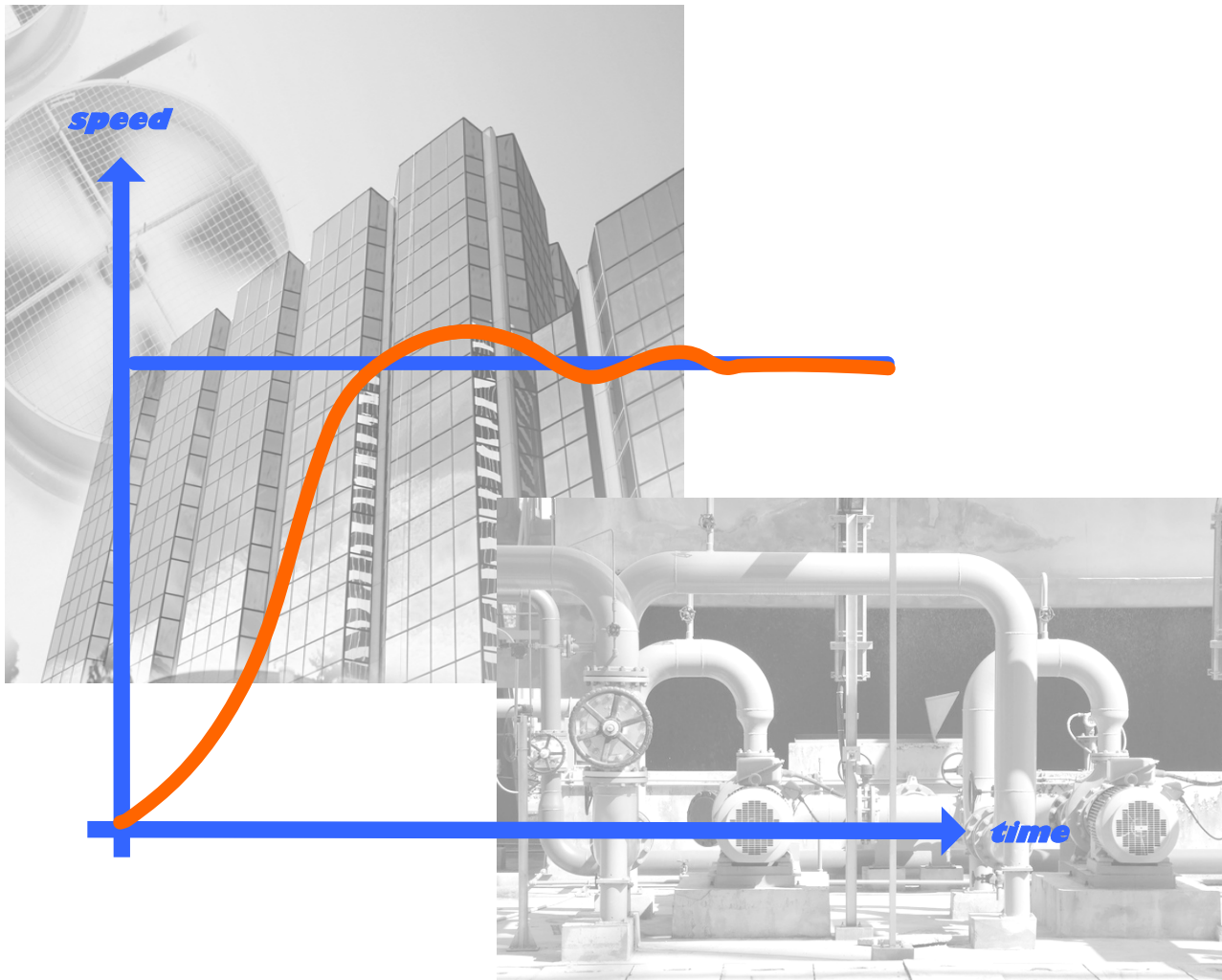


MA7200 PLUS INVERTER SERIES

PID Quick Start Manual For Fan and Pump Applications *1 to 2 HP*

*Models- MA7200-2001/2-N1 (230V)
&
MA7200-4001/2-N1 (460V)*



TECO   **Westinghouse**

Rev. 1.3 - May 27th 2008

PID Quick Start Guide for Fan and Pump Applications

PID is a control method that can be used for the purpose of automatically regulating flow or pressure in fan and pump applications. Following steps 1 through 13 listed below in this guide will simplify the start up of the MA7200 PLUS Inverter series for fan and pump applications using PID control. Some of the steps are specific to pump applications *only* and will be so noted. The guide is not intended to replace the MA7200 PLUS Installation and Operation Manual, and the user is urged review this manual.

The PID method of control covered by this guide will consist basically of a **set-point** (operating point, e.g. flow, pressure etc.) entered through the keypad and an analog transducer **feedback** signal (0 – 10 VDC or 4 - 20 mA). These two signals are then compared, and through PID processing, correct for any load or environmental changes to maintain the **set-point**. Only the **(P) proportional** and **(I) integral** parameters will be set and adjusted through the keypad to optimize performance. The parameter **(D) derivative** will not be discussed or used in this guide as the factory setting is usually sufficient for fan and pump applications. Actual values will be used to provide a realistic example of setting up PID control.

Although the inverter can be controlled via *serial communication*, it is beyond the scope of this guide and the user is referred to the MA7200 PLUS Installation and Operating Manual for further information on this subject.

- Step 1 – Before starting the inverter –*Safety First!*
- Step 2 – Apply power to the drive.
- Step 3 – Set drive to run mode.
- Step 4 – Check fan or pump motor operation.
- Step 5 – Making external digital input / output and analog feedback control wiring connections.
- Step 6 – Select stop / start method of control.
- Step 7 – Setting minimum speed in pump applications. **(Pump applications only)**
- Step 8 – Select PID control and feedback input
- Step 9 – Select engineering units.
- Step 10 – Setting PID parameters
- Step 11 – Setting acceleration and deceleration. (Note 1)
- Step 12 – Setting PID sleep functions. **(Pump applications only)**
- Step 13 – Testing the system.

Note 1 – The acceleration and deceleration parameters are not specific to PID control but are included as part of the PID set-up.

SAFETY FIRST!

Step 1 - Before Starting the Inverter

- Referring to the MA7200 PLUS Instruction Manual, please review and verify that the correct inverter size for the motor was received free of damage. To ensure personnel safety and to avoid equipment damage, follow the precautions and the installation procedures for mounting, wiring, and operating environment.



CAUTION - To avoid damage to the inverter when removing the inverter cover and/or LCD Operator, refer to Appendix B for the proper procedure.

- In accordance with applicable codes make electrical connections to the motor and input power terminals. (Refer to the block diagram, Fig. 4). *No other external connections should be made at this time, as the initial control will be from the keypad.*

Step 2 - Apply Power to the Drive

- Apply AC power to the Inverter and observe the LCD Display Line 1; it should read "Freq. Cmd 000.00Hz". Line 2 should read "TECO". The red LED on the **STOP** key should be *on*. The **DRIVE** and **FWD** LED's should be *on*. (See Fig. 1 below)

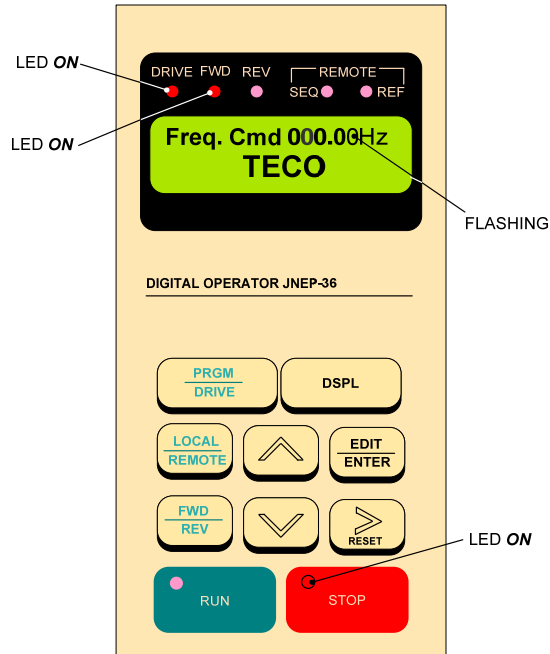


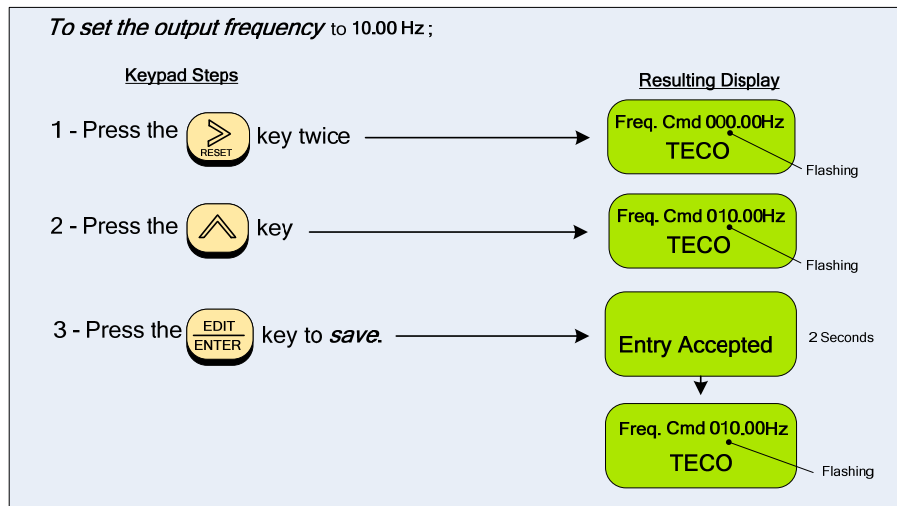
Fig. 1 MA7200 PLUS Keypad

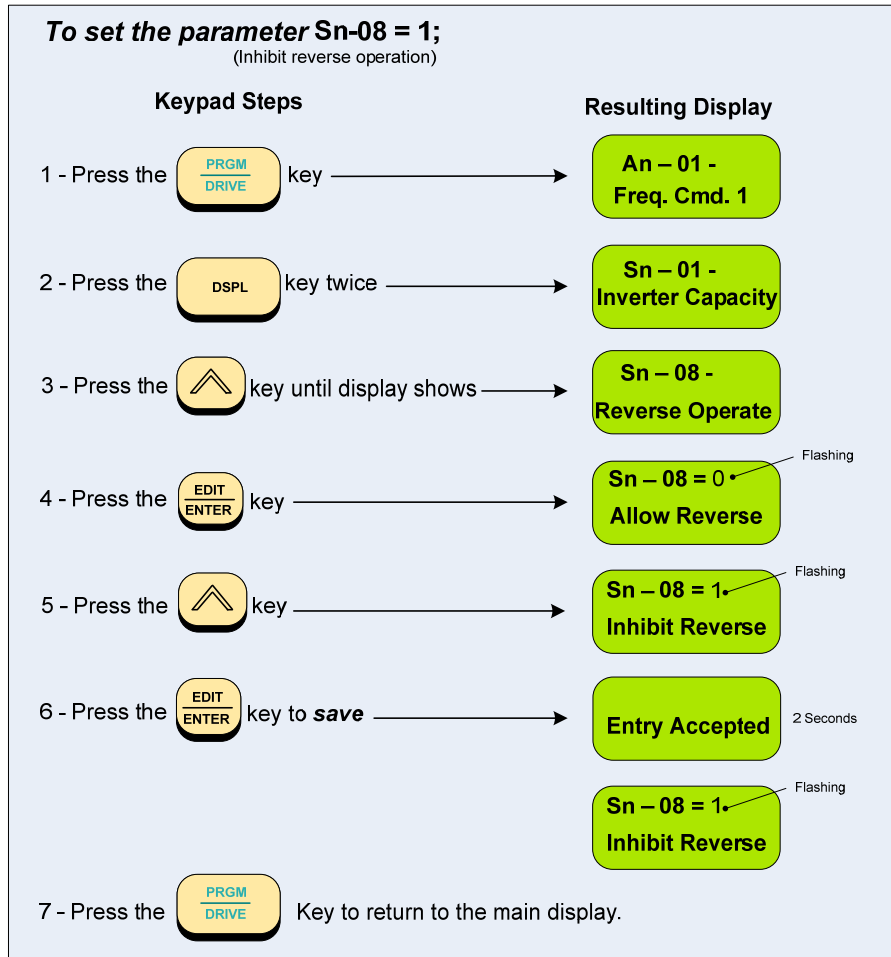
Step 3 - Set Drive to Run Mode

- If the red **DRIVE** LED is not on with AC power up, press the **PRGM / DRIVE** key until the red **Drive** LED is *on*. The Inverter is now in the **RUN** mode.

Step 4 - Check Fan or Pump Motor Operation

- Enter **10.00Hz** for the frequency reference and set parameter **Sn-08 = 1** to disable Reverse Direction Operation. **Note:** The output from the inverter is displayed in **Hz** as factory default. If desired, the output may be displayed in other **units** such as (%) of full speed, PSI etc. (see **Step 9**)





- Press the **RUN** key, and check the fan or pump direction of rotation. If the direction is not correct, press the **STOP** key and wait until the fan or pump has come to a complete **STOP**. Next, **power down the inverter**.



Danger

After the power has been turned OFF, wait at least 5 minutes until the charge indicator extinguishes completely before touching any wiring, circuit boards or components.

- Reverse any **two** of the fan or pump motor connections at the inverter (U(T1),V(T2), or W(T3)). Next, following **STEP 2**, power-up the inverter; the motor direction should now be correct.

Step 5 – Making External Digital Input/Output and Analog Feedback Control wiring Connections

- **Before removing any covers or making any external control connections, power down the inverter.**



Danger

After the power has been turned OFF, wait at least 5 minutes until the charge indicator extinguishes completely before touching any wiring, circuit boards, or components.

- In this step the external wiring connections will be made for the various control functions. To do this, the method of control and feedback used in your particular application must be determined. In the following pages are wiring examples for (digital input) Start / Stop, and (analog) Feedback. Also included are E-Stop, (digital output) Restart, and Fault indication connections.

DIGITAL INPUT / OUTPUT terminal connections

Fig's 2a, 2b, and 2c below show the terminal connections for input control functions. The connections shown are typical and the user is referred to the **MA7200 PLUS Manual** if additional information is required. Fig.2d shows an example for the use of the **Fault Output Relay**.

Fig. 2a Start / Stop Switch Connection

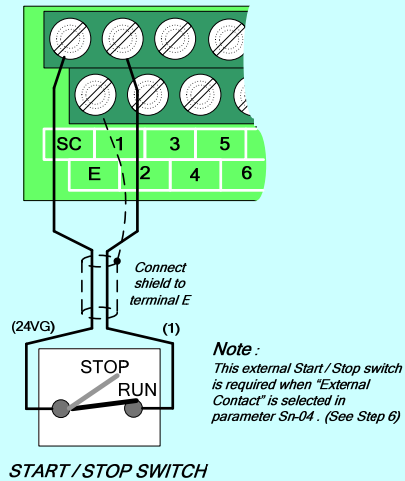


Fig. 2b External Fault Contact Connection

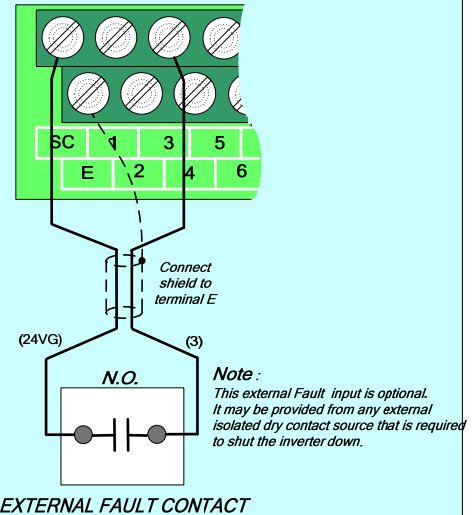


Fig. 2c Fault Reset Switch Connection

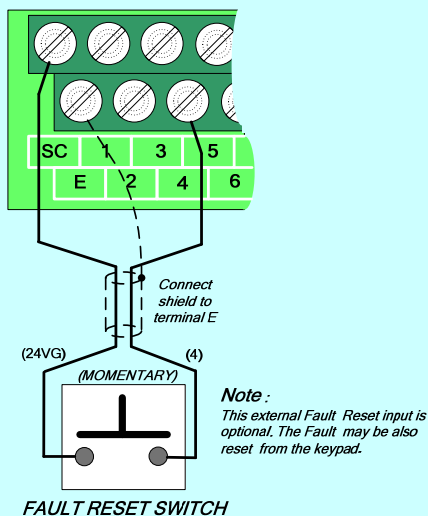
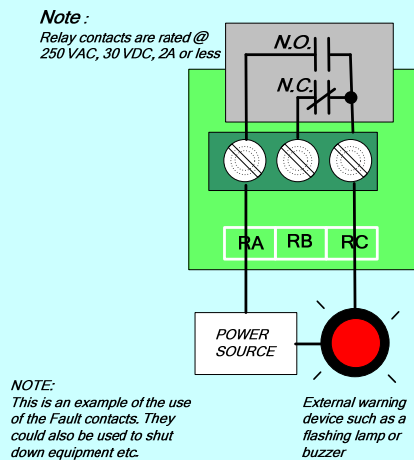


Fig. 2d Fault Output Contacts



ANALOG FEEDBACK terminal connections

Fig's 3a,3b, and 3c, show the analog feedback schemes for **0-10VDC or 4-20mA** devices to control flow, level, pressure etc.

Fig. 3a Speed Control Potentiometer Input

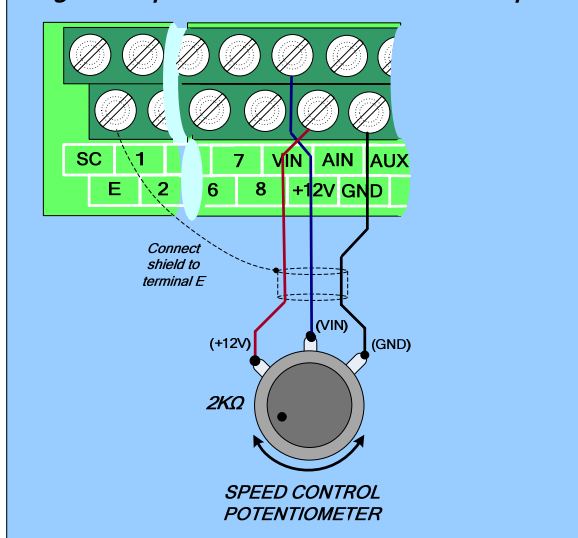
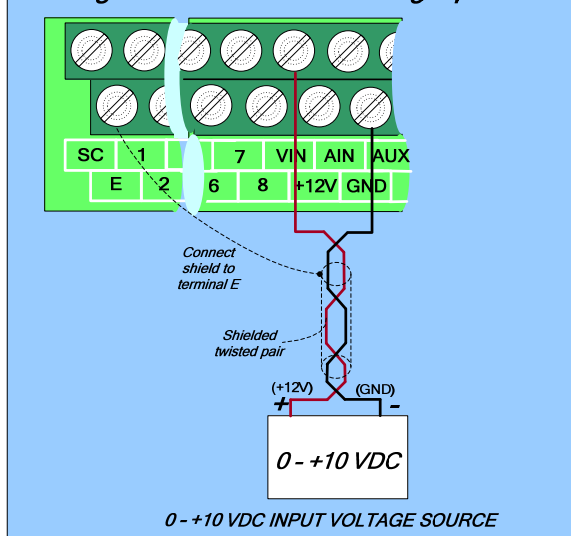


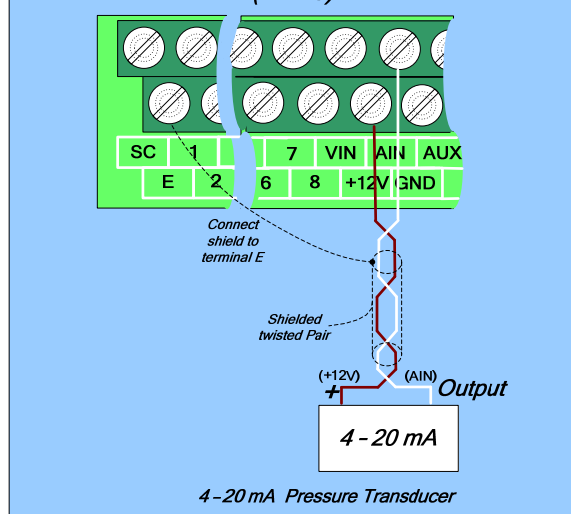
Fig. 3b 0 - +10 VDC Analog Input



NOTES:

- 1 - Before connecting any feedback device, be sure to read the manufacturers instructions thoroughly as wiring color codes and connections may vary.
- 2 - Fig's 3a and 3b show typical connections for 0 - +10VDC and 4 - 20 mA feedback devices. The wiring color codes red and black and the connections shown are for illustrative purposes and may be different for a particular feedback device.
- 3 - As an example Fig. 3c shows the connections for a 4-20 mA pressure transducer used in water pump applications. Note that the color code is brown and white and the connections are to +12 and AIN.

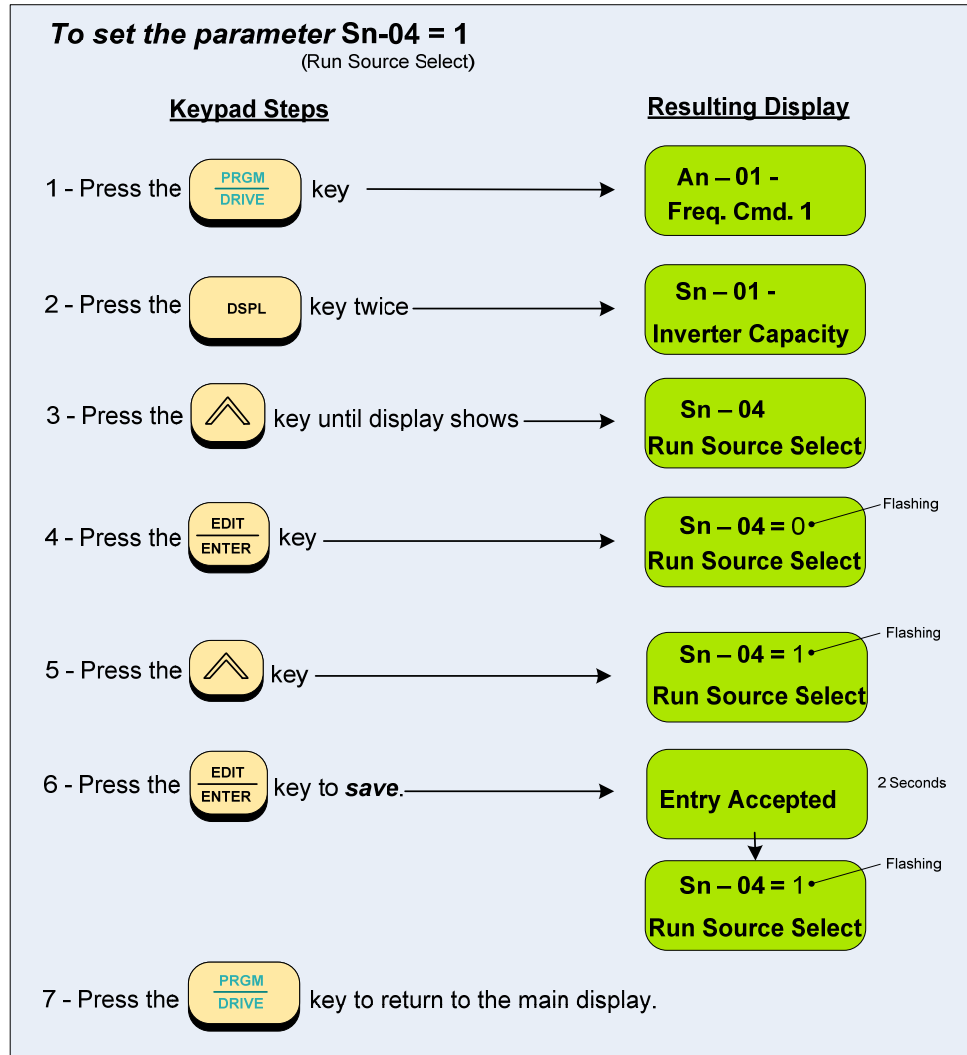
Fig. 3c 4 - 20 mA Analog Feedback
(Note 3)



- After all of the external wiring has been completed and secure, replace all covers and power up the inverter.

Step 6 – Select Start / Stop Method of Control (Sn-04)

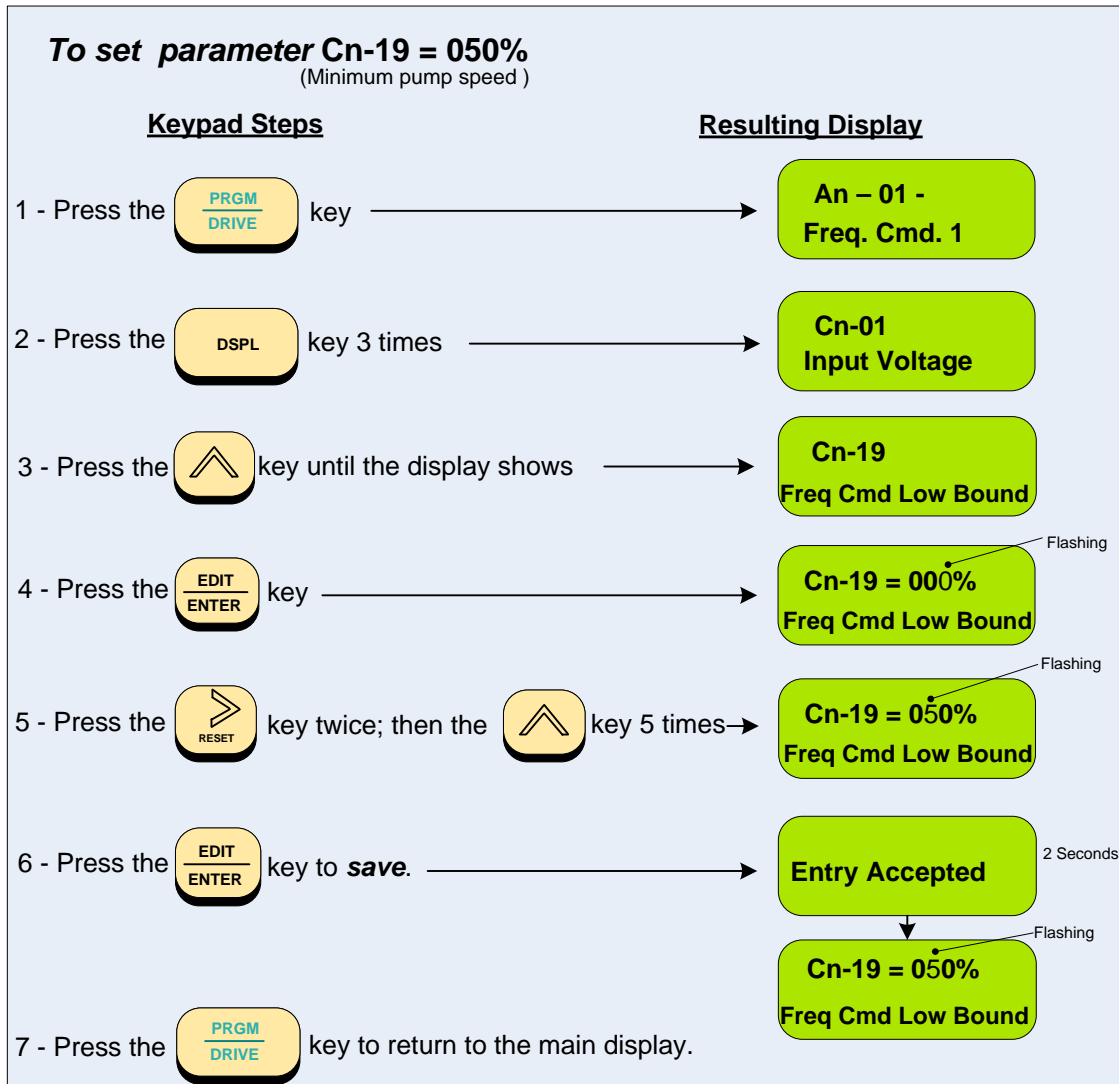
- Before selecting this parameter, **ensure the inverter is in the STOP mode.**
- The **set-point** is selected by the keypad (**Sn-05=0**), and the **start / stop** method can be from the keypad or external contact (**see Fig. 2a**). **NOTE: The set-point can also be set from an external source but commonly it is set from the keypad.**
- The parameter (**Sn – 04**) is set to = **0 (keypad)**, as factory default. If **external** contact is desired, follow the navigation procedure below to set (**Sn-04 = 1**).



Step 7 – Setting Minimum Speed in Pump Applications

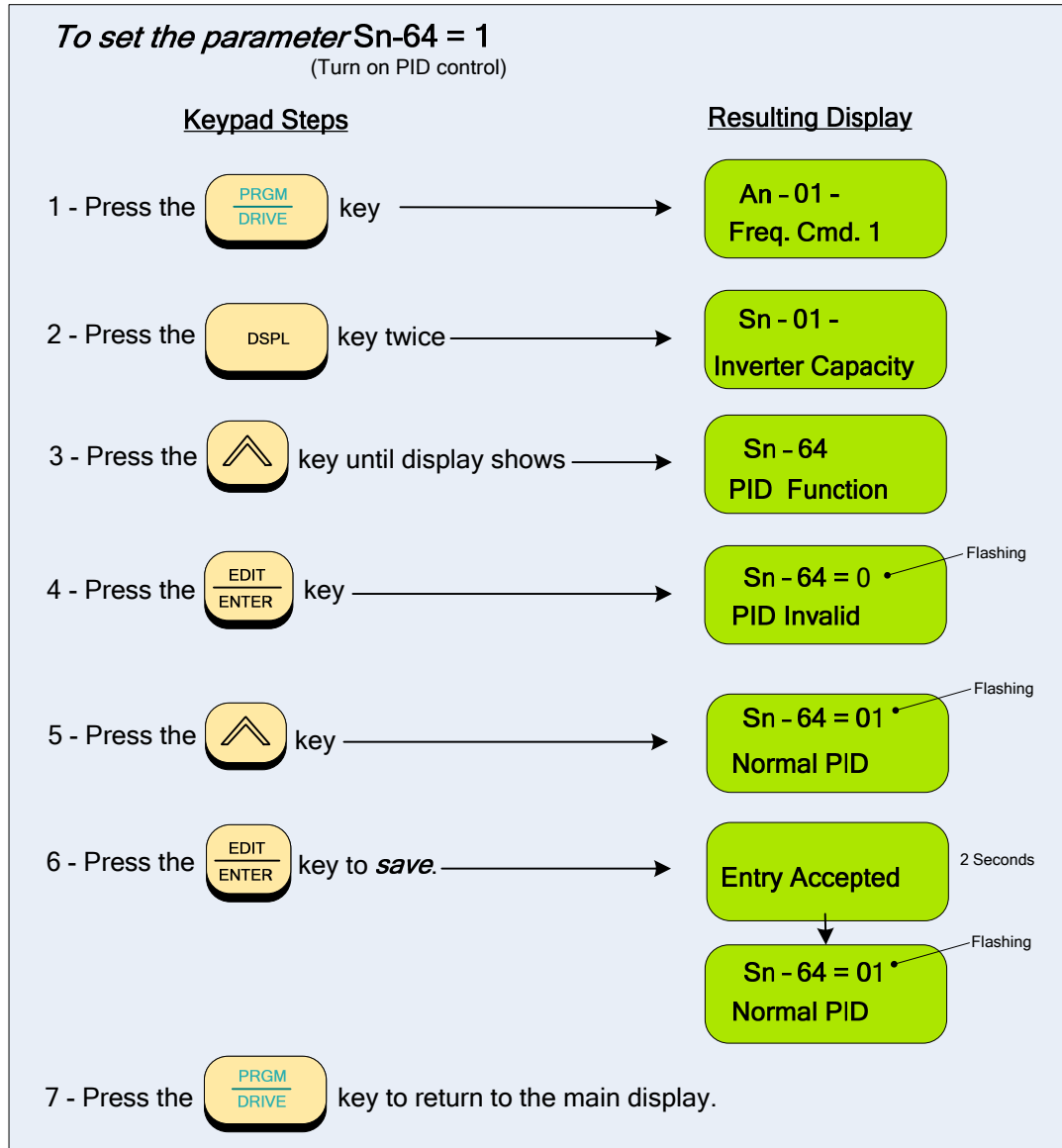
(NOTE: In the case of a fan application skip this step and go to Step 8)

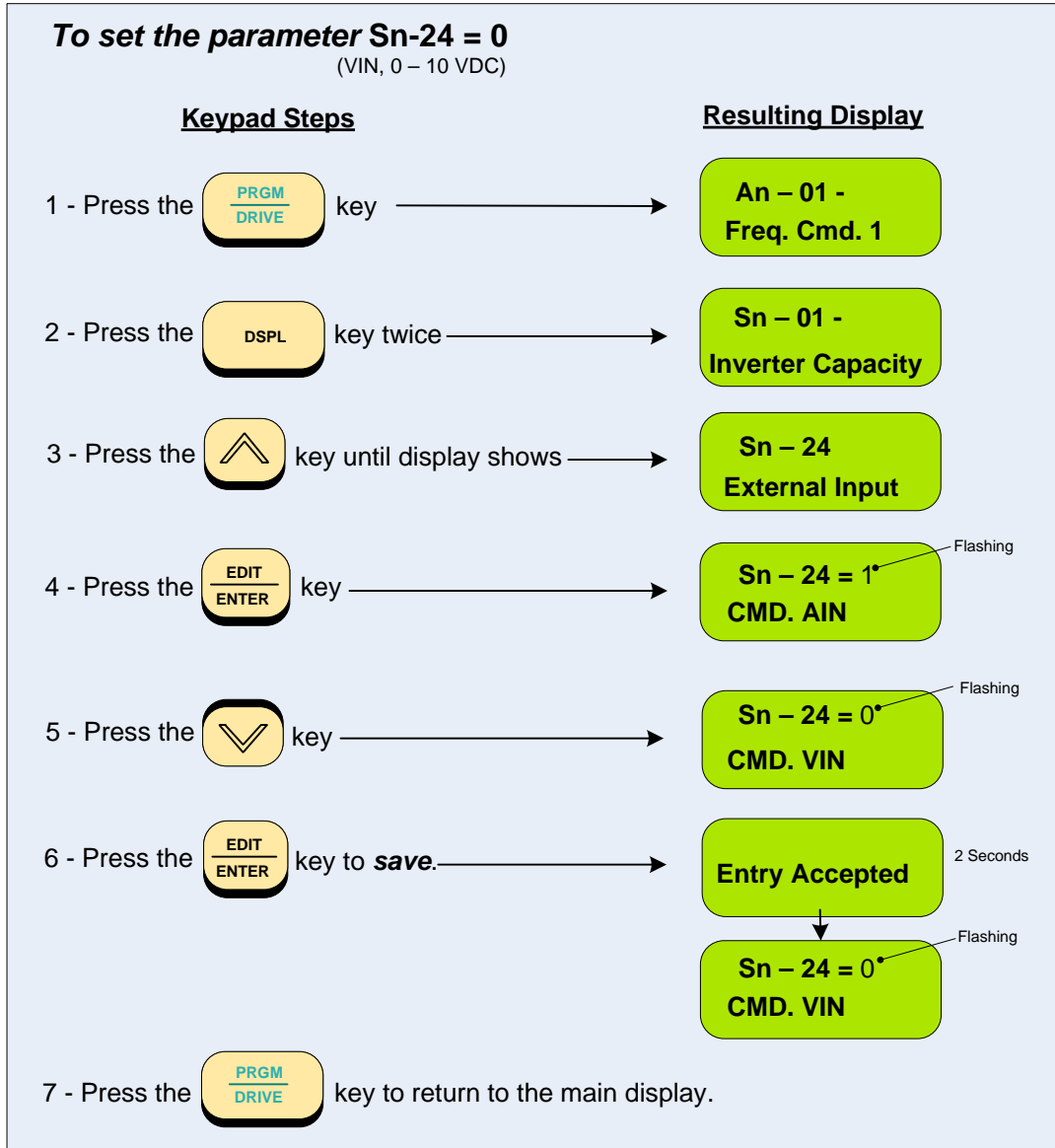
- In the case of pump applications it is normally required to limit the minimum speed that the pump will operate regardless of the input speed command. The pump minimum speed is usually specified either by the pump manufacturer or the application. Once this value has been established, the minimum output frequency of the inverter and thus the minimum motor (pump) speed can be set by parameter **Cn-19**. This parameter sets the minimum inverter frequency output, and thus a minimum motor (pump) speed to a **percentage** of the maximum output command frequency.
- The following is an example of setting the minimum motor (pump) speed to **1800 RPM**, which is **50%** of the maximum pump speed, **3600 RPM**.



Step 8– Select PID control (Sn-64), and Feedback input (Sn – 24) [4 – 20 mA or 0 – 10 Vdc]

- Before selecting the parameter(s), **ensure the inverter is in the STOP mode.**
- To activate PID control parameter (**Sn-64**) must be set to =1.
- The Feedback Input parameter (**Sn –24**) is set to = 1 (AIN, 4-20 mA), as factory default. To select (VIN, 0-10 Vdc), (**Sn-24**) must be set to 0. (See Figs. 3a, 3b and 3c for feedback connections)
- To set the parameter(s), follow the navigation procedure as shown next.

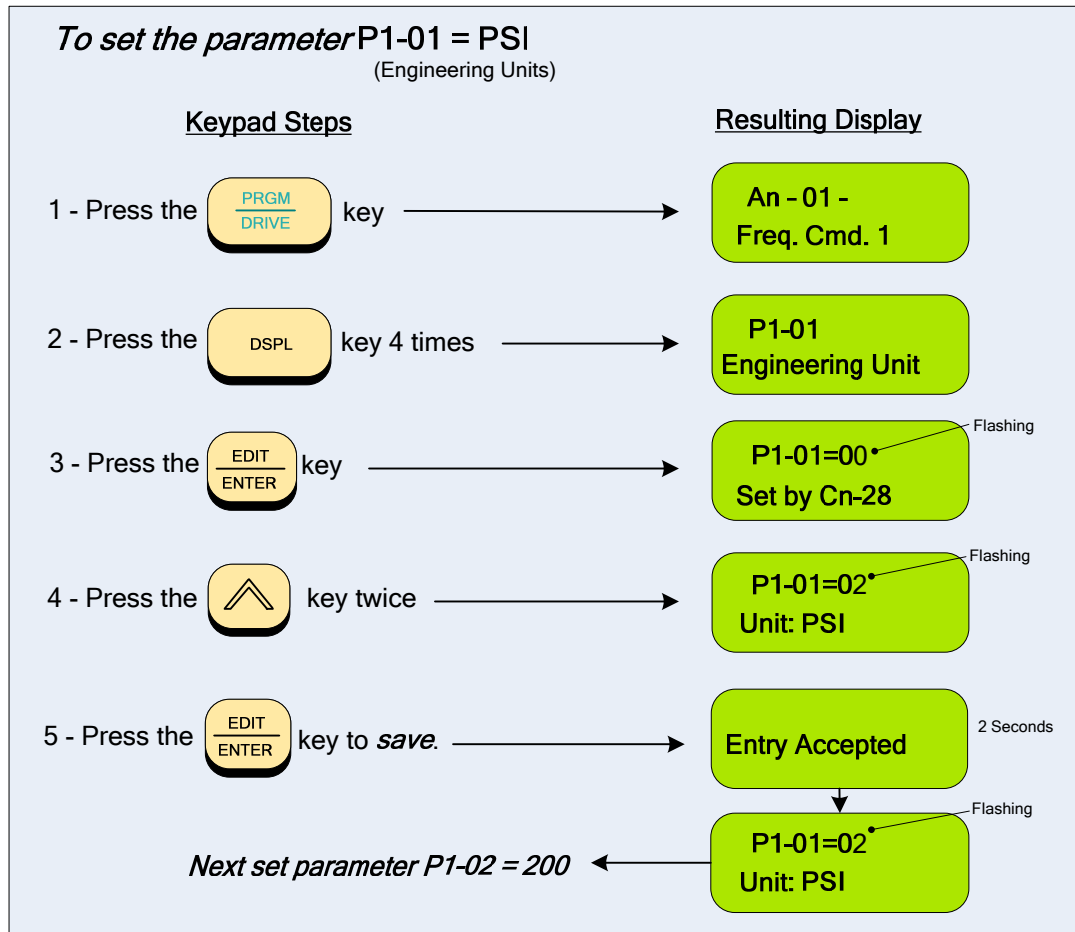




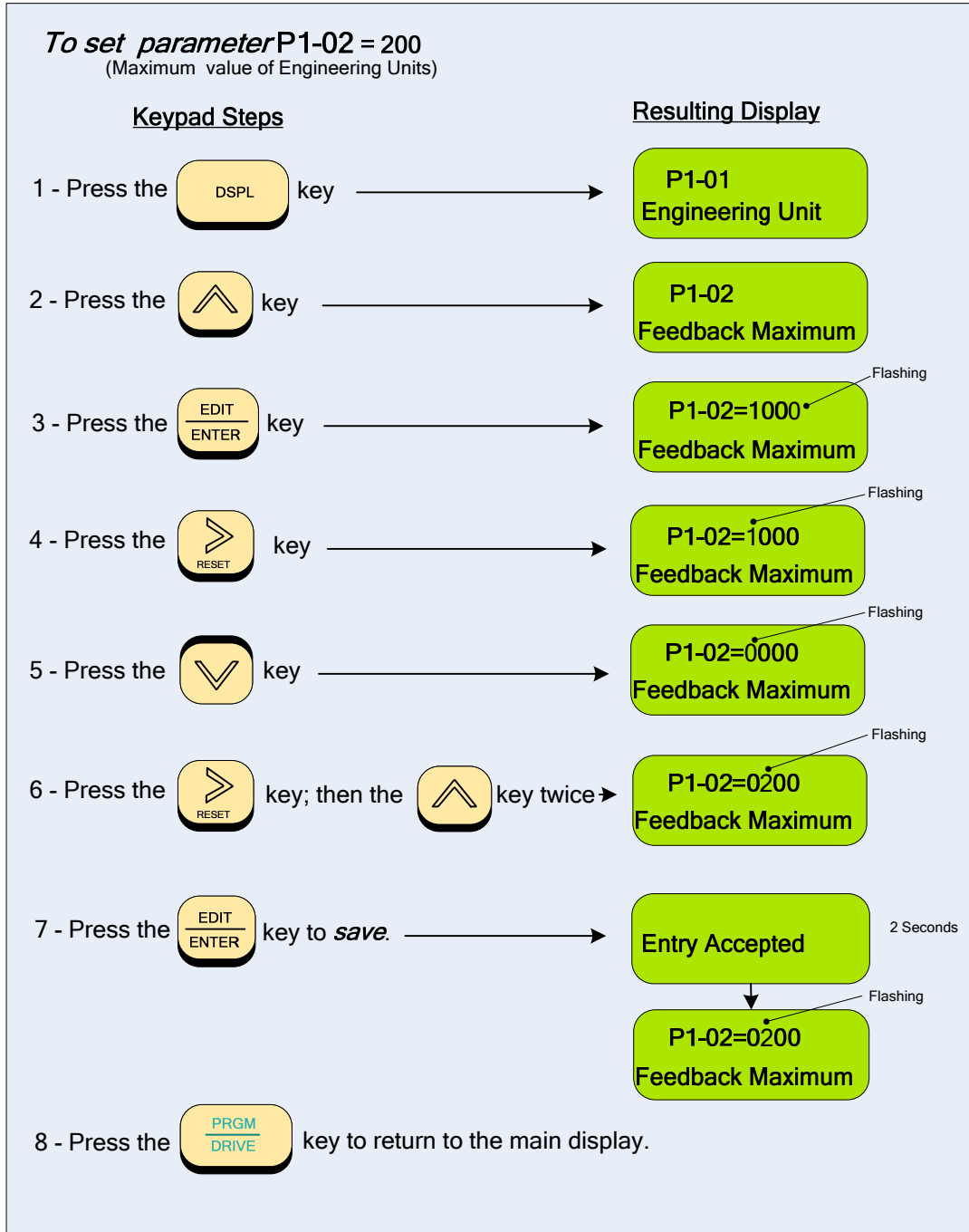
Step 9 – Select Feedback Engineering Units (P1-01) and Scaling (P1-02)

- Initially the display will read *output frequency* in (Hz) as the *factory default* and is set by parameter (**Cn-28=0**). If (**Cn-28**) is changed to (**=1**), then the display will read out in (%). The setting of (**Cn-28**) is only *valid* if (**P1-01=0**), which is the *factory default*. Other engineering units may be selected by parameter setting (**P1-01**) as described on the following page.
- In this step, the feedback engineering units that the system is controlling such as CPM in fan applications or PSI in the case of pumps can be selected by parameter (**P1-01**). (See **Appendix A** for additional selections). The *maximum* value that the engineering units will be in any given application is set by parameter (**P1-02**). These selections will now be displayed on the digital operator.

Example: A pump application that has a feedback transducer with a maximum value of 200 PSI i.e 200 PSI = 20mA or 10 Vdc, can be set as shown next.

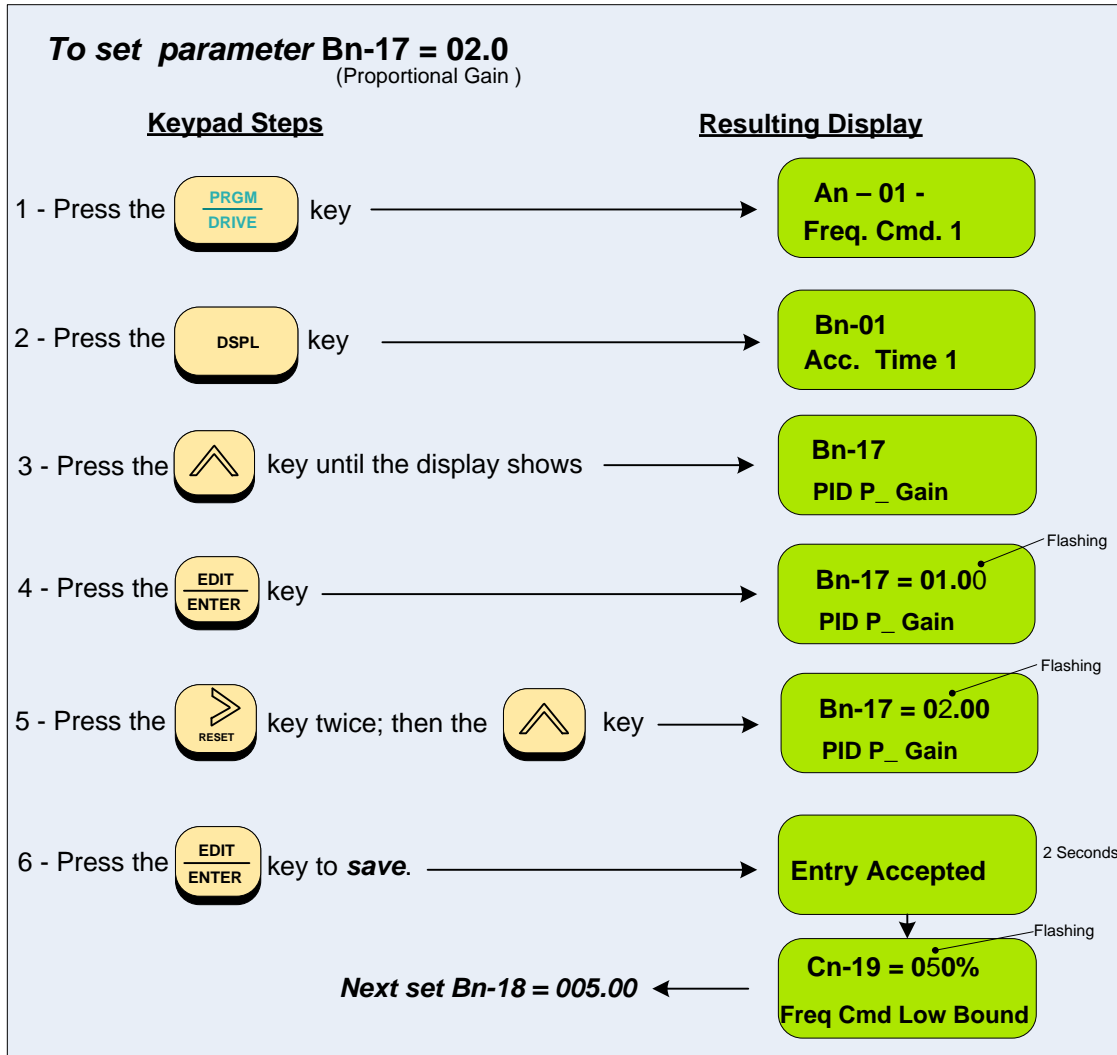


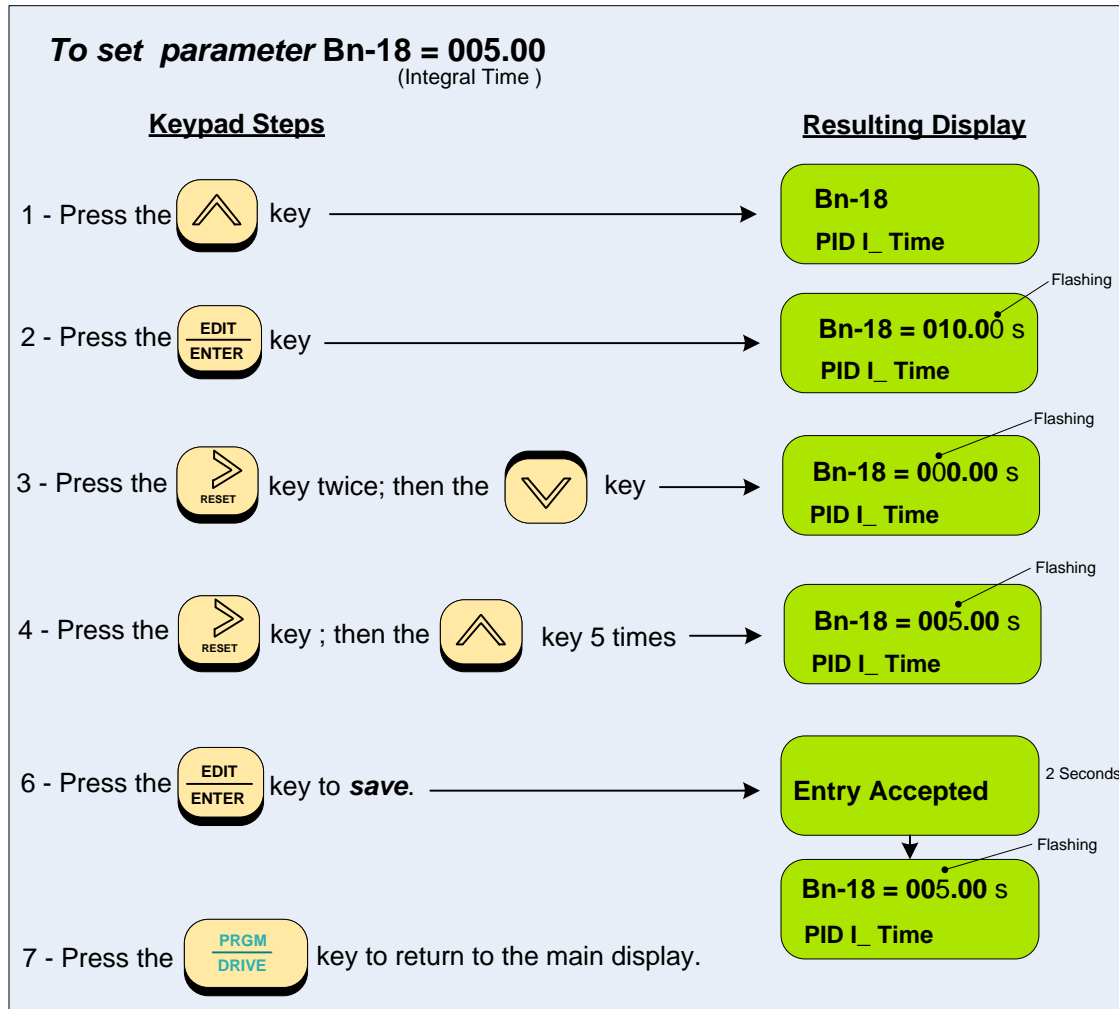
Note: Once P1-01 is set to a non-zero value, then Cn-28 is no longer valid.



Step 10 – Setting PID Parameters; Proportional Gain (Bn-17) and Integral Time (Bn-18)

- After all external connections have been made and the protective covers have been replaced, **power up** the inverter **but do not run at this point**.
- Parameters **Bn-17 = 1.0** (*Proportional Gain*) and **Bn-18 = 10.0s** (*Integral Time*) are factory set to the values shown. However, a good starting point for these values is setting the **Proportional Gain Bn-17 = 2.0** and the **Integral Time Bn-18 = 5.0s**. To change these parameters, follow the keypad navigation procedure below.





Word About PID Control-

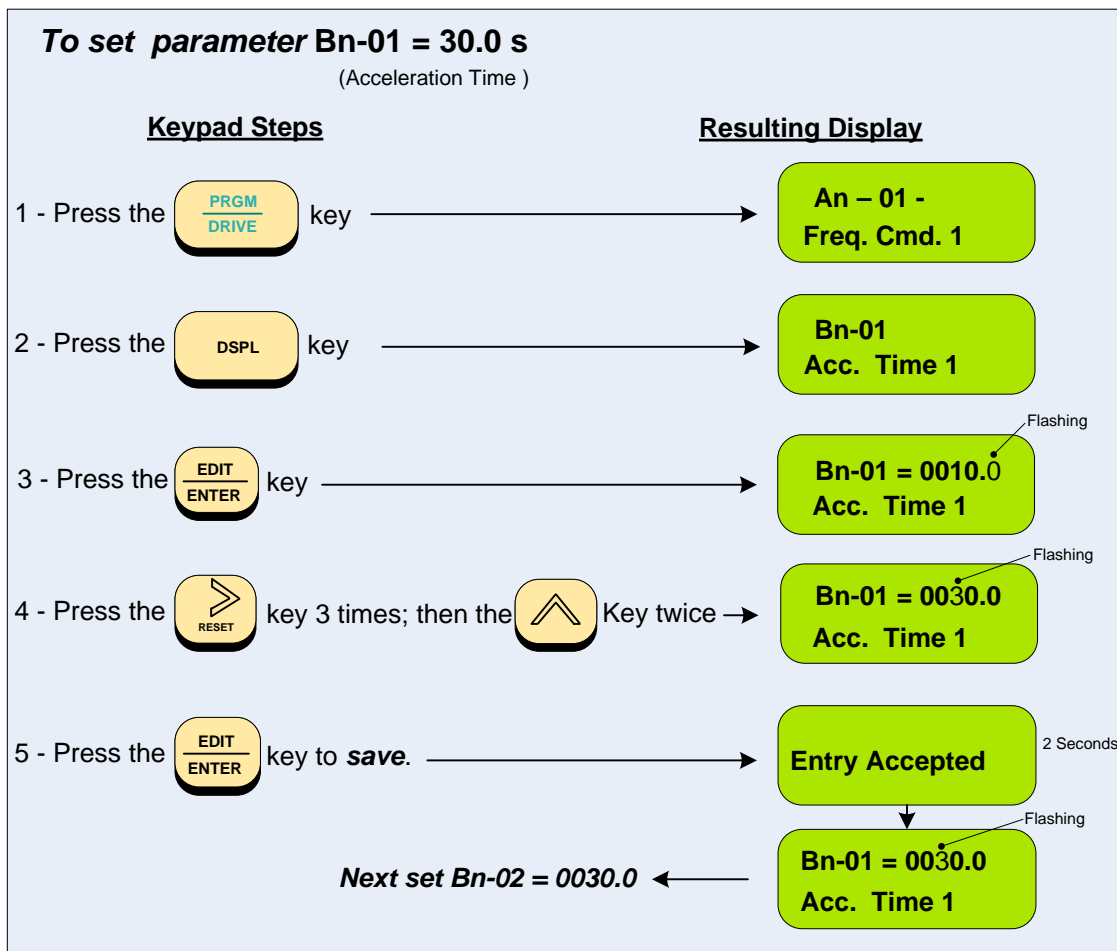
The PID control serves to maintain a given process within certain limits whether it be pressure, flow etc. To do this the **feedback** signal is compared to the **set-point** and the difference becomes the error signal for the PID control. The PID control then responds by trying to adjust output motor frequency to minimize this error. How small the difference becomes is dependent upon the value of the **Proportional Gain** set by parameter **Bn-17**. The greater the gain the lower the difference. However, in any system as the gain is increased there is a point that the system will become unstable (oscillate). To correct this instability, the response time of the system may be **slowed** down by increasing the **Integral Time** set by parameter **Bn-18**. However slowing the system down too much may be unsatisfactory for the process. The end result is that these two parameters in conjunction with the acceleration (**Bn-01**) and deceleration (**Bn-02**) times (see **STEP 11**) are adjusted to achieve optimum performance for a particular application.

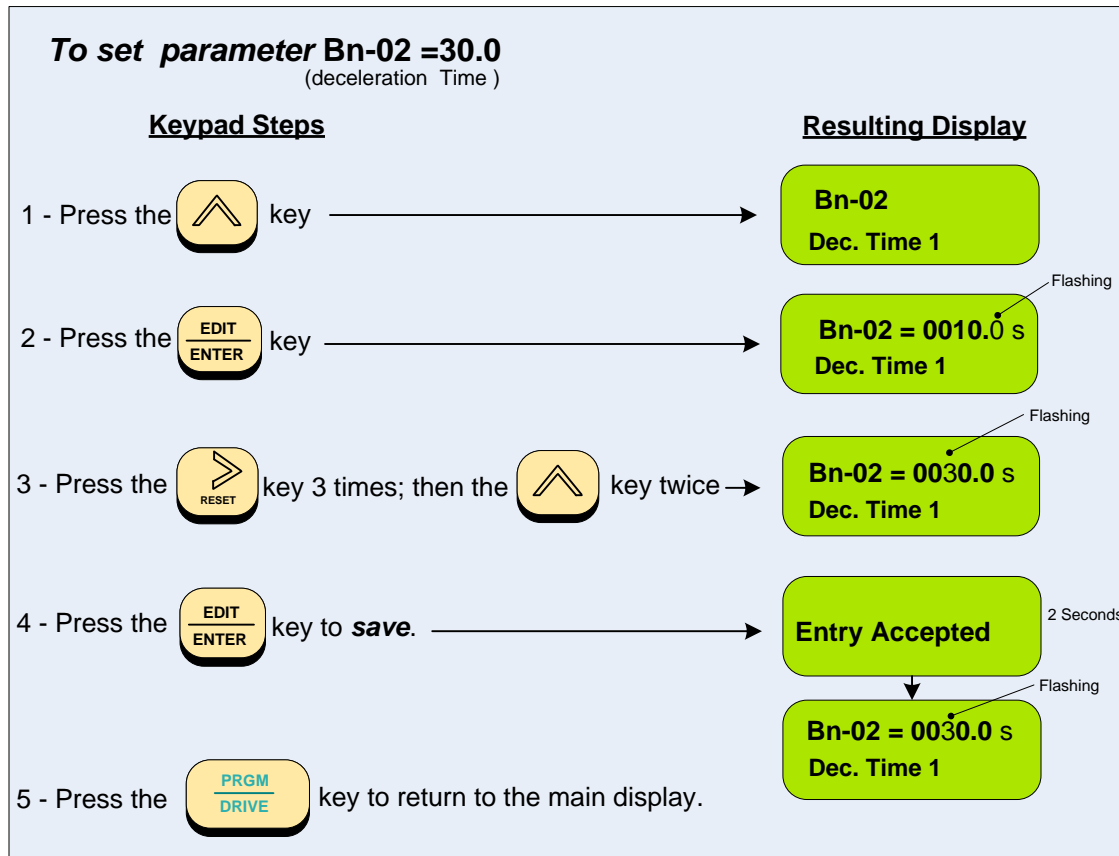
Step 11 – Setting parameters acceleration (Bn-01) and deceleration (Bn-02) times

- Acceleration and Deceleration times as well as the PID control [(P) Proportional Gain and/or the (I) Integral Time (see STEP 11) directly control the system dynamic response. The longer the acceleration and deceleration time, the slower the system response, and the shorter time, the faster the response. An excessive amount of time can result in sluggish system performance while too short of a time may result in system instability.

The starting values suggested by this guide normally result in good system performance for the majority of fan and pump applications. If the values need to be adjusted, caution should be exercised, and the changes should be in small increments to avoid system instability.

- Parameters **Bn-01** (Acceleration) and **Bn-02** (Deceleration) are **both** set at the factory for **10.0 seconds**. For fan and pump applications, the recommended starting values are **30 seconds**. To change these parameters, follow the keypad navigation procedure as shown next.

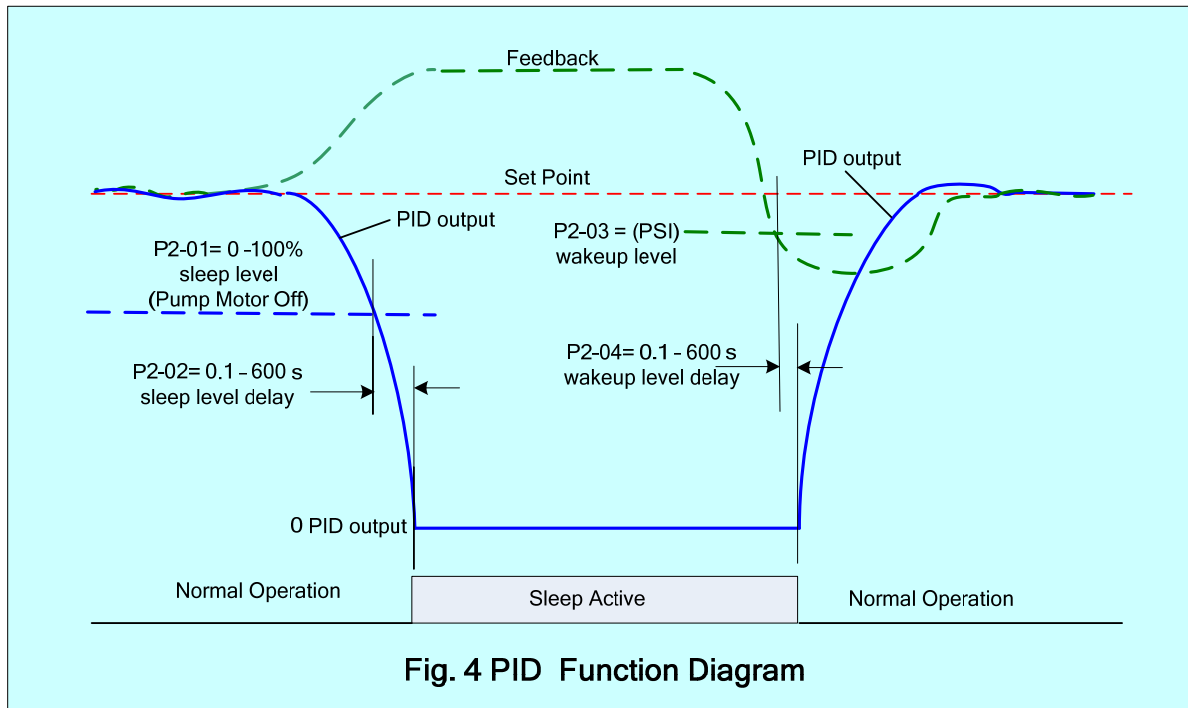




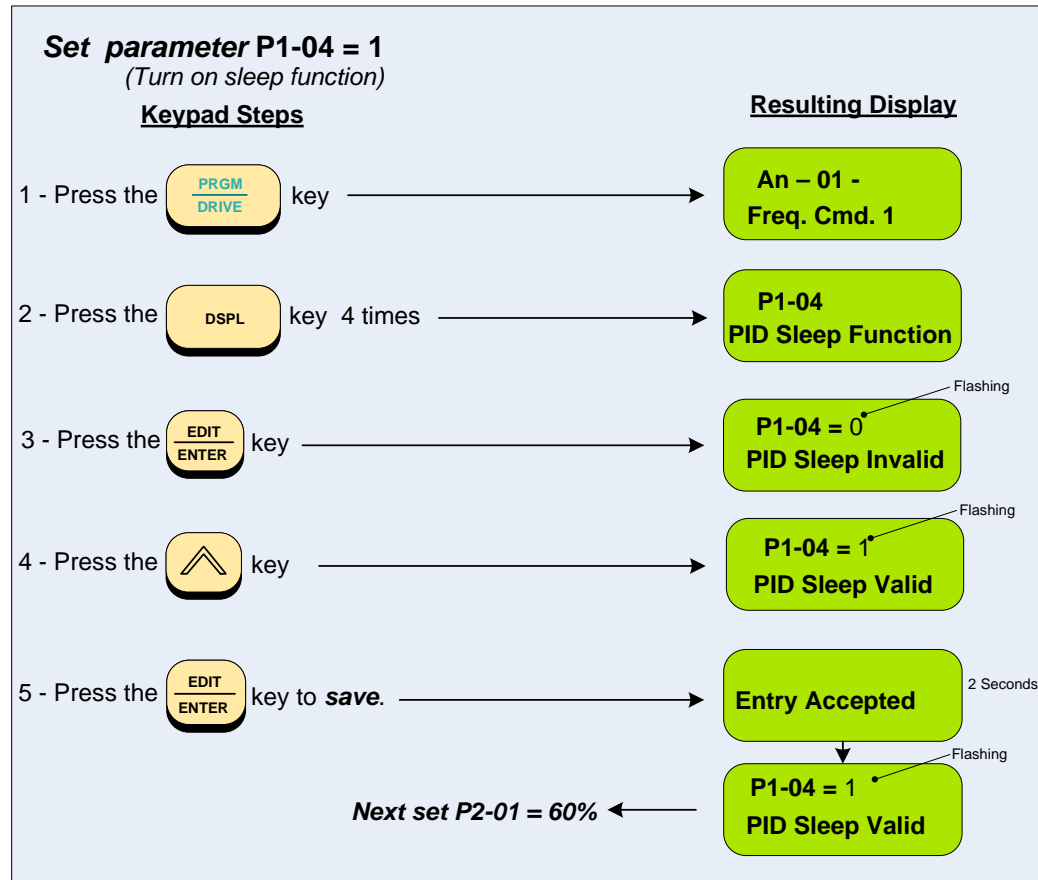
Step 12 – Setting PID Sleep Function parameters (P1-04), (P2-01), (P2-02), (P2-03) and (P2-04).

(NOTE: In the case of a Fan application skip this step and go to Step13)

- The *PID Sleep* function is turned on by parameter **(P1-04)** when set to **(=1)**. This allows the system to *turn off* the PID and thus the inverter output so that the pump does not run when the system level (PSI) is above the set-point. This *sleep start level* is set by parameter **(P2-01)** in a range from 0 – 100% of the maximum inverter output. When the system level drops below a value (*the units are selected by Step 8*) set by parameter **(P2-03)**, the *sleep wakeup level*, the output of the inverter will turn on. Parameters **(P2-02)** and **(P2-04)** provide delay times in *seconds* for *sleep start level* and *sleep wakeup level* respectively. Fig. 4 will serve to illustrate this.



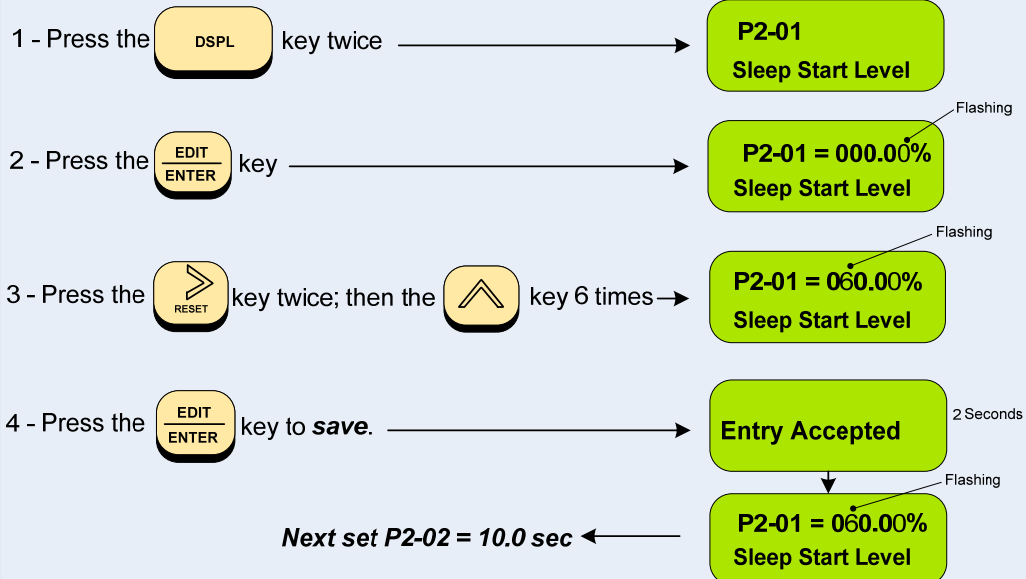
- To further cover the PID Sleep function, the following is an example of the various parameter settings that could be used. In this example the system will have the following specifications:
 - Max. Pump Motor Speed : 3600 RPM.
 - Set Point: 150 PSI.
 - Feedback Transducer Range: 0 – 200 PSI.
 - Pump System Sleep Level: 2160RPM or 60% of max. speed set by **(P21-01=060.00)**. Sleep Level Delay Time: 10 sec. set by **(P2-02=010.0)**.
 - Pump System Wakeup Level: 100 PSI set by **(P2-03=0100)**. Wakeup Time: 5 sec. set by **(P2-04=005.0)**.
 - Referring to **Step 9**, set the engineering units to *PSI* (**P1-01=02**) and then the range to 200 (**P1-02=0200**).
 - On the following pages the keypad navigation sequence is shown in setting the PID parameters.
- NOTE: The inverter must be in the Stop mode in order to turn on the sleep function.**



Next set parameter P2-01 = 60%
(Sleep Start Level)

Keypad Steps

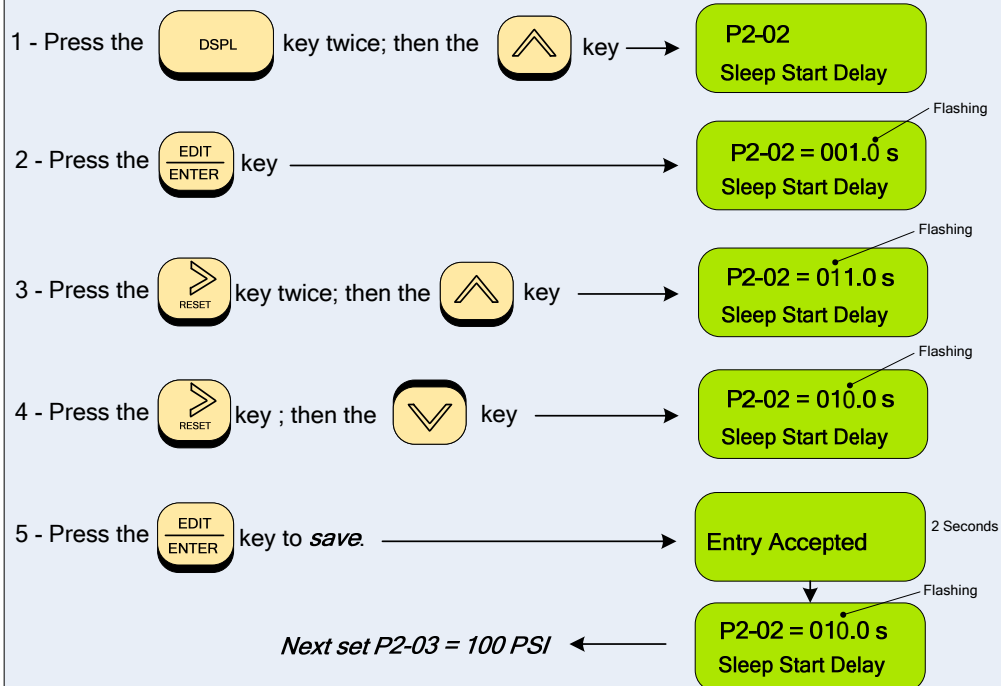
Resulting Display

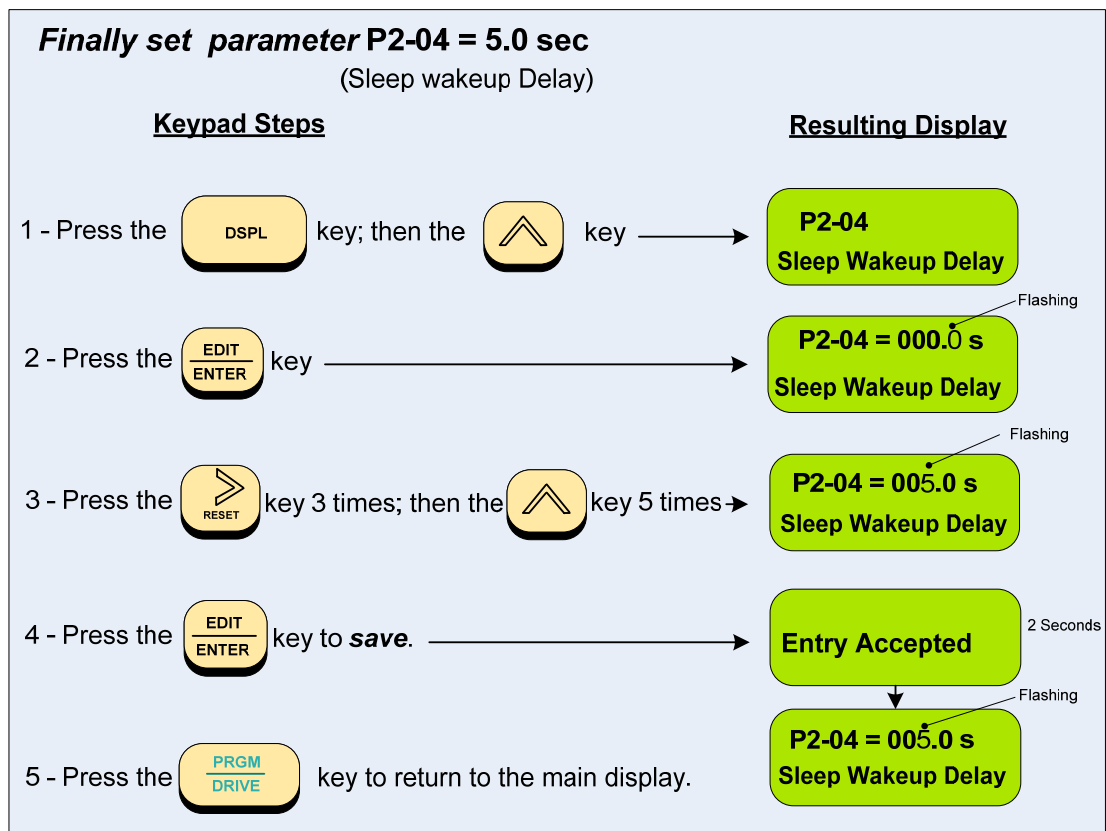
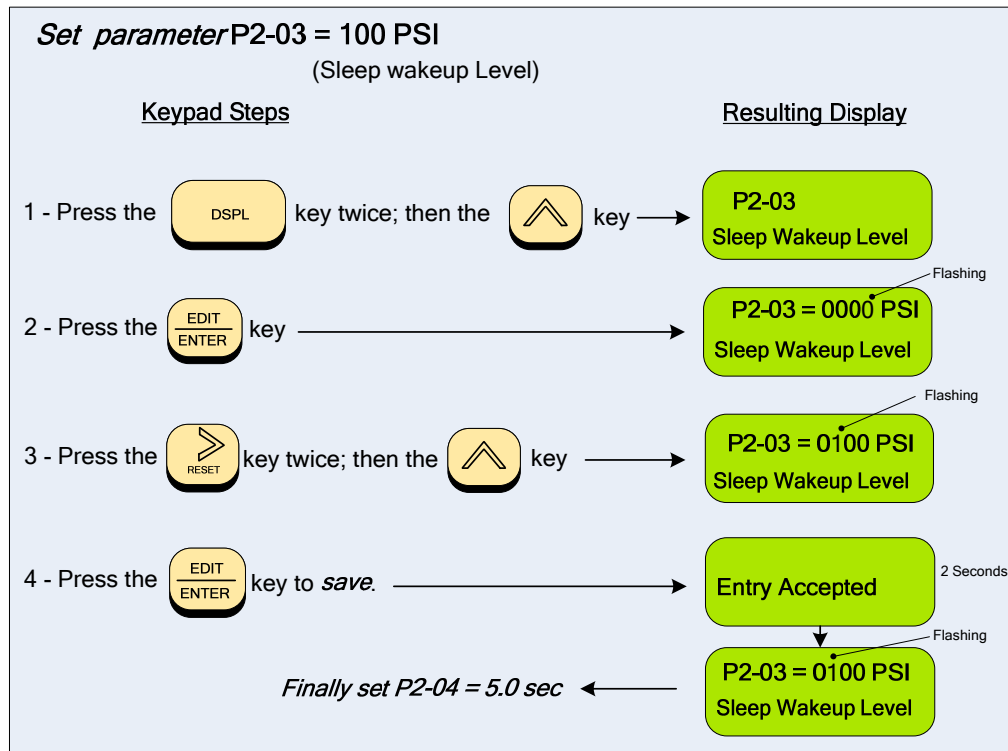


Next set parameter P2-02 = 10.0 sec
(Sleep Start Level Delay Time)

Keypad Steps

Resulting Display





Step 13 – Testing The System

- The system can now be tested for performance. To do this, set the **set-point** through the keypad and run the drive at some low level and check that the motor is operating properly and that the **feedback** signal level and polarity are correct.
- Check the system for dynamic operation and make any adjustments necessary for optimum performance. This may require making adjustments to parameters **Bn-17 proportional gain** and **Bn-18 Integral Time. (Refer to Step 10)**

NOTE: Parameters Bn-17 and Bn-18 may be changed through the keypad while the system is operating.

A word of CAUTION ! - the parameter changes should be made in small increments and the results checked to avoid highly unstable and possibly damaging conditions.

- This should complete the installation.

MA7200 PLUS BLOCK DIAGRAM

Fig. 5 is an overall basic electrical connection diagram for the **MA7200 PLUS**. It is used in conjunction with the other sections of this guide to give the user the ability to successfully start up a fan or pump application. More detailed information is available in the **MA7200 PLUS Manual** to which the user is referred, if further information is required.

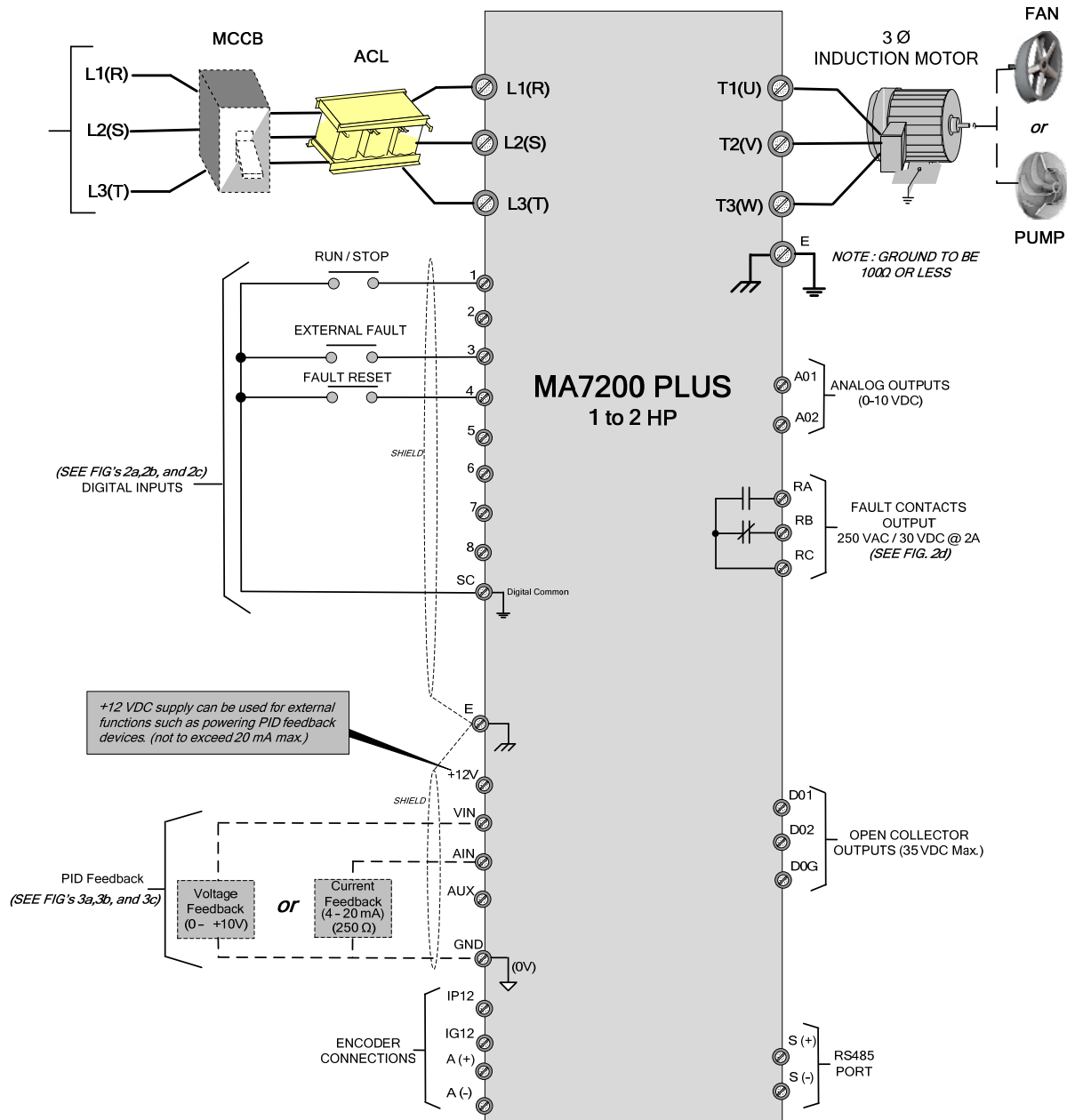


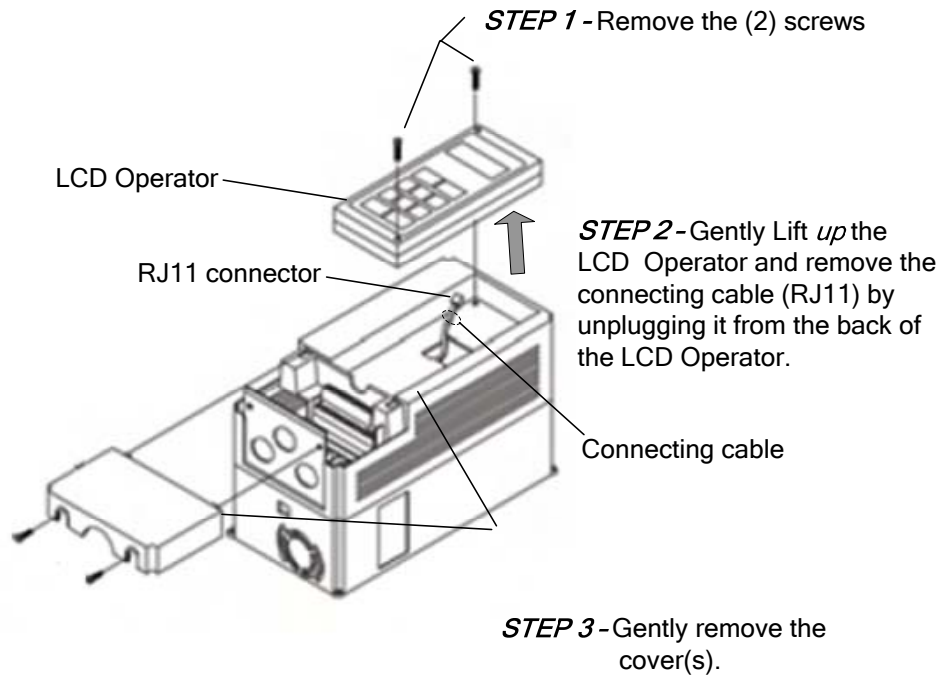
Fig. 5 MA7200 PLUS 1 to 2 HP FAN or PUMP Application Diagram

Appendix A-

Engineering Units Selected by P1-01=					
Setting	Unit	Description	Setting	Unit	Description
0	-----		13	MPM	meter / minute
1	%	%	14	CMM	meter ³ / minute
2	PSI	PSI	15	W	W
3	GPH	gallon / hour	16	kW	kW
4	GPM	gallon / minute	17	°C	°C
5	InW	Inch water	18	m	meter
6	FPM	feet / minute	19	A	A
7	CFM	feet ³ / minute	20	RPM	RPM
8	In	inch	21	SPM	stroke/minute
9	Ft	feet	22	/s	unit / s
10	HP	HP	23	/m	unit / m
11	°F	°F	24	/h	unit / h
12	m/s	meter / second	25		none

Appendix B -

Removing the LCD Digital Operator and Inverter Cover(s)



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