APPENDIX 3

A. PID Function Set-up Instructions

Use the following procedure to activate PID Function:

1. Enable PID control by setting Parameter 5 – 05 (MFIT Input S6) = 0020 (PID Feedback Signal.
2. Select the Type of PID Function to Perform by selecting the appropriate value for Parameter 11 – 0 (see table below):

Parameter 11 – 0 Value	**Description Of PID Mode**	**Comments**
0000	PID Function Disabled	No PID Control
0001	Error Control Enabled	If (PID Reference - PID Feedback) is greater than zero, Speed Increases.
0002	Differential Error Control Enabled	If Neither PID Reference or PID Feedback is changing, the Speed is Zero. While (PID Reference – PID Feedback) is increasing, Speed Increases.
0003	Reverse Error Control Enabled	If (PID Reference - PID Feedback) is less than zero, Speed Increases.
0004	Reverse Differential Error Control Enabled	If Neither PID Reference or PID Feedback is changing, the Speed is Zero. While (PID Reference – PID Feedback) is decreasing, Speed Increases.
0005	Frequency Command + Error Control Enabled	If (PID Reference - PID Feedback) is greater than zero, Speed is added to the Basic Frequency Command.
0006	Frequency Command + Differential Error Control Enabled	If Neither PID Reference or PID Feedback is changing, the Speed Doesn't Change. While (PID Reference – PID Feedback) is increasing, Speed Increases.
0007	Frequency Command + Reverse Error Control Enabled	If (PID Reference - PID Feedback) is less than zero, Speed is added to the Basic Frequency Command.
0008	Frequency Command + Reverse Differential Error Control Enabled	If Neither PID Reference or PID Feedback is changing, the Speed Doesn't Change. While (PID Reference – PID Feedback) is decreasing, Speed Increases.

3. Select the Type of PID Reference (Target Value) to use by selecting the appropriate value for Parameter 1 – 06 (see table below):

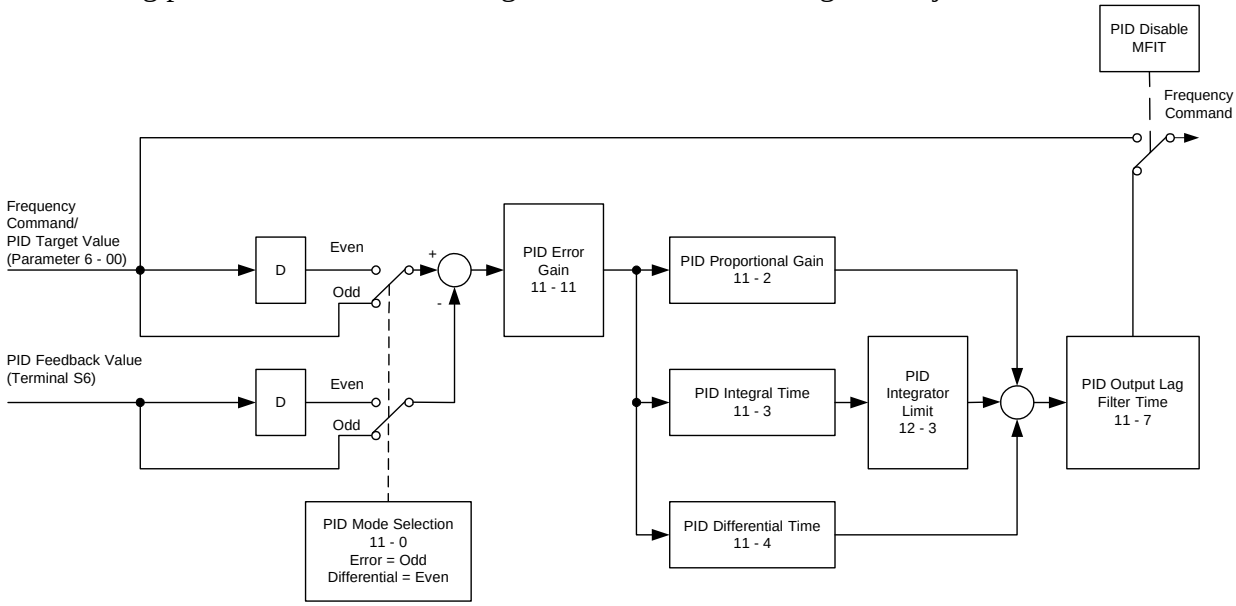
Parameter 1 – 06 Value	Description Of PID Reference Source	Comments
0000	Keypad	Use Keypad Up/Down Keys to set PID Reference.
0001	Potentiometer on Keypad	Use Potentiometer on Keypad to set PID Reference.
0002	External Analog Signal	Use External Analog Signal (AIN Terminal) to Set PID Reference (5 – 06 MFIT Input AIN must equal 0023).
0003	Up/Down MFIT Signal	Use Up/Down Function on MFIT inputs to set PID Reference (One MFIT must be programmed to 0014 and another MFIT 0015).
0004	Serial Communication	PID Reference set by Serial Communications

4. If the "Keypad" or "Up/Down MFIT Signal" is selected for the PID Reference (Target Value) in step 3 above, the Target value will be entered in Hertz. It is easier to enter the Target Value if it is expressed in user units (for example PSI, or CFM). To calibrate the display in user units perform the following steps:
    a. Determine the PID Feedback Device calibration at maximum output (10 VDC or 20 mA) and enter this value in parameter 4 – 04 (For example: If the feedback device is a pressure transducer that provides a 20 mA signal at 200 PSI, then enter 200 in parameter 4 – 04).
    b. Set parameter 4 – 05 = 0001 to enable custom display units. When the drive is stopped the display will show the PID Reference in user units. When the drive is running, the drive will display motor speed in user units.
5. If the External Analog Input was selected for the PID Reference (Target Value), set Analog Input Offset based on the type of Analog Input used:
    a. 0 – 10 VDC Analog Input: Set AIN Bias (Parameter 7 – 01) = 0 %.
    b. 4 – 20 mA Analog Input: Set AIN Bias (Parameter 7 – 01) = 20 %.
    c. Set AIN Bias Selection (Parameter 7 – 02) = 0001 (Negative)
    d. Set AIN Slope (Parameter 7 – 03) = 0000 (Positive)
6. If the PID Feedback Device provides a 0 – 10 VDC Output, set Parameter 12 – 6 = 0000 (0 – 10 VDC PID Feedback).
7. If the PID Feedback Device provides a 4 – 20 mA Output, set Parameter 12 – 6 = 0001 (4 – 20 mA PID Feedback).
8. If you want to run the drive in both PID Control (Auto Mode) and as a speed control (Manual Mode), program one of the MFIT inputs as PID Disable (5 – 00 ~ 5 – 05 = 0017).
9. If desired, the PID Feedback value can be programmed to the Multi-Function Analog Output (FM+) for an analog meter. Set Parameter 8 – 00 = 0005 to send the PID Feedback value to the Multi-Function Analog Output.
10. Turn Off power to the inverter and wait 5 minutes or until the LED display on the drive turns off.

11. Remove the Terminal Cover from the drive to gain access to the TM2 terminals.
12. If a 0 – 10 VDC signal is used for PID Feedback, set switch SW3 to the “V” position (Up). Connect the PID Feedback Signal to terminals S6 (positive) and COM (negative) on the TM2 terminal block.
13. If a 4 – 20 mA signal is used for PID Feedback, set switch SW3 to the “A” position (Down). Connect the PID Feedback Signal to terminals S6 (positive) and COM (negative) on the TM2 terminal block.
14. If a 0 – 10 VDC signal is used for the PID Reference (Target Value), set switch SW2 to the “V” position (Up). Connect the PID Reference Signal to terminals AIN (positive) and COM (negative) on the TM2 terminal block.
15. If a 4 – 20 mA signal is used for the PID Reference (Target Value), set switch SW2 to the “A” position (Down). Connect the PID Reference Signal to terminals AIN (positive) and COM (negative) on the TM2 terminal block.
16. If one of the MFIT inputs is programmed to PID Disable (5 – 00 ~ 5 – 05 = 0017), Connect the PID Disable (Auto / Manual) switch to the appropriate terminals (S1 ~ S5, and COM or 24V). This switch should be closed in the PID Disable (Manual) position.
17. If the Multi-Function Analog Output is programmed to output PID Feedback, connect the PID Feedback Meter to terminals FM+ (positive) and COM (negative).

Use the following procedure to adjust the PID Function:

The Factory Settings for the PID Function Parameters provide adequate operation for many applications. Should you wish to optimize the Parameter settings for a particular application, use the following procedure Refer to the diagram below while making PID adjustments.



PID Function Simplified Block Diagram

1. To enable PID Function Set 5 – 05 (S6 MFIT Function) = 0020 (PID Feedback = S6).
2. The target value for the PID Function is the Frequency Command 6 – 00 (as selected by Parameter 1 – 06).

1. Apply Power to the inverter.
2. Set Parameters 11 – 2 (Proportional Gain), 11 – 3 (Integral Time), and 11 – 4 (Differential Time) all equal to zero.
3. Set any external PID Disable Switch (if used) to the Enable PID Function Position (OFF).
4. Set the PID Reference (Target Value) to the desired value.
5. Run the inverter by pressing the “Run/Stop” key on the keypad or closing an external “Run” contact.
6. Gradually increase the value of parameter 11 – 2 (Proportional Gain) until the motor begins to rotate.
7. If the motor rotates in the wrong direction:
    a. Stop the drive.
    b. Remove Power from the Drive.
    c. Wait 5 minutes or until the LED display on the drive goes blank.
    d. Remove the terminal cover and exchange the motor T1 and T2 wires at the TM1 terminal block on the drive.
    e. Replace the Terminal cover.
    f. Apply power
    g. Run the inverter by pressing the “Run/Stop” key on the keypad or closing an external “Run” Contact.
    h. Verify the motor now rotates in the correct direction.
8. Continue increasing Parameter 11 – 2 until the motor speed becomes unstable.
9. Reduce the setting of Parameter 11 – 2 to approximately 70 % of the value that motor speed instability was first noticed. Verify the motor speed is stable at this new setting.
10. Stop the inverter and change parameter 11 – 3 (Integral Time) to a value of 100.0 Seconds.
11. Run the inverter and gradually start reducing the value of parameter 11 – 3 until motor speed becomes unstable.
12. Increase the setting of parameter 11 – 3 (Integral Time) to twice the value that motor speed instability was first noticed. Verify the motor speed is stable at this new setting.
13. If motor speed stability cannot be achieved by adjusting parameters 11 – 2 and 11 – 3, check the Acceleration and Deceleration Time parameters (3 – 02 and 3 – 03). If Acceleration or Deceleration time is too long, the PID Function may never stably regulate. If the drive is to be operated both in the PID Mode and Manually, you may want two sets of Acceleration/Deceleration Times. One of the MFIT inputs can be programmed to switch Acceleration/Deceleration Times from parameters 3 – 02/3 – 03 to parameters 3 – 06/3 – 07 when in the PID mode. See parameters 5 – 00 ~ 5 – 06 for details.
14. If the operating range of the PID Feedback is narrow (i.e. PID Target Value is always set in the range of 4 to 5 Volts/10 to 12 mA), it may be desirable to multiply the PID Error before performing the PID Function. Parameter 11 – 1 (PID Feedback Calibration Gain) multiplies the PID Error (Target Value – PID Feedback) before the PID Calculations are performed. Increasing parameter 11 – 1 increases the sensitivity of the PID function to changes in the PID Feedback.

15. If motor speed overshoots during acceleration, adjusting parameter 11 – 4 may reduce overshoot. Start with parameter 11 – 4 = 0.00 (Differential Gain Disabled) and start increasing parameter 11 – 4. If motor speed becomes unstable, reduce parameter 11 – 4 until stability returns.
16. Parameters 11 – 7 (PID Output Filter) can be used to filter the output of the PID Control to limit the rate of change of motor speed when the PID Function is active. Increase the value of parameter 11 – 7 to slow the response time of the PID Function. A value of 0.0 in parameter 11 – 7 turns off the PID Output Filter.
17. Parameter 12 – 3 can be used to limit the effective speed range of the PID Function. This is particularly important if the PID Function Parameter 11 – 0 is set to values from 0005 to 0008. This parameter is a percentage of motor rated frequency (parameter 0 – 05).
18. Parameters 11 – 5 and 11 – 6 can be used to set a minimum speed that the PID Function will operate:
    a. 11 – 5 = 0000 (Positive Offset).
    b. 11 – 6 = Minimum Speed in percent of Rated Motor Speed (parameter 0 – 05).
    c. 12 – 3 = 100 – (value in parameter 11 – 6).
19. Sleep Mode: Parameter 12 – 7 (Sleep Level) sets the minimum frequency the drive will run in the PID Mode. Should the PID Output commands a frequency less than the Sleep Level, the drive will operate at the Sleep Level Frequency. If the drive PID Output continues to command a frequency less than the Sleep Level for a time period longer than the value of Parameter 12 – 8 (Sleep Delay Time), the drive will enter the Sleep Mode. When entering the Sleep Mode, the drive will decelerate to zero speed following the normal programmed Deceleration Time and turn off the output voltage to the motor. The drive will exit the Sleep Mode when the PID Output commands a frequency greater than the Sleep Level. If Parameters 12 – 7 and 12 – 8 both equal zero, the Sleep Mode is disabled. If the Sleep Mode is enabled, Parameter 11 – 6 (PID Offset) should be set to zero or the Sleep Mode may never function.
20. PID Feedback Loss: If the (PID Reference – PID Feedback) exceeds the value in parameter 12 – 1 (PID Feedback Loss Level) for a time period longer than PID Feedback Loss Delay Time (Parameter 12 – 2), a PID Feedback Loss will occur.
21. The action the drive takes when a PID Feedback Loss occurs is defined by Feedback Loss Detection Mode (Parameter 12 – 0) as shown in the table below:

Feedback Loss Detection Mode 12 - 0	**Drive Action when PID Feedback Loss Occurs**
0000	PID Feedback Loss is disabled.
0001	PID Feedback Loss is enabled. When a PID Feedback Loss occurs, the drive will continue to run in the PID mode and the display will indicate “PDER”.
0002	Feedback Loss is enabled. When a PID Feedback Loss occurs, the drive will stop running and display a “PDER” fault code.

22. If desired, the PID Integrator can be reset to zero when the PID Feedback equals the target value. If the PID Integrator reset function is enabled, you have a choice of resetting the Integrator 1 second after the Feedback equals the target value or 30 seconds after the Feedback equals the target value. See parameter 12 – 4 per the table below.

Integrator Reset Time Delay Parameter 12 - 4	**Drive Action**
0000	Integrator Reset Disabled
0001	Integrator Resets 1 second after PID Feedback equals target value.
0002	Integrator Resets 30 seconds after PID Feedback equals target value.

23. If parameter 12 – 4 is enabled, parameter 12 – 5 determines the amount of difference between the PID target value and the PID Feedback value required to cause the Integrator to stop resetting to zero. If a value of 100 is entered for parameter 12 – 5, a difference of 100 /8192 (or 1.22 % of the maximum feedback value) is required between the PID target value and the PID Feedback value to cause the integrator to stop resetting. Use the formula below to calculate the Integrator Reset threshold.

$$\text{Integrator Reset Threshold (\% of maximum feedback value)} = \frac{(\text{Parmeter } 12\text{-}5 \text{ value}) \times 100}{8192}$$