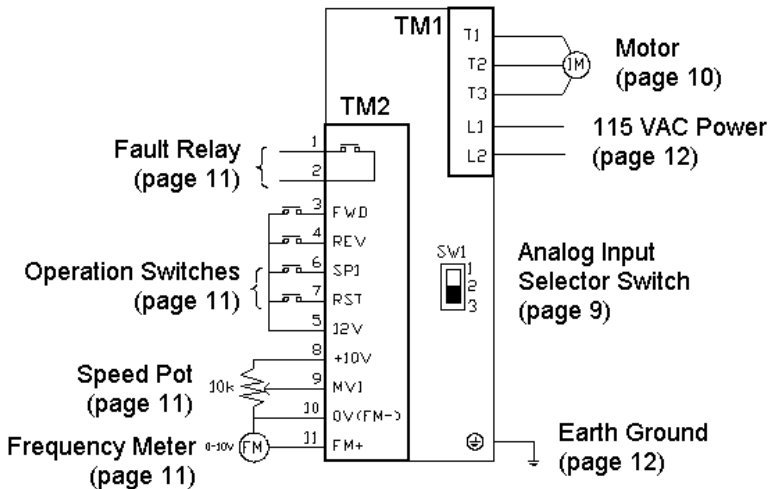


FIGURE 1 – Basic Connection Diagram. Refer to noted pages for details. Function F25 returns all functions to their factory settings.

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INTRODUCTION

ABOUT THIS MANUAL - This manual contains the basic information needed to install and operate Bodine PACESETTER™ 115V "NANO" series inverters, models 2701 and 2703.

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.



PRODUCT SPECIFICATIONS

ABOUT THIS PRODUCT - Bodine's PACESETTER™ "NANO" series inverter is a PWM type inverter that converts a single phase AC input voltage into an adjustable frequency three phase AC output voltage. Since the speed of AC induction motors is proportional to the line frequency, adjusting the output frequency of the inverter enables adjustable speed operation of the motor.

		Model Number:	2701	2703
Ratings	Motor HP		1/4	1/2
	Motor kW		0.2	0.4
	Output Amps		1.4	2.3
	Input Volts		Single phase 100-120V (+10%-15%) , 50/60Hz (+/-5%)	
	Output Volts		Three phase 200-240V +10%-15% (Input Voltage Max)	
	Weight, Lb (Kg)		1.5 (0.7)	1.6 (0.72)
Control Characteristics	Carrier Frequency		1 – 16 kHz	
	Frequency Control Range		0 – 200 Hz	
	Frequency Resolution		Digital: 0.1 Hz (0 - 99.9Hz); 1 Hz (100-200Hz) Analog: 1 Hz / 60Hz	
	Frequency Setting Signal		Keypad or external signal (0-10 V, 4–20 mA, 0–20 mA)	
	Accel / Decel Time		0.1 - 999 Seconds	
	Braking Torque		About 20% without external braking resistor (no provisions for external resistor)	
	V/F Pattern		3 Patterns each for 50 Hz & 60 Hz	
Protection features	Overload protection		150% for 1 min.	
	Over-voltage		DC voltage > 410V	
	Under voltage		DC voltage < 200V	
	Momentary Power Loss		0 - 2 seconds: inverter can be restarted by speed search	
	Stall Prevention		Accelerate / Decelerate / Constant speed	
	Output terminal short-circuit		Electronic circuitry protection	
	Grounding fault		Electronic Circuitry protection	
	Other function		Heat sink temperature protection, Current limit	
Operation Conditions	Indication function		3 character LED display indicates frequency or inverter parameter or fault record or program version.	
	Inputs		2 multi-function, PNP type (source)	
	Output		1 multi-function	
	Torque control		Torque boost level adjustable (manual torque boost)	
	Other function		Decelerate or free run stop, Auto reset, DC braking frequency / Voltage / Time can be setup by constants.	
Environmental Conditions	Ambient Temperature		-10 to +40°C	
	Humidity		0 - 95% RH non-condensing.	
	Vibration		Under 1 G (9.8 m/s ²)	
	Enclosure		IP20	
	Dimensions, W x H x D		2.83" x 5.20" x 4.64" (72 mm x 132 mm x 118 mm)	
	Mounting		Install by mounting screw or DIN rail (Option).	

IMPORTANT SAFETY PRECAUTIONS

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 using 200V class type III standard.

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 on an adhesive label on the side of the inverter. Carefully examine the control for shipping damage. Parts errors should be reported to Bodine. Shipping damage claims should be made to the freight carrier.



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 of the inverter directly impacts the full functionality and lifespan of the inverter. Because the PACESETTER™ “NANO” series inverter has a ventilated enclosure (IP 20 rating) and is fan-cooled, the following guidelines should be adhered to:

- Mount the unit vertically so that the fan is on top for better heat dissipation.
- Make sure the temperature around the inverter is between -10°C and $+40^{\circ}\text{C}$ (avoid locations in direct sunlight or near heating equipment). If inverter is installed in a control panel, an additional cooling fan may be needed.
- Prevent liquid from dripping into the enclosure vent holes.
- Avoid humid environments.
- Avoid environments with corrosive gas.
- Prevent solid objects, such as dust and metal scraps, from falling into the enclosure vent holes.
- Avoid locations near radioactive matter or flammable material.
- Avoid locations near equipment that generate electromagnetic interference (soldering or power machinery).
- Avoid mounting the inverter to a surface that vibrates.

Step 3 – Mount the Control

Install the inverter onto firm metal base or other inflammable material by inserting screws through the three 4.5 mm diameter holes in the enclosure base.

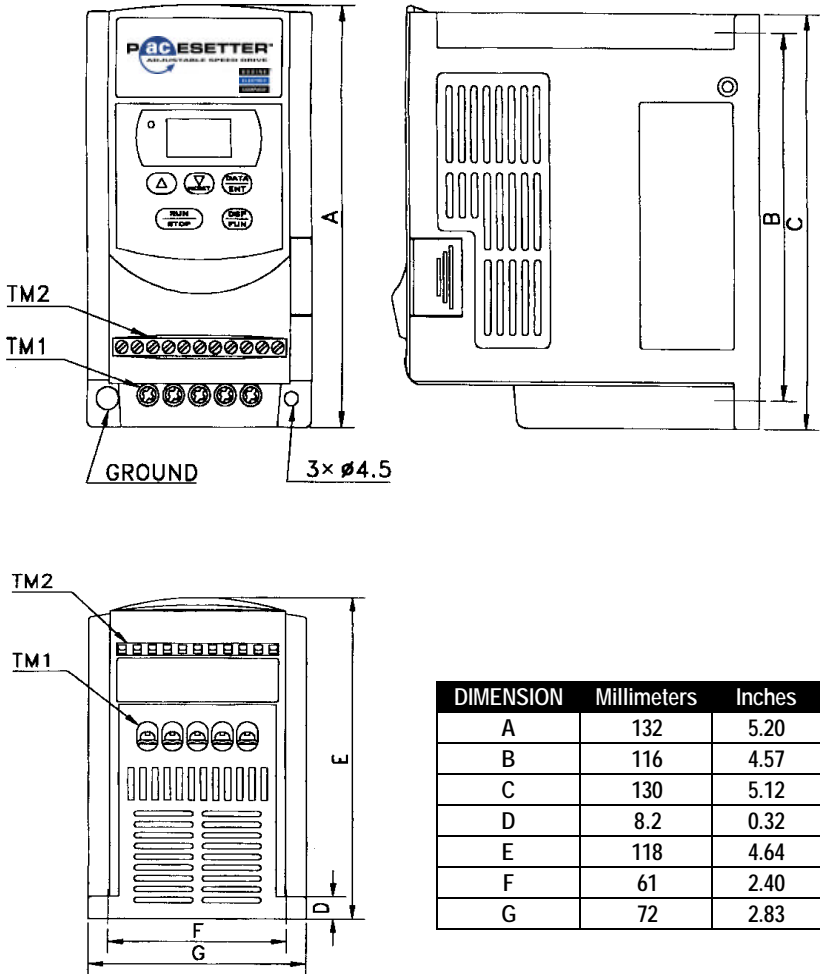


FIGURE 2 – Mounting dimensions.

MULTIPLE DRIVES IN ONE PANEL - If several inverters are installed into one control panel, then observe the guidelines in Fig. 3 in order to maximize the usefulness of the fan in dissipating heat from the inverter. Inverters should be mounted side by side and not one above the other.

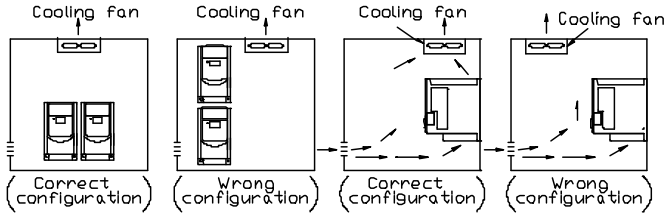


FIGURE 3 – Layout of several inverters inside one panel showing front view (left) and side view (right).

DIN RAIL MOUNTING – Purchase Bodine’s DIN Rail Mounting Kit, model 2730, and follow the instructions that come with it.

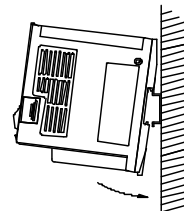


FIGURE 4 – Inverter installed on DIN Rail.

Step 4 – Preliminary Setup

This step is only required when a remote analog current signal is to be used to adjust motor speed. Refer to Fig. 5 and remove the small sliding cover on the side of the inverter. Inside is a small slide switch on the printed circuit board. The factory setting of the switch is for an analog voltage input and is in the “down” position where “V” is printed on the circuit board. To configure the drive for an analog current signal input, slide the switch “up” to the side where “I” is printed on the circuit board.

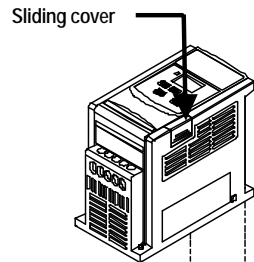


FIGURE 5 – Location of sliding cover

FIGURE 6 – Switch settings for analog input signal

SWITCH 1	External signal type
	0-10 VDC analog signal (When Fn11 set to 1)
	0-20mA analog signal (When Fn_11 is set to 1) OR 4-20mA analog signal (When Fn_11 is set to 2)

Step 5 – Electrical Connections

CAUTION

- The PCB of the inverter is vulnerable to static electrical charges. Do not contact the PCB.
- Choose the appropriate power source with correct voltage settings for the input voltage specification of the AC inverter.
- Do not use a separate device to switch ON or OFF motor during operation. Otherwise, the inverter may experience an over-current breakdown.

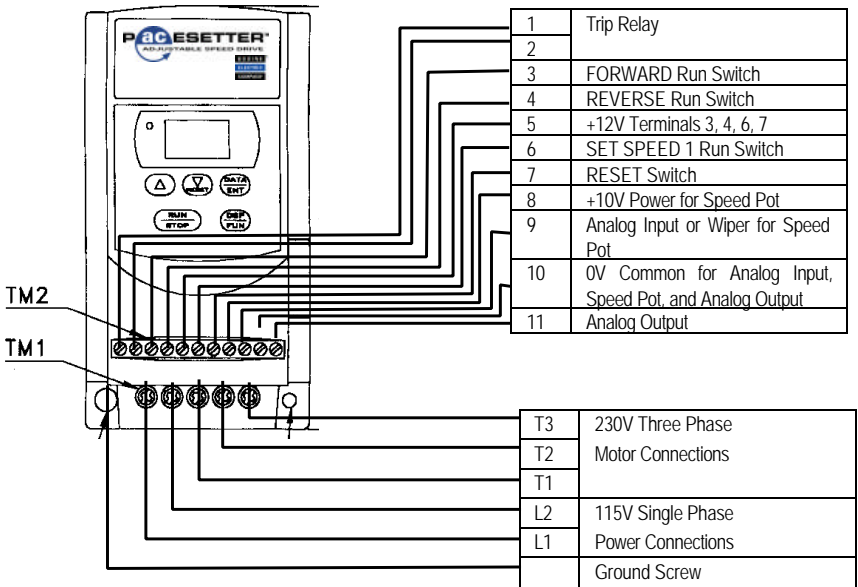


FIGURE 7 – Electrical connections with remote inputs and outputs.

Step 5a – Connect the Motor

Connect a 230 VAC three-phase squirrel-cage induction motor with appropriate ratings for the inverter to the “T1”, “T2”, and “T3” screw terminals on terminal block TM1. Use a Phillips screwdriver to clamp the stripped motor wires. Tighten to 12 lb-in. It doesn’t matter which motor wires go to which terminal. If the motor doesn’t rotate in the desired direction as connected, swap any two of the three motor wires.

Step 5b – Connect Remote Control Devices (optional)

The drive can be completely controlled by the keypad and it is recommended that you operate the inverter this way first to verify that it is operating properly by itself before proceeding to connect external devices to it. For remote operation, the following devices can be connected to terminal block TM2.

FORWARD RUN/STOP SWITCH & REVERSE RUN/STOP SWITCHES – To enable these switch inputs, change programmable parameter F10 to “001” (refer to Step 7 for procedure). Use 20 AWG wire to connect switches with low voltage contacts between terminals 3 and 5 (FWD) and between 4 and 5 (REV). When the FWD (or REV) switch is closed, motor will run in forward (or reverse) direction at the set speed. When the switch is opened, motor will stop. The function of these switch inputs can be changed with programmable function F03.

PRESET SPEED RUN/STOP SWITCH (SP1) - Use 20 AWG wire to connect a switch with low voltage contacts to terminals 6 and 5. When switch is closed, and when motor is commanded to run, motor will run at the speed set by programmable parameter F08. When switch is opened, motor will run at the speed set by either the keypad or a remote signal. The function of this switch input can be changed with programmable function F19.

RESET SWITCH (RESET) - Use 20 AWG wire to connect a switch with low voltage contacts to screw terminals 7 and 5 on terminal block TM2. Close the switch to reset the drive after a fault condition. The function of this switch input can be changed with programmable function F20.

SPEED SIGNAL INPUT (Vin) – To make this input functional, programmable parameter F11 must be changed to “001” or “002” (refer to Step 7 for procedure). Use 20 AWG wire to connect a remote analog voltage or current signal screw terminal 9 on terminal block TM2, using terminal 10 as the signal common. The drive will accept a 0 – 10 VDC, 0 – 20 mA, or 4 –20 mA signal (refer to Step 4 if using a current signal). Alternatively, a speed potentiometer can be connected to the drive as shown in Fig. 1 with the wiper connected to terminal 9 and the two end terminals of the speed pot connected to terminals 8 and 10 on the drive.

ANALOG OUTPUT (FM+) – This output produces a 0 – 10 VDC signal proportional to the output frequency of the drive. Use 20 AWG wire to connect a remote readout or programmable controller to screw terminals 10 and 11 on terminal block TM2.

FAULT OUTPUT (TRIP RELAY) – This relay output has a contact rating of 250 VAC, 1 Amp or 30 VDC, 1 Amp. Use 20 AWG wire to connect a remote device to screw terminals 1 and 2 on terminal block TM2. The relay is normally open and closes when there is a fault condition. This can be used to close the circuit of an alarm or to signal a programmable controller to shut down.

Step 5c – Ground the Inverter

The grounding terminal of the inverter must be correctly grounded in compliance with 200V class type three grounding.

- Grounding wire should be wired in accordance to electrical equipment (AWG) with the length of the grounding wire as short as possible.
- The grounding wire of the inverter must not be grounded together with other large current loading (such as soldering machine or large power motor). They should be grounded separately.
- Prevent ground loops when grounding several inverters together.

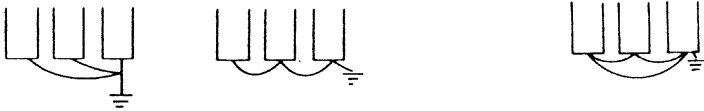


FIGURE 8 – Grounding multiple drives. The two circuits on the left are correct. The circuit on the right creates a ground loop and is incorrect.

Step 4h – Connect Circuit Breaker

Connect a 2-pole circuit breaker between terminals L1 & L2 on terminal block TM1 and the 115 VAC single phase supply.

Step 5d – Connect the AC Line

Connect the 115 VAC single-phase power line to the “L1” and “L2” screw terminals on terminal block TM1. Terminations to the Inverter must be made with either UL listed field wiring lug kits or UL listed crimp type ring terminals.

OPERATION

Step 6 – Check System Before Starting



WARNING

- Recheck all connections.
- Do not remove the front cover of the inverter when the power is ON to avoid personnel injury caused by electrical shock.
- When the automatic restart function is enabled, the motor and machinery will be restarted automatically.
- Do not attempt to install or remove input or output connectors of inverter when the power supply is turned on. Otherwise, the inverter may be damaged due to the surge peak caused by the insertion or removal.
- Do not attempt to wire circuitry while power is on.
- Do not attempt to examine the components and signals on the PCB while the inverter operating.
- Do not touch the heat-sink base during operation.

CAUTION

- 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.
- This product is not provided with over speed protection. The inverter can be easily operated from a low-speed to high-speed range. Please reconfirm the operating range of motor and the machinery you are controlling.

Step 7: Operate the Control

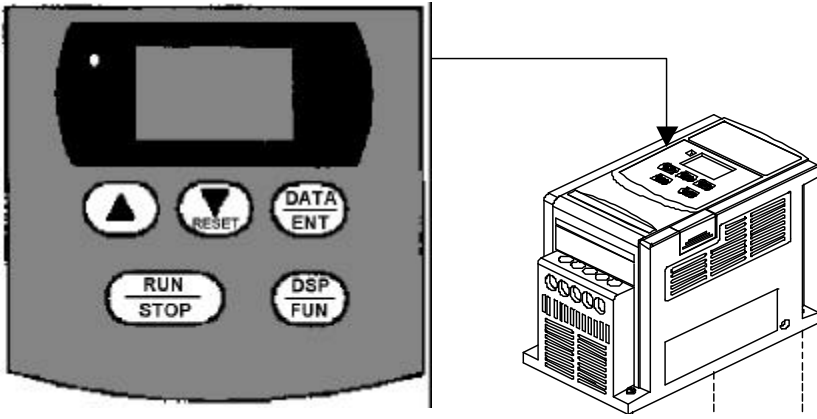


FIGURE 9 – Keypad location and layout

Step 7a – Operate the Inverter using the Keypad

The PACESETTER™ “NANO” series inverter is factory-set for operation using the pushbutton keypad. Use the following procedure to start the motor and adjust speed.

- 1) Turn the AC power ON. The LED display will illuminate and show the current setting for output frequency. The power light just to the left of the LED display will also illuminate.
- 2) Press the button labeled “**RUN/STOP**”. The display will change to show actual output frequency, which will start at “**000**” and ramp up to the set frequency. Simultaneously, the motor will start and accelerate.
- 3) Press the button labeled “**▲**” to increase the output frequency. The motor will accelerate until the “**▲**” button is released. Note that the output frequency changes at a progressively faster rate the longer you hold the button down. Press the “**▼**” button to decrease the output frequency.
- 4) Press the button labeled “**RUN/STOP**” again to stop the motor.
- 5) If the motor does not start promptly and run smoothly, refer to “**TROUBLESHOOTING**”.

Step 7b – Operate the Inverter using remote devices

To enable operation from remote inputs, some of the programmable parameters need to be changed. Assuming the drive is connected as shown in Fig. 7, use the following procedure to enable remote control of start/stop operation, speed adjustment, and direction.

1. Switch on the AC power.
2. Press the **"DSP/FUN"** key. The LED display will change from set output frequency to a function number between **"F00"** and **"F30"**.
3. Press either the **"▼/RESET"** key or the **"▲"** key to scroll through the available function numbers until you reach **"F11"**. This is the function that enables remote control of speed adjustment.
4. Press the **"DATA/ENT"** key. This will change the LED display from the function number to the current setting of the parameter. The factory setting for parameter F11 is "000" for keypad control of speed.
5. Press either the **"▼/RESET"** key or the **"▲"** key to change the setting to either **"001"** or **"002"** (see "Speed Control Method (F11)" on page X).
6. Press the **"END"** key to save the new setting. The LED display will change to **"End"** for 1/2 second and then back to the function number.
7. Repeat the above steps, changing the setting of function number F10 to **"001"** to enable remote control of direction and start/stop operation.
8. When finished programming, press the **"DSP/FUN"** key. The LED display will change back to the set output frequency.

Step 7c – Change other parameters (optional)

Before changing the programmable parameters, first stop the motor if necessary. Only acceleration time (F01), deceleration time (F02), motor direction (F04), and torque compensation (F13) can be changed while motor is running. Use the same procedure described in Step 7b to change other parameters. The following pages give a brief description of each parameter. To clear the inverter of all changes and return it to the factory settings, change function F25 to "020".

Parameter List, Functions F01 – F11

Function	Description	Range	Factory setting
F01	Acceleration time	00.1 – 999 seconds	05.0
F02	Deceleration time	00.1 – 999 seconds	05.0
F03	External operation mode	000: FWD/Stop, REV/Stop 001: Run/Stop, FWD/ REV	000
F04	Direction selection	000: Forward 001: Reverse	000
F05	V/F pattern setting	001: 50 Hz General application 002: 50 Hz High starting torque 003: 50 Hz Variable torque 004: 60 Hz General application 005: 60 Hz High starting torque 006: 60 Hz Variable torque	004
F06	Maximum frequency	01.0 - 200 Hertz	60.0
F07	Minimum frequency	00.0 - 200 Hertz	00.0
F08	Preset speed 1 (SP1)	01.0 - 200 Hertz	10.0
F09	JOG frequency	01.0 – 200 Hertz	06.0
F10	Operation control method	000:keypad 001: external terminal	000
F11	Speed control method	000: keypad 001: external signal (0–10v/0–20mA) 002: external signal (4–20mA)	000

Parameter List, Functions F12 – F27

	Function Description	Range	Factory setting
F12	Switching frequency	001: 4 kHz 002: 5 kHz 003: 6 kHz 004: 7.2 kHz 005: 8 kHz 006: 10 kHz 007: 12 kHz 008: 14.4 kHz 009: 15 kHz 010: 16 kHz	005
F13	Torque boost adjustment	00.0 - 10.0%	00.0
F14	Stopping method	000: decelerate stop 001: free run stop	000
F15	Braking time	00.0 - 25.5 seconds	00.5
F16	Braking starting frequency	01.0 - 10.0 Hertz	01.5
F17	Braking level	00.0 - 20.0%	08.0
F18	Current limit	000 - 200%	100
F19	Input terminal 6 function	001: Jog 002: SP1 003: Emergency stop 004: External Base Block 005: Reset 006: SP2	002
F20	Input terminal 7 function	001: Jog 002: SP1 003: Emergency stop 004: External Base Block 005: Reset 006: SP2	005
F21	Output terminal function	001: Operating 002: Frequency reached 003: Fault	003
F22	Reverse enable	000: REV command enabled 001: REV command disabled	000
F23	Auto restart enable	000: Auto restart enabled 001: Auto restart disabled	000
F24	Auto restart times	000 – 005 times	000
F25	Restore factory settings	010: Restore to 50Hz settings 020: Restore to 60Hz settings	000
F26	Preset speed 2 (SP2)	01.0 - 200 Hertz	020
F27	Preset speed 3 (SP3)	01.0 - 200 Hertz	030

Description of Programmable Functions

F01: Acceleration Time

Function F01 can be changed to adjust the acceleration time from the default setting of 5.0 seconds to any time between 0.1 and 999 seconds.

$$\text{Acceleration time} = F01 \times \frac{\text{Set Frequency}}{60 \text{ Hz}}$$

F02: Deceleration Time

Function F02 can be changed to adjust the deceleration time from the default setting of 5.0 seconds to any time between 0.1 and 999 seconds.

$$\text{Deceleration time} = F02 \times \frac{\text{Set Frequency}}{60 \text{ Hz}}$$

F03: Start / Stop Control from TM2

Function F03 sets the function of input terminals 3 and 4, provided that function F10 is set at "001" for external control operation. The default setting of F03 is "000", which configures input terminal 3 for a "Forward/Stop" switch (close to run forward, open to stop) and input terminal 4 for a "Reverse/Stop" switch (close to run reverse, open to stop). The alternate setting of F03 is "001", which configures input terminal 3 for a "Run/Stop" switch (close to run, open to stop) and input terminal 4 for a "Forward/Reverse" switch (close for forward direction, open for reverse).

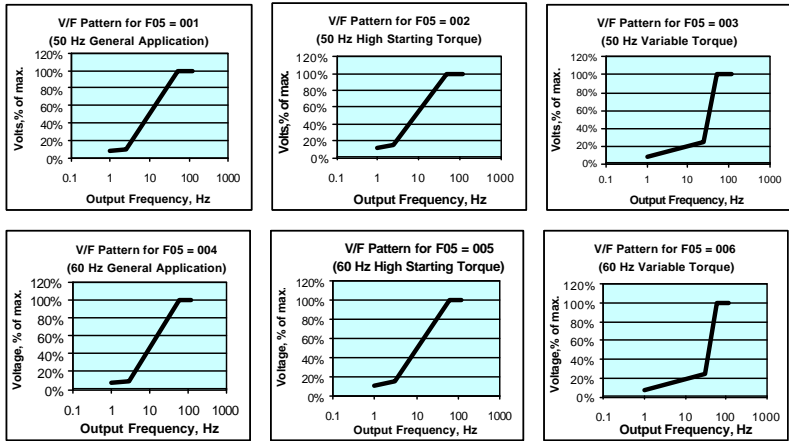
F04: Direction Selection

Although there is no Forward/Reverse push button on the digital control panel, it is possible to change motor direction without changing the motor connection by changing function F04. The factory setting is "000" for forward direction. Changing F04 to "001" will result in reverse direction. NOTE: When F22 = "001", reverse is disabled and F04 can not be set to "001". If it is, the keypad indication will display the error message "LOC".

F05: V/F Pattern Setting

Function F05 can be changed from its factory setting of "004" to any number between "001" and "006". Settings "001" through "003" are to be used only when the inverter is configured for 50 Hz input power. Settings "004" through "006" are to be used only when the inverter is configured for 60 Hz input power. The three different settings for each input frequency control the ratio of output voltage to output frequency. The factory setting of "004" with 60 Hz input power produces a constant volts/frequency ratio between output frequencies of 0 to 60 Hz (above 60 Hz, the output voltage is fixed). The alternate settings either boost the voltage at lower frequencies for higher starting torque (F05 = "002" or "005") or reduce the voltage at lower frequencies for applications where the torque increases with speed, like a fan (F05 = "003" or "006"). See Fig. 10.

FIGURE 10 – Six different V/F settings.



F06: Upper Frequency Limit

Use function F06 to change the upper frequency limit, and hence the maximum motor speed limit, by changing F06 from the factory setting of “60.0” (60 Hz) to any number between “01.0” and “200” in increments of 0.1 Hz up to 100 Hz and increments of 1 Hz after that.

F07: Lower Frequency Limit

Use function F07 to change the lower frequency limit, and hence the minimum motor speed limit, by changing F07 from the factory setting of “00.0” (0.0 Hz) to any number between “00.0” and “200” in increments of 0.1 Hz up to 100 Hz and increments of 1 Hz after that. If F07 > “00.0” and the frequency command \leq F07, the inverter will output according to F07 setting.

F08: Preset Speed 1 (SP1) Frequency

Change the frequency of the SP1 input by changing F08 from the factory setting of “10.0” (10 Hz) to any number between “01.0” and “200” in increments of 0.1 Hz up to 100 Hz and increments of 1 Hz after that. When F19 or F20 = “002” and the corresponding input terminal is ON, the inverter operates at the frequency set by F08. The priority of reading frequency setting is: Jog setting \rightarrow SP1 setting \rightarrow keypad setting or external frequency signal

F09: Jog Speed Reference

Use function F09 to change the frequency of the JOG input by changing F09 from the factory setting of “06.0” (6 Hz) to any number between “01.0” and “200” in increments of 0.1 Hz up to 100 Hz and increments of 1 Hz after that. When F19 or F20 = “001” and the corresponding input terminal is ON, the inverter operates at the frequency set by F09. The priority of reading frequency setting is: Jog setting \rightarrow SP1 setting \rightarrow keypad setting or external frequency signal

F10: Start / Stop Control Method

Use function F10 to select between the keypad (F10 = "000") or an external signal (F10 = "001") for run/stop instruction. The factory setting of F10 is "000". When F10 = "001", emergency stop on the keypad is enabled.

F11: Frequency Command Selection

Use function F11 to select where the frequency command comes from. The factory setting of F11 is "000", so that the frequency command comes from the keypad. Alternate settings allow the frequency command to come from an analog signal on TM2, either 0 ~ 10V or 0 - 20mA (F11 = "001"), or 4 - 20mA (F11 = "002").

F12: Carrier Frequency

Use function F12 to change the PWM switching frequency from the factory setting of 8 kHz (F12 = "005") to any one of the settings listed in Fig. 11.

FIGURE 11 – Ten different PWM switching frequencies to choose from.

F12	carrier frequency	F12	carrier frequency
001	4 kHz	006	10 kHz
002	5 kHz	007	12 kHz
003	6 kHz	008	14.4 kHz
004	7.2 kHz	009	15 kHz
005	8 kHz	010	16 kHz

If F12 = 007 thru 010, the inverter will run hotter than normal. Additional cooling may be required or a motor smaller than the normal rating should be used. Although IGBT TYPE inverters can provide a low audible noise environment during operation, it is possible that high frequency switching may interfere with external electronic components (or other controllers).

F13: Torque compensation gain

Function F13 changes torque compensation gain from the factory setting of 0.0% ("000") to any number between 0.0% ("000") and 10% ("010"). The voltage at the B and C points on the V/F patterns (refer to F05 description) are boosted by the percentage set by F13 to enhance output torque.

F14: Stopping Mode

Function F14 changes the stopping method. If F14 = "000" (factory setting) and the inverter receives a stop instruction, it decelerates to the frequency set by F16 by applying the output voltage level set by F17 for the time duration set by F15. If F14 = "001", the motor coasts to a stop.

F15: DC Braking Time

Function F15 changes DC braking time from the factory setting of 0.5 seconds to any number between 0.0 and 25.5 in increments of 0.1 second.

F16: DC Braking Injection Frequency

Function F16 changes the frequency at which DC Braking begins during deceleration. The factory setting of 1.5 Hz can be changed to any number between 1 and 10 Hz, in increments of 0.1 Hz.

F17: DC Braking Level

Function F17 changes the DC braking level from the factory setting of 8.0% to any number between 0 and 20% in increments of 0.1%.

F18: Electronic Motor Overload Protection

Function F18 changes the current limit from the factory setting of 100% to any number between 0 and 200% in increments of 1%.

- 1) Set F18 so that $F18 = \text{motor current rating} / \text{inverter current rating}$.
- 2) While load is $\leq 100\%$ of motor current rating, operation may continue indefinitely. When load reaches 150% of motor current rating, operation may continue for only 1 minute more, after which the electronic thermal protection is activated and inverter output is shut off. The LED display flashes "OLI". To resume operation, push the RESET button or activate the external reset terminal.
- 3) The electronic thermal protection activation level automatically reduces to a lower level at low frequencies to compensate for the motor's lower heat dissipation efficiency at lower speeds.

F19: Multi-function Input Terminal 6

F20: Multi-function Input Terminal 7

F19 changes the function of input terminal 6 (factory setting is "Preset Speed 1") and F20 changes the function of input terminal 7 (factory setting is "Reset"). Either terminal can be set for any of the following functions: "Jog" ("001"), "Preset Speed 1" ("002"), "Emergency Stop" ("003"), "External Base Block" ("004"), "Reset" ("005"), or "Preset Speed 2" ("006").

Note on Emergency Stop: When F20 = "003" and terminal 6 is shorted to terminal 5 (12V), inverter decelerates motor to a stop (ignoring F14 setting) and LED display flashes "E.S.". After emergency stop signal is removed, either turn RUN switch OFF and ON (if F10 = "001") or push RUN key (if F10 = "000") to restart inverter. If stop signal is removed before motor stops, inverter still executes emergency stop.

Note on External Base Block: When F20 = "004" and terminal 6 is shorted to terminal 5 (12V), inverter output immediately shuts off. The LED display flashes "b.b.". After base block signal deactivated, either turn the RUN switch OFF and ON (if F10 = "001") or push the RUN key (if F10 = "000") to restart the inverter.

Note on Preset Speed 3 (SP3): A single switch closure at either terminal 6 or terminal 7 (depending on settings of F19 and F20) can execute Preset Speed 1 (SP1) or Preset Speed 2 (SP2). To execute Preset Speed 3 (SP3), switches at both terminals 6 and 7 must be closed with F19 and F20 set for "002" and "006" or "006" and "002".

F21: Multi-function Output Terminal

Use function F21 to change the function of output terminal from the factory setting of "Fault" signal (F21 = "003") to either "Running" signal (F21 = "001") or "Frequency Reached" signal (F21 = "002").

F22: Reverse Enable

Function F22 can be used to change the reverse instruction from the factory setting of "REV command enabled" (F22 = "000") to the alternate setting of "REV command disabled" (F22 = "001"). NOTE: When F04 is set to "001" (reverse), F22 can not be set to "001", indication displays "LOC". F04 must be change to "000" before setting F22 to "001".

F23: Momentary Power Loss Ride-Through Enable

Function F23 can be used to change the restart after momentary power loss from the factory setting of "restart enabled" (F23 = "000") to the alternate setting of "restart disabled" (F23 = "001").

- 1) When AC power supply is temporarily drops below the low voltage protection level, the inverter will stop output immediately. If the power source resumes within 2 seconds, the inverter can restart by speed search (start tracing from the breaking frequency), otherwise the inverter break away from "LVC".
- 2) When F23 = "000", if the transient power off duration is less than 2 sec., the inverter resume operation via speed search at 0.5 sec after power up. The restart times is not limited by F24. If the transient power off duration is longer than 2 sec., it is up to the setting on the F24 to decide if the inverter can be automatically restarted.
- 3) When F23 = "001", the inverter break from operation immediately after the transient power off and indicate "LVC". It can not be restarted. (Not controlled by F24)

F24: Number of Auto Restart Attempts

Function number F24 can be used to change the number of auto-restart times after momentary power loss from the factory setting of zero (F24 = "000") to any number between zero (F24 = "000") and five (F24 = "005").

- 1) When F24 = "000", the inverter will not automatically restart after malfunction break from operation.
- 2) When F24 > "000", the inverter will resume operation via SPEED SEARCH at 0.5 second after malfunction break and turn output from inertial operation to the operating frequency before break-up. After that, the inverter will accelerate or decelerate to current frequency setting.
- 3) When the inverter is set to deceleration or DC breaking, the transient restart procedure is not performed.
- 4) When either of following situation happen, the transient restart count will be reset:
 - a. No additional malfunction (in operation or stop) occurs within 10 minutes.
 - b. Press RESET button or external terminal RESET is ON.

F25: Return Drive to Factory Settings

Function number F25 can be used to return all programmable parameters back to their factory setting (F25 = "020") or it can be used to configure the control for the factory settings for 50 Hz power lines (F25 = "010"). F25 is restored back to "000" after the reset process is complete.

- 1) When F25 is set to "010", F05 = "001" and F06 = "050".
- 2) When F25 is set to "020", F05 = "004" and F06 = "060".

F26: Preset Speed 2 (SP2) Frequency

Use F26 to change from the factory setting of SP2 from "10.0" (10 Hz) to any number between "01.0" and "200" in increments of 0.1 Hz up to 100 Hz and increments of 1 Hz after that. When F19 or F20 = "002" and the corresponding input terminal is ON, the inverter operates at the frequency set by F26. The priority of reading frequency setting is: Jog setting → SP2 setting → keypad setting or external frequency signal

F27: Preset Speed 3 (SP3) Frequency

Use F27 to change the factory setting of SP3 from "10.0" (10 Hz) to any number between "01.0" and "200" in increments of 0.1 Hz up to 100 Hz and increments of 1 Hz after that. When F19 or F20 = "002" and the corresponding input terminal is ON, the inverter operates at the frequency set by F27.

TROUBLESHOOTING

WARNING

- Do not remove the cover of the inverter when the power is ON to avoid personnel injury caused by electrical shock.
- When the automatic restart function is enabled, the motor machinery will be restarted automatically after fully stop from operation. Do not get close to the machinery to avoid personnel injury.
- Do not proceed with disassemble or examination procedure before ensuring that the power is off and the Power LED extinguished.

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. Even if the drive itself is definitely defective, it may be that another defective component in the system caused it to fail, in which case replacing the drive alone and not tending to the root cause of the failure may result in another damaged drive. The charts on the following pages assist in troubleshooting common problems which occur during installation and operation.

If problems persist, contact your source of purchase or a Bodine Authorized Service Center and describe the problem in detail. Do not disassemble the product unless authorized by Bodine Electric Company. Performing unauthorized repairs or removing screws will void the Warranty.

GENERAL EVALUATION – Knowing the circumstances under which the problem occurred can help to identify the root cause of the problem. The following are two questions you should ask yourself before tearing everything apart:

Has the system ever operated properly? If the system was just installed and hasn't worked right from the beginning, then it is very likely that something wasn't done correctly in the installation. Focus on incorrect wiring or programming. On the other hand, if the system has been working for an extended period of time and just recently stopped working, then this would indicate that the system was initially installed properly but has somehow changed. Focus instead on failed components or deteriorated wiring.

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 interference.

ISOLATE THE PROBLEM – If there are no obvious indications that the drive has failed (i.e. burns marks or black smoke), then don't assume that it is the defective component.

Disconnect everything except power – With nothing but power connected to the drive, is the display illuminated? Are you able to change some of the programmable functions? If so, the drive logic is okay. If there is no display, then the drive is probably damaged and has to be replaced, but double-check that the drive really is getting power first. Also double-check the wiring for any short circuits to ground which may damage the new drive if not corrected.

Reconnect the motor only – With only the motor and power connected to the drive, see if it now operates properly. If it does, then there may be a problem with one of the external devices. If it still doesn't operate properly, then try replacing the motor. Make sure to replace the cable connecting the motor to the drive or connect the motor directly to the drive to rule out the possibility of a bad cable.

Reconnect external devices one at a time - Assuming the system worked okay with just the motor and power connected, reconnect and test each external device separately to identify which one is causing the problem. Remember that the problem may not be the device itself, but the wiring connecting it to the inverter.

FIGURE 12 - General problem evaluation method

ABNORMALITY	CHECK POINT	COUNTERMEASURE
Motor does not operate	Is LED display illuminated?	<ul style="list-style-type: none"> ● Check that power source is switched on. ● Reconfirm the power voltage level.
	Is error message on LED display?	● See Fig. 19 for interpretation of message.
	Is there a forward or reverse command?	● Check that one of the run switches is closed.
	Is the analog frequency setting loaded?	<ul style="list-style-type: none"> ● Check wiring for analog input signal ● Check that drive is getting speed command.
Motor operates, but in opposite direction	Is F10 setting correct?	● Correct F10 setting for either keyboard or remote speed control.
	Is wiring on the output terminals T1, T2 and T3 correct?	● Swap any two of the three motor wires.
Motor operates, but speed can't be adjusted	Is the wiring for the forward and reverse signals correct?	● Examine the wiring and correct it.
	Is the wiring for analog frequency input correct?	● Examine the wiring and correct it.
	Is F10 setting correct?	● Correct F10 setting for either keyboard or remote speed control.
Motor operates, but speed is too high or too low	Is the loading too heavy?	● Reduce loading
	Is the specification of motor (poles, voltage) correct?	● Reconfirm motor specification.
	Is the gear ratio correct?	● Reconfirm gear ratio
Motor operates, but with abnormal speed variations	Is the highest output frequency setting correct?	● Check F06 setting.
	Is the loading too heavy?	● Increase inverter and motor capacity
Motor operates, but with abnormal speed variations	Is the loading variation too large?	● Reduce loading variation
	Is input power steady and stable?	● Install AC reactor on power supply input.

LED DISPLAY MESSAGES – During most operating conditions, the LED display will show the output frequency of the drive. There are four special operating conditions where a text message (b.b., E.S., SP0, and SP2) is displayed to indicate the special status. There are seventeen text messages that indicate a fault condition when they are displayed. Some of these messages only occur momentarily because of the auto-reset feature of the drive. Other messages occur with a shutdown of the drive and remain displayed until the fault condition is corrected and the drive is manually reset. Fig. 13 lists all twenty-one text messages with an explanation of each one along with any action that may be required when the message is displayed.

FIGURE 13 – LED display messages and interpretation

DISPLAY	REASON	PROBABLE CAUSE	CORRECTIVE ACTION
b.b.	Base block, external	An external BASE BLOCK signal was activated by shorting input terminal 6 or 7 to 12V terminal 5. This requires F19 or F20 to be set at "004".	N/A – this is a status indication, not a fault
CPF	Program error	Outside noise interference from magnetic contact	Place an RC surge absorber in parallel with the magnetic contact
EPR	EEPROM error	EEPROM defective	Return the inverter for repair
Er1	Error in keypad operation	Pressed ▲ or ▼ keys when F11 = "001" or during SP1 operation	Use ▲ or ▼ keys to adjust frequency setting only when F11 = "000"
		Attempted to modify F29	Do not modify F29
Er2	Error in parameter setting	Tried to change a parameter that can't be changed while motor is running	Change parameter only when motor is stopped
		F06 ≤ F07	F06 > F07
E.S.	Emergency stop, external	An external emergency stop signal was activated by shorting input terminal 6 or 7 to 12V terminal 5. This requires F19 or F20 to be set at "003".	N/A – this is a status indication, not a fault
LOC	Locked motor direction	Tried to reverse direction when F22 = "001"	Adjust F22 to "000"
		Tried to set F22 = "001" when F04 = "001"	Adjust F04 to "000"
LV	Low voltage while not operating	Power source voltage too low.	Examine power supply
		Detection circuitry defective.	Return inverter for repair
LVC	Low voltage while operating	Power supply voltage too low	Improve power source quality
		Power supply voltage variation too large	Install reactor on power supply input
OC	Over-current at stop condition	Detection circuit malfunction	Return the inverter for repair
OCA	Over-current at acceleration	Acceleration time too short	Adjust for longer acceleration time
		Improper V/F curve selection	Adjust to a proper V/F curve
		Motor too large for inverter	Replace inverter with larger model
OCb	Over-current at braking	DC Braking frequency, braking voltage, or braking time too long	Adjust to reduce settings of F15, F16, or F17

FIGURE 13 (CONTINUED) – LED display messages and interpretation

DISPLAY	REASON	PROBABLE CAUSE	CORRECTIVE ACTION
OCC	Over-current at steady speed	Transient load fluctuation	Examine loading configuration
		Transient power supply fluctuation	Put inductor on power supply input
Ocd	Over-current at deceleration	Deceleration setting too short	Adjust to longer deceleration time
OCS	Over-current while starting	Motor coil shorted to frame	Repair or replace motor
		External motor connections shorted to ground	Correct wiring
		Transistor module damaged	Repair or replace inverter
OH	Overheated inverter while not operating	Detection circuit defective.	Repair or replace inverter
		Excessive ambient temperature or poor ventilation	Improve ventilation
OHC	Overheated heatsink while operating	Loading too heavy	Reduce motor load
		Ambient temperature too high or poor ventilation	Improve ventilation
OL1	Overloaded motor	Loading too large	Replace motor with larger one
		Improper V/F model setting	Adjust V/F curve setting
		Improper Fn_18 setting	Adjust F18 to a proper setting
OL2	Overloaded inverter	Loading too large	Replace inverter with larger one
		Improper V/F model setting	Adjust V/F curve setting
OV	Over-voltage while stopped	Power supply voltage too high	Examine the power supply
		Detection circuitry defective	Return the inverter for repair
OVC	Over-voltage during deceleration	Deceleration time too short or inertial loading too large	Adjust to longer deceleration time
		Excessive supply voltage variation	Put inductor on power supply input
SP0	Zero Speed Stopping	F11 = "000", F07 = "000" and frequency setting < 1 Hz	N/A – this is a status indication, not a fault
		F11 = "001", F07 < F06/100, and frequency setting < F06/100	N/A – this is a status indication, not a fault
SP2	Keypad emergency stop	The inverter is set up for external operation (F10 = "001") and the STOP key is pressed while motor is running. The inverter stops according to the setting of F14. The RUN switch must be turned OFF then ON to restart the machine.	N/A – this is a status indication, not a fault

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The Bodine Electric Company warrants all products it manufactures to be free of defects in workmanship and materials when used under Normal Operating Conditions and when applied in accordance with nameplate specifications. This warranty shall be in effect for a period of twelve months from date of purchase or eighteen months from date of manufacture, whichever comes first.

The Bodine Electric Company will repair or replace at its option, any of its products which has been found to be defective and is within the warranty period, provided that the product is shipped freight prepaid, with previous authorization, to Bodine's plant in Chicago, Illinois 60618 U.S.A., or to the nearest Bodine Authorized Service Center. At its option, all return shipments are F.O.B. Bodine's plant or 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 or purpose.

Bodine's liability under this warranty shall be solely limited to repair or replacement of the Bodine product within the warranty period and Bodine shall not be liable, under any circumstances, for any consequential, incidental or indirect damages or expenses associated with the warranted products.

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