

P7 Drive Programming Manual

*This Manual
also available on
www.drives.com*



Warnings and Cautions

This Section provides warnings and cautions pertinent to this product, that if not heeded, may result in personal injury, fatality, or equipment damage. Yaskawa is not responsible for consequences of ignoring these instructions.

WARNING

YASKAWA manufactures component parts that can be used in a wide variety of industrial applications. The selection and application of YASKAWA products remain the responsibility of the equipment designer or end user. YASKAWA accepts no responsibility for the way its products are incorporated into the final system design. Under no circumstances should any YASKAWA product be incorporated into any product or design as the exclusive or sole safety control. Without exception, all controls should be designed to detect faults dynamically and fail safely under all circumstances. All products designed to incorporate a component part manufactured by YASKAWA must be supplied to the end user with appropriate warnings and instructions as to that part's safe use and operation. Any warnings provided by YASKAWA must be promptly provided to the end user. YASKAWA offers an express warranty only as to the quality of its products in conforming to standards and specifications published in the YASKAWA manual. NO OTHER WARRANTY, EXPRESS OR IMPLIED, IS OFFERED. YASKAWA assumes no liability for any personal injury, property damage, losses, or claims arising from misapplication of its products.

WARNING

- Read and understand this manual before installing, operating, or servicing this Drive. All warnings, cautions, and instructions must be followed. All activity must be performed by qualified personnel. The Drive must be installed according to this manual and local codes.
- Do not connect or disconnect wiring while the power is on. Do not remove covers or touch circuit boards while the power is on. Do not remove or insert the digital operator while power is on.
- Before servicing, disconnect all power to the equipment. The internal capacitor remains charged even after the power supply is turned off. Status indicator LEDs and Digital Operator display will be extinguished when the DC bus voltage is below 50 VDC. To prevent electric shock, wait at least five minutes after all indicators are OFF and measure DC bus voltage level to confirm safe level.
- Do not perform a withstand voltage test on any part of the unit. This equipment uses sensitive devices and may be damaged by high voltage.
- The Drive is not suitable for circuits capable of delivering more than the specified RMS symmetrical amperes. Install adequate branch short circuit protection per applicable codes. Refer to the specification. Failure to do so may result in equipment damage and/or personal injury.
- Do not connect unapproved LC or RC interference suppression filters, capacitors, or overvoltage protection devices to the output of the Drive. These devices may generate peak currents that exceed Drive specifications.
- To avoid unnecessary fault displays caused by contactors or output switches placed between Drive and motor, auxiliary contacts must be properly integrated into the control logic circuit.
- YASKAWA is not responsible for any modification of the product made by the user; doing so will void the warranty. This product must not be modified.
- Verify that the rated voltage of the Drive matches the voltage of the incoming power supply before applying power.
- To meet CE directives, proper line filters and proper installation are required.



- Some drawings in this manual may be shown with protective covers or shields removed, to describe details. These must be replaced before operation.
- Observe electrostatic discharge procedures when handling circuit cards to prevent ESD damage.
- The equipment may start unexpectedly upon application of power. Clear all personnel from the drive, motor, and machine area before applying power. Secure covers, couplings, shaft keys, and machine loads before energizing the Drive.
- Please do not connect or operate any equipment with visible damage or missing parts. The operating company is responsible for any injuries or equipment damage resulting from failure to heed the warnings in this manual.

■ Intended Use

Drives are intended for installation in electrical systems or machinery.

For use in the European Union, the installation in machinery and systems must conform to the following product standards of the Low Voltage Directive:

EN 50178, 1997-10, Equipping of Power Systems with Electronic Devices

EN 60201-1, 1997-12 Machine Safety and Equipping with Electrical Devices

Part 1: General Requirements (IEC 60204-1:1997)/

EN 61010, 1997-11 Safety Requirements for Information Technology Equipment

(IEC 950:1991 + A1:1992 + A2:1993 + A3:1995 + A4:1996, modified)

■ Other

The P7 Drive is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical amperes, 240Vac maximum (240V Class) and 480Vac maximum (480V Class).

Introduction

This Section describes the applicability of the Manual

The P7 Drive is a Pulse Width Modulated Drive for 3-Phase AC induction motors. This type of Drive is also known as an Adjustable Frequency Drive, Variable Frequency Drive, AC Drive, AFD, ASD, VFD, and Inverter. In this manual, the P7 Drive will be referred to as the “Drive”.

The P7 Drive is a variable torque AC drive, designed specifically for industrial fans, blowers and pumps. The Drive includes numerous built-in features.

The LCD keypad/operator is equipped with copy feature, 7 language choices, and 5 lines of display with 16 characters per line. User parameter settings can be recovered at any time via “user initialization”. Optional software allows upload/download, as well as graphing and monitoring of drive parameters from a PC for ease of drive management.

Built-in PI control eliminates the need for closed loop output signals from an automation system. It includes feedback display, inverse, square root and differential control functions, and maintains setpoint for closed loop control of fans and pumps for pressure, flow, or temperature regulation.

This manual is applicable to P7 Drives defined by model numbers of CIMR-P7U_ _ _ _ . This manual reflects the software version 1020.

This manual is subject to change as product improvements occur. The latest version of the manual can be obtained from the Yaskawa website www.drives.com . The date shown on the rear cover is changed when revisions are made.

This manual may describe trademarked equipment, which is the property of other companies. These trademarks are the property of the registered owner companies and may include the following:

APOGEE™ FLN, trademark of Siemens Building Technologies, Inc.

LONWORKS®, trademark of Echelon Corporation

Other Documents and Manuals are available to support special use or installation of this product. These documents may be provided with the product or upon request. Contact Yaskawa Electric America, Inc. as required. Documents may include the following:

TM.P7.01.Users... Manual included on CD ROM with product

TM.P7.11.Modbus... Manual included on CD ROM with product

TM.AFD.20.LONWORKS... Manual included on CD ROM with product

TM.P7B.01. Bypass... This manual should be used when the P7 Drive is packaged with Bypass Control

DriveWizard ... Software and Manual...Included on CD ROM with product

Option Instructions... Included on CD ROM with product

Programming

This Manual contains descriptions of all user accessible parameters contained in the Drive. Parameters are listed in alpha-numerical order. Parameter number and name, along with a detailed description and its settings are described on the following pages.

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P7 Basic Programming Parameters

The initialization group contains parameters associated with initial set-up of the Drive. Parameters involving the display language, access levels, initialization and password are located in this group.

◆ A1 Initialization

■ A1-00 Select Language

Setting	Description
0	English (<i>factory default</i>)
1	Japanese
2	Deutsch
3	Francais
4	Italiano
5	Espanol
6	Portugues

The setting of parameter A1-00 determines which international language the Drive will use to display non-numerical text. The A1-00 parameter will not be changed by an Initialization of the drive (A1-03= “1110: User Initialize”, “2220: 2-Wire Initial”, or “3330: 3-Wire Initial”).

If the Drive is accidentally set to a language unfamiliar to the operator, locating the parameter to change the operator language can be done by performing the following:

1. Press the MENU key until the “-ADV-” MENU is shown in the upper left corner of the digital operator.
2. Press the DATA/ENTER key to enter the programming menu. The first parameter shown is A1-00 (Select Language).
3. Press the DATA/ENTER key again and use the INCREASE and DECREASE arrow keys to choose the preferred language from the list below:

0 : English
1 : Japanese
2 : Deutsch (German)
3 : Francais (French)
4 : Italiano (Italian)
5 : Español (Spanish)
6 : Portugu s (Portuguese)

■ A1-01 Access Level Selection

Setting	Description
0	Operation Only
1	User Level
2	Advanced Level (<i>factory default</i>)

A1-01 can be used to allow access to and permission to change all Drive parameters. If the Drive is programmed for Operation Only (A1-01= “0: Operation Only”), then only the OPERATION and the PROGRAMMING menus are accessible. Within the PROGRAMMING menu only parameters A1-01 and A1-04 are adjustable.

If A1-01 is configured for Advanced Access (A1-01= “2: Advanced Level”), then all menus and all parameters are shown. If the Access Level Selection is set to Advanced, all parameters should be adjustable unless:

1. The Drive parameters are password protected (A1-04) which will prevent access to A1-00 through A1-03 and all A2 parameters.
2. A digital input has been configured as a Program Lockout (H1-0X= 1B) is active.
3. During serial communication writing, if a parameter change is also attempted via the digital operator, a “BUSY - WRITE PROTECTED” message will display. Parameter change will not be possible from the digital operator until an Enter command is received via the serial communication to finish the serial writing process.

■ A1-03 Initialize Parameters

Setting	Description
0	No Initialize (<i>factory default</i>)
1110	User Initialize
2220	2-Wire Initialize
3330	3-Wire Initialize

The Drive can be set back to one of three default states via the A1-03 parameter.

1. User Initialization – 1110: The modified Drive parameters are returned to the values selected as user settings. User settings are stored when parameter o2-03= “1: Set Defaults”.
2. 2-Wire Initialization – 2220: The Drive parameters are returned to factory default values with digital inputs S1 and S2 configured as Forward Run and Reverse Run, respectively.
3. 3-Wire Initialization – 3330: The Drive parameters are returned to factory default values with digital inputs S1, S2, and S5 configured as Run, Stop, and Forward/Reverse respectively.

After an initialization is performed, parameter A1-03 will automatically be set back to 0.

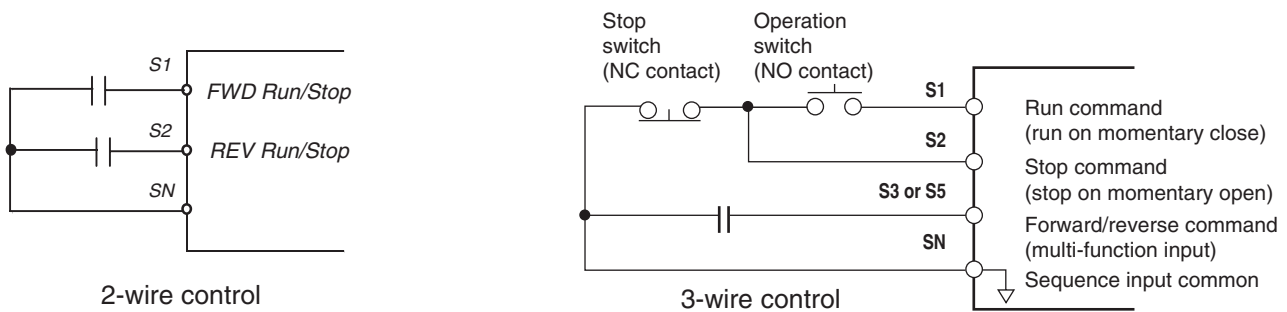


Fig. 1 2 & 3-Wire Control Wiring Examples

IMPORTANT

Some parameters are unaffected by either the 2-Wire or 3-Wire initialization. The following parameters will not be reset when parameter A1-03=2220 or 3330:

A1-00	Language Selection
E1-03	V/f Pattern Selection
o2-04	kVA Selection

■ A1-04 Password Entry

Setting Range: 0 to 9999

Factory Default: 0

If parameters A1-01 through A1-03 and all of the A2 parameters are locked (unchangeable) they can be unlocked by entering the correct password number into A1-04.

Once the correct password number is entered and the specified parameters are unlocked, a 2-Wire or 3-Wire initialization will reset the password to 0000.

■ A1-05 Select Password

Setting Range: 0 to 9999

Factory Default: 0

When the value set into A1-04 does NOT match the value set into A1-05, parameters A1-01 thru A1-03 and A2-32 cannot be changed. All other parameters determined by A1-01 can be changed. Parameter A1-05 can be accessed by displaying parameter A1-04, then press and hold the RESET key along with the MENU key simultaneously.

◆ A2 User Parameters

■ A2-01 - A2-32 User Parameter

Setting Range: b1-01 to o3-02

Factory Default: <none>

The Drive can be programmed to select up to 32 parameters for limited-access programming. By setting the Access Level to User Level (A1-01= "1: User Level"), only the parameters entered into parameters A2-01 through A2-32 can be accessed and modified by the user.

Parameter A1-01 must first be set to 2 (Advanced Access Level) in order to program the A2 parameters to the desired user parameters. Once the A2 parameters are programmed, A1-01 should be set to 1(User Access Level) to prevent the user from changing any parameters except the A1 parameters and the parameters specified in A2-01 through A2-32.

◆ b1 Sequence

The Sequence Group contains parameters associated with starting and stopping the Drive. Parameters involving the Run Command, Speed Reference location, Stopping Method and Local/Remote changeover are located in this group.

■ b1-01 Reference (Speed Command) Source Selection

Setting	Description
0	Operator - Digital Preset Speed d1-01
1	Terminals - Analog Input Terminal A1 (or Terminal A2, see Parameter H3-13)
2	Serial Com - RS-485 Terminals R+, R-, S+ and S-
3	Option PCB - Option Board connected at 2CN

In order to run the Drive and motor, the Drive must receive a Run command and a speed command. Parameter b1-01 specifies from where the speed command is received when in the “Remote” mode. Switching into the “Remote” mode can be done by pressing the LOCAL/REMOTE button on the digital operator while the Drive is stopped.

IMPORTANT

If a Run command is input to the Drive but no corresponding speed command is input, the Run indicator on the digital operator will turn on and the STOP indicator on the digital operator will blink.

If you want the Drive to follow the speed command set by the digital operator: Use the “Local” mode by pressing the LOCAL/REMOTE key or set b1-01= “0: Operator”. The speed command can then be entered into the U1-01 monitor parameter in the “-DRIVE-” Menu.

If you want the Drive to follow an analog speed command: Set b1-01= “1: Terminals”, and connect a 0 – 10 Vdc speed command signal between terminals A1 and AC or a 4 – 20 mA speed command signal to terminals A2 and AC.

If you want the Drive to receive the speed command from serial communication: Set b1-01= “2: Serial Com”, and connect the RS-485/422 serial communications cable to terminals R+, R-, S+, and S- on the control I/O terminal block.

If you want to use LONWORKS® to input a speed command: Set b1-01= “3: Option PCB”, and plug a LONWORKS® option board (p/n SI-J) into the 2CN port on the Drive Control PCB. Consult the manual supplied with the option board for instructions on integrating the Drive into the LONWORKS® System.

IMPORTANT

If b1-01= “3: Option PCB” but a LONWORKS® card is not installed in 2CN, an OPE05 Operator Programming Error will be displayed on the digital operator and the Drive will not run.

■ b1-02 Run Source

Setting	Description
0	Operator
1	Terminals (<i>factory default</i>)
2	Serial Com
3	Option PCB

To successfully operate the Drive remotely, an external run command must be received by the Drive. Parameter b1-02 specifies from where the run command will be accepted.

Although the Run Source and the Reference Source (b1-01) are normally taken from the same source (e.g. digital operator, terminals or serial communication), this is not always the case.

To issue a run command from the digital operator: Set b1-02= “0: Operator”, and use the RUN and STOP buttons to start and stop the Drive.

To issue the run command from the terminals: Set b1-02= “1: Terminals”, and select between 2-wire and 3-wire control operation by doing the following:

2-Wire Control The factory default setting is for 2-wire operation. In the 2-wire configuration a closure between S1 and SN will be interpreted as a Forward Run command by the Drive. A closure between S2 and SN will be interpreted as a Reverse Run command. If both S1 and S2 are closed, the Drive will stop (decelerate to zero speed) and the digital operator will display an EF (external fault) alarm (Flashing).

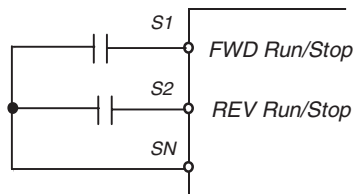


Fig. 2 2-Wire Control

3-Wire Control When any of the multi-function digital input parameters, H1-01 through H1-05, is set to 0, terminals S1 and S2 become Run and Stop, respectively. The multi-function digital input that was set to 0 will function as a Forward/Reverse input for the Drive. When the Forward/Reverse input is open the Drive will run in the Forward direction and when the input is closed, the Drive will run in the Reverse direction.

In 3-wire operation a momentary closure (> 50mS) of S1 will cause the Drive to run provided that S2 is held closed. The Drive will stop anytime the S2-SN connection is broken. If the 3-wire configuration is implemented via a 3-wire Initialization (A1-03= “3330: 3-Wire Initial”), then terminal S3 becomes the Forward/Reverse input.

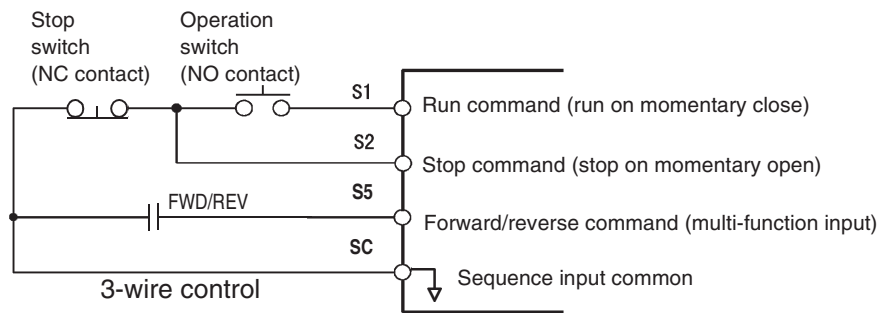


Fig. 3 3-Wire Control

To issue a run command via serial communication: Set b1-02= “2: Serial Com” and connect the RS-485/422 serial communication cable to R+, R-, S+, and S- on the removable terminal block.

To issue the Run command via the LONWORKS® option card: Set b1-02= “3: Option PCB”, and plug a LONWORKS® option board (p/n SI/J) into the 2CN port on the Control PCB. Consult the manual supplied with the option board for instructions on integrating the Drive into your LONWORKS® System.

IMPORTANT

If b1-01= “3: Option PCB” but a LONWORKS® card is not installed in 2CN, an “OPE05” operator programming error will be displayed on the digital operator and the Drive will not run.

■ b1-03 Stopping Method

There are four methods of stopping the Drive when the Run command is removed.

Setting	Description
0	Ramp to Stop (<i>factory default</i>)
1	Coast to Stop
2	DC Injection to Stop
3	Coast w/Timer

“0: Ramp to stop”: When the Run command is removed, the Drive will decelerate the motor to 0 rpm. The rate of deceleration is determined by the active deceleration time. The factory default Decel Time is in parameter C1-02.

When the output frequency has dropped below the DC Injection Start Frequency in b2-01 (Default = 0.5HZ) DC current will be injected in the motor at a level determined by b2-02 (50% Default). The DC Injection condition will occur for the time specified by b2-04 (0.0 Default), to establish the end point of the ramp. DC injection can be used to insure the motor is at zero rpm prior to the Drive shutting off.

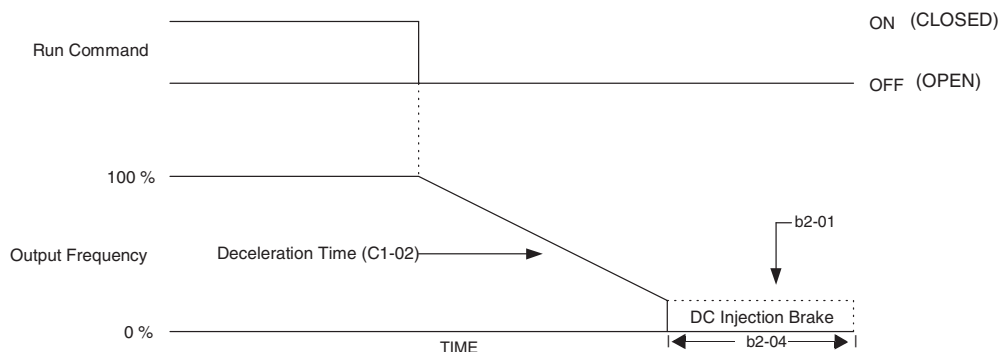


Fig. 4 Deceleration to Stop

The actual deceleration time can be determined by the following formula

$$\text{Time to Stop} = \frac{\text{Output Freq. at time of stop command}}{\text{Maximum Frequency (E1 - 04)}} \times \text{Setting of active Decel Time (C1 - 02 or C1-04)}$$

If S-Curve characteristics are specified by the Drive programming, they will add to the total time to stop.

“1:Coast to stop”: When the Run command is removed, the Drive will turn off its output and the motor will coast (uncontrolled deceleration). The friction of the driven equipment will eventually overcome any residual inertia of the system and the rotation will stop.

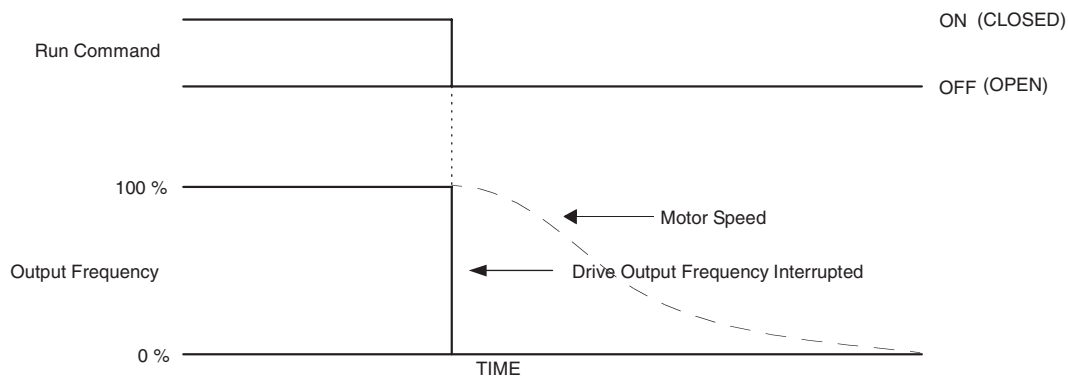


Fig. 5 Coast to Stop

IMPORTANT

After a stop is initiated, a subsequent Run commands input before the Minimum Baseblock Time (L2-03) has expired, will be ignored.

2:DCInj to Stop: When the Run command is removed, the Drive will Baseblock (turn off its output) for the Minimum Baseblock Time (L2-03). Once the Minimum Baseblock Time has expired, the Drive will inject DC current into the motor windings to lock the motor shaft. The stopping time will be reduced as compared to Coast to Stop. The level of DC Injection current is set by parameter b2-02 (50% Default). The DC Injection brake time is determined by the set value in b2-04 and the output frequency at the time the Run command is removed.

$$\text{DC Injection Brake Time} = \frac{(b2 - 04) \times 10 \times \text{Output Frequency}}{\text{Maximum Frequency (E1 - 04)}}$$

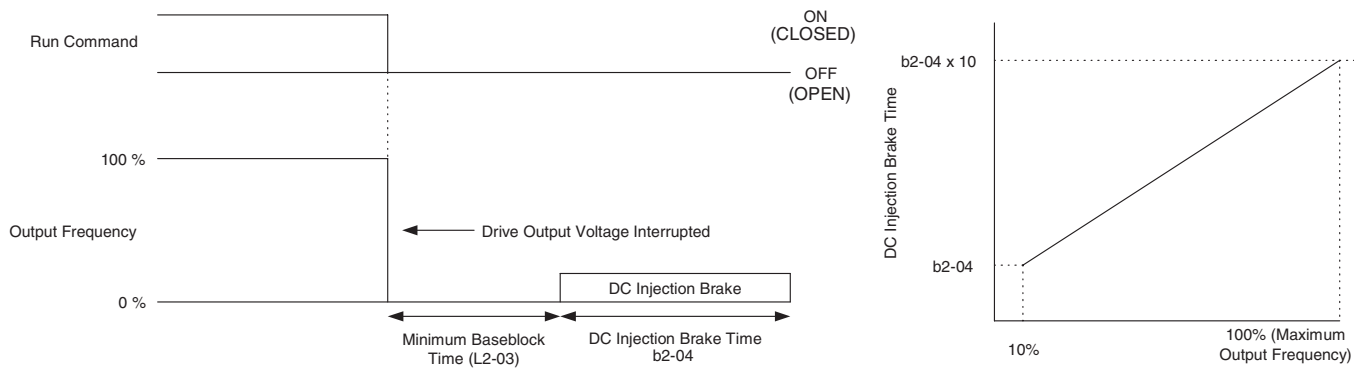


Fig. 6 DC Injection Braking to Stop

IMPORTANT

If an overcurrent (OC) fault occurs during DCInj to Stop, lengthen the Minimum Baseblock Time (L2-03) until the fault no longer occurs.

3:Coast w/Timer: When the Run command is removed, the Drive will turn off its output and the motor will coast to a stop. If a Run command is input before time T (operation wait time) expires, the Drive will not run and the Run command will need to be cycled before operation can occur. The time T (operation wait time) is determined by the output frequency when the Run command is removed and the active deceleration time (C1-02).

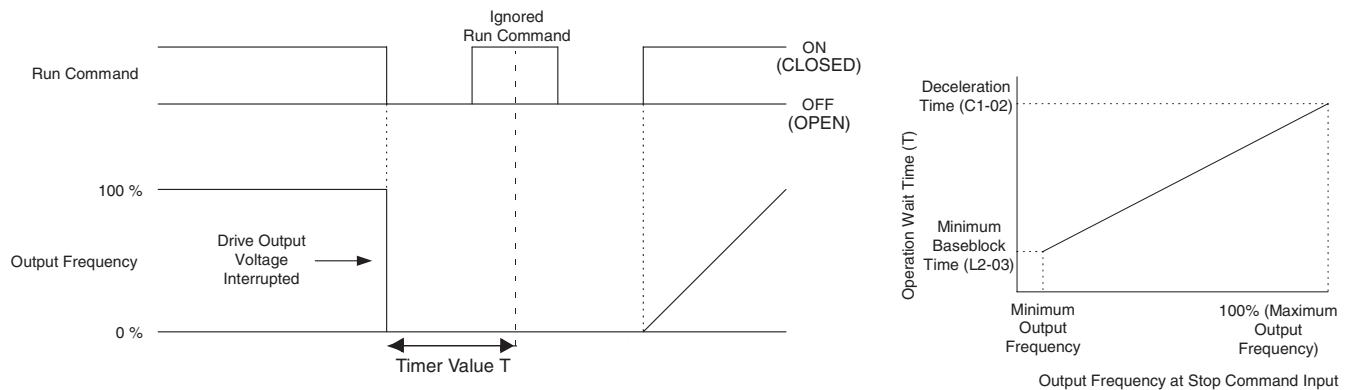


Fig. 7 Coast to Stop with Timer

■ b1-04 Reverse Operation

Setting	Description
0	Reverse Enabled
1	Reverse Disabled (<i>factory default</i>)
2	Exchange Phase
3	ExchgPhs, Rev Dsbl

For some applications reverse motor rotation is not applicable and may even cause problems (e.g., air handling units, pumps, etc.). Setting parameter b1-04 to 1 or 3 will cause the Drive to ignore any inputs for reverse operation. Setting parameter b1-04 to either 2 or 3 will change the motor shaft rotation when a Forward Run command is given by exchanging the order of the output phasing.

The factory default setting of parameter b1-04 is “1: Disabled”. When b1-04= “1: Disabled”, reverse operation is prohibited and no exchanging of output phasing occurs.

Drive Terminal S2 is a dedicated input for “Reverse Run/Stop.”

■ b1-07 Local/Remote Run Selection

Setting	Description
0	Cycle Extern Run (<i>factory default</i>)
1	Accept Extrn Run

When the Drive is switched between the Local mode (the digital operator) to the Remote mode (determined by b1-01 and b1-02), there is the possibility that a Run command is already present (i.e. a contact closure between S1 and SN when b1-02= “1: Terminals”). Parameter b1-07 determines whether the Drive will:

Ignore the external Run command until it is removed and re-instated (b1-07= “0: Cycle Extern Run”)

OR

Accept the already present Run command and immediately begin acceleration to the commanded speed (b1-07= “1: Accept Extrn Run”).

IMPORTANT

When switching from Local mode to Remote mode when b1-07=“1: Accept Extrn Run” the Drive may start unexpectedly if the Run command is already applied. Be sure all personnel are clear of rotating machinery and electrical connections prior to switching between Local mode and Remote mode.

■ b1-08 Run Command Selection During Programming

Setting	Description
0	Disabled (<i>factory default</i>)
1	Enabled

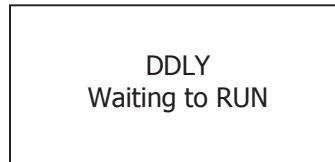
As a safety precaution, the Drive will not normally respond to a Run input when the digital operator is being used to adjust parameters. If it is necessary that external Run commands be recognized even while the Drive is being programmed, set b1-08= “1: Enabled”.

■ b1-11 Drive Delay Time Setting

Setting Range: 0 to 600 Seconds

Factory Default: 0 Seconds

If a time is set into parameter b1-11, the Drive will delay executing any run command until the b1-11 time has expired. During Drive delay time execution, the digital operator will display:



Both the ALARM and Run indicators will blink while the Drive waits to execute the Run command.

◆ b2 DC Braking

The DC Braking Group contains parameters associated with the DC injection braking feature. Parameters involving the starting frequency, current level, braking time, and motor pre heat current level are located here.

■ b2-01 DC Injection Braking Start Frequency

Setting Range: 0.0 to 10.0 Hz

Factory Default: 0.5 Hz

Parameter b2-01 sets the output frequency where the Drive begins DC Injection during Ramp to stop, in order to lock the rotor of the motor and established the end point of the ramp. If $b2-01 < E1-09$ (Minimum Frequency), then DC Injection begins at E1-09.

Parameter b2-01 also determines the output frequency that the Drive must be at or below before a Zero Speed condition is considered true. This affects any digital output configured as a Zero Speed signal (H2-0x= "1: Zero Speed").

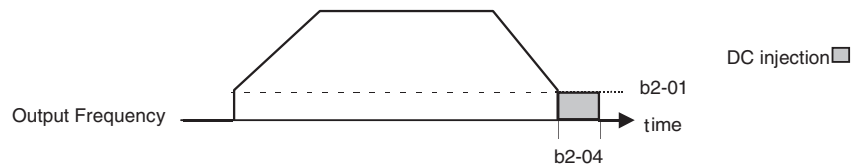


Fig. 8 DC Injection Braking During Stopping

■ b2-02 DC Injection Braking Current

Setting Range: 0 to 100%

Factory Default: 50%

The level of DC Injection Braking Current affects the strength of the magnetic field attempting to lock the motor shaft. Increasing the level of current will increase the amount of heat generated by the motor windings and should only be increased to the level necessary to hold the motor shaft. DC Injection current is set in percentage of Drive rated output current. Drive rated output current is stated on the Drive nameplate.

■ b2-03 DC Injection Braking Time at Start

b2-04 DC Injection Braking Time at Stop

Setting Range: 0.00 to 10.00 Seconds

Factory Default: 0.00 Seconds

The Drive can be programmed to automatically DC Inject for a predetermined amount of time prior to accelerating to speed (b2-03) and/or at the end of a Ramp to stop (b2-04). Parameter b2-03 can be used to stop a rotating motor prior to attempting acceleration (i.e. a wind milling fan). If DC Injection braking at start or Speed Search is not enabled, attempting to drive a spinning motor may cause nuisance tripping.

Parameter b2-04 can be used to resist any residual motion of the load after the deceleration has finished.

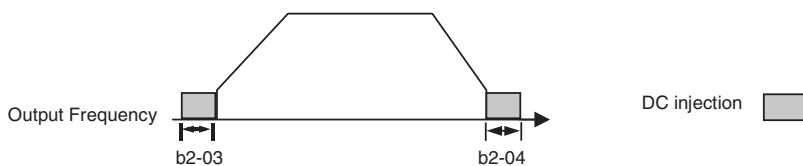


Fig. 9 DC Injection Braking During Starting and Stopping

Parameter b2-04 also serves the function of affecting the length of time DC Injection to stop (b1-03= “2: DC Injection to Stop”) will occur.

■ b2-09 Motor Pre-Heat Current

Setting Range: 0 to 100%

Factory Default: 0%

A DC current can be circulated within the motor windings while the motor is stopped. The current will produce heat within the motor and prevent condensation. Parameter b2-09 determines the percentage of Drive rated output current that will be used for the motor pre-heat function. This function can be useful in applications where the motor sits for extended periods of time in humid conditions. Motor pre-heating can only be initiated by closing a digital input programmed as a Motor Pre-heat Input (H1-0x= 60). Check with the motor manufacturer to determine the maximum acceptable current level the motor can withstand when stopped. Be sure not to exceed the motor manufacturers recommended level.

◆ b3 Speed Search

The Speed Search function allows the Drive to determine the speed of a motor shaft that is being driven by rotational inertia. Speed Search will allow the Drive to determine the speed of the already rotating motor and begin to ramp the motor to a set speed without first having to bring it to a complete stop. When a momentary loss of supply power is experienced, the Drive output is turned off. This results in a coasting motor. When power returns, the Drive can determine the speed of the coasting motor and start without requiring it to be brought to minimum speed. Speed Search can be programmed to always be active by setting b3-01 or it can be commanded by remote contact closure by setting a digital input.

There are two forms of Speed Search in the Drive, the speed estimation method and the current detection method.

IMPORTANT

When setting the Drive for remote Speed Search input, via a contact closure, the method of Speed Search is determined by the setting of b3-01. If b3-01= "0: SpdsrchF Disable" then the remote input will initiate speed estimation method, and if b3-01= "2: SpdsrchI Disable", then the remote input will start the current detection method.

Parameters L2-03 and L2-04 also affect the current detection method of Speed Search operation.

■ b3-01 Speed Search Selection

This parameter is effective only when the Drive is given a new "RUN" command.

Setting	Description
0	SpdsrchF Disable
1	SpdsrchF Enable
2	SpdsrchI Disable (<i>factory default</i>)
3	SpdsrchI Enable

Speed Estimation: Method (b3-01= 0 or 1) The speed estimation method will calculate the speed using measurements of residual motor fields. The speed estimation version is bi-directional and will determine both the motor speed and direction. To enable speed estimation Speed Search at start, set b3-01= "1: SpdsrchF Enable".

IMPORTANT

If the speed estimation method of Speed Search is to be used, then Auto-tuning must be performed prior to using Speed Search. If the length of cable between the Drive and motor is ever changed after Auto-tuning then Auto-tuning should be performed again.

IMPORTANT

The speed estimation mode cannot be used when there are multiple motors operated by one Drive or the motor is two or more frames smaller than the standard size motor per the Drive capacity.

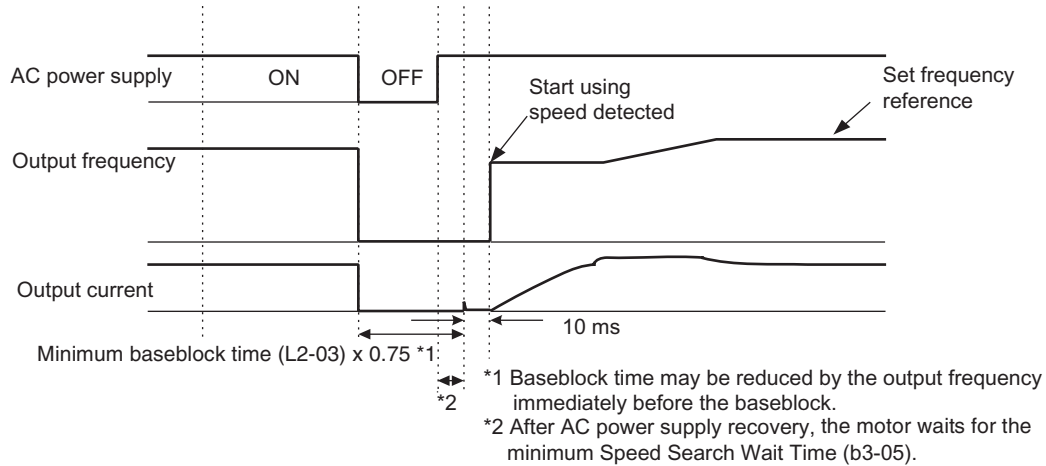


Fig. 10 Speed Search (Estimated Speed Method) after momentary power loss where the power loss time is less than the minimum baseblock time

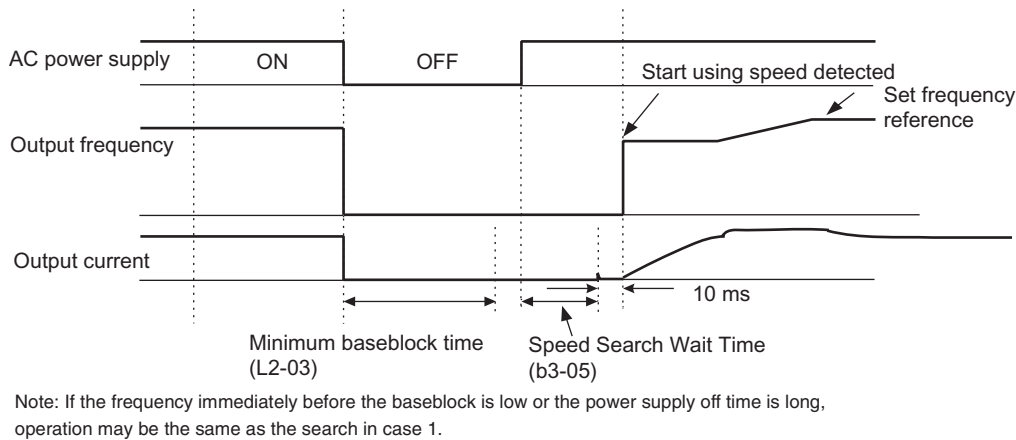


Fig. 11 Speed Search (Estimated Speed Method) after momentary power loss where the power loss time exceeds the minimum baseblock time

Current Detection Method (b3-01=2 or 3): The current detection method starts searching from a predetermined frequency while monitoring the Drive output current to determine when the rotor speed and the Drive output speed (frequency) match. The current detection version is not bi-directional. To enable current detection Speed Search at start set b3-01= “3: SpdsrchI enable” and program any digital input equal to Speed Search 1 (H1-0x= 61) or Speed Search 2 (H1-0x= 62). Speed Search 1 will start searching from the max. frequency (E1-04) and ramp down to meet the rotor speed. Speed Search 2 will start searching from the set frequency and ramp down to meet the rotor speed.

IMPORTANT

If a UV1 fault occurs when current detection Speed Search is attempted, increase the setting of L2-04.

IMPORTANT

If an OC fault occurs when Speed Search is attempted after power loss recovery, increase the setting of L2-03.

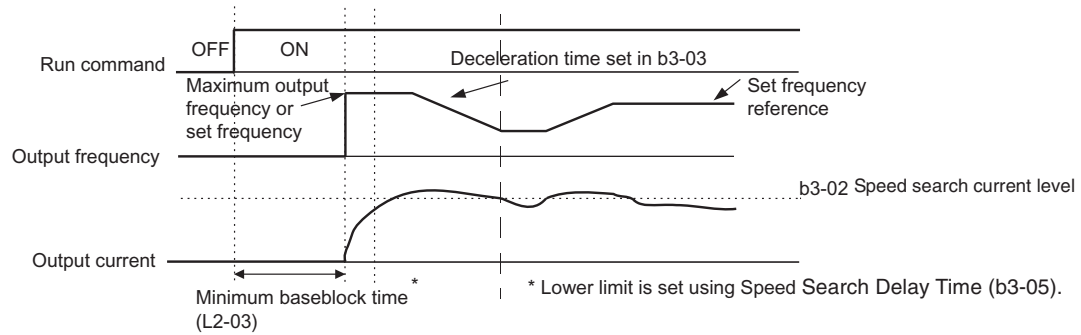


Fig. 12 Speed Search (Current Detection Method) at Startup

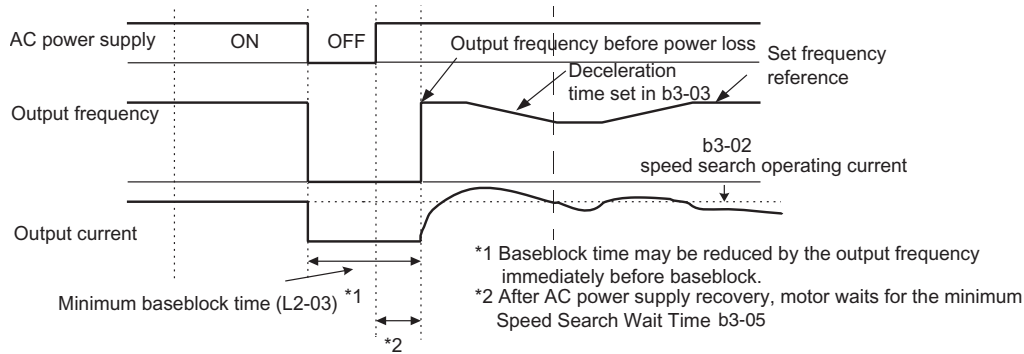


Fig. 13 Speed Search (Current Detection Method) after momentary power loss where the power loss time is less than the minimum baseblock time

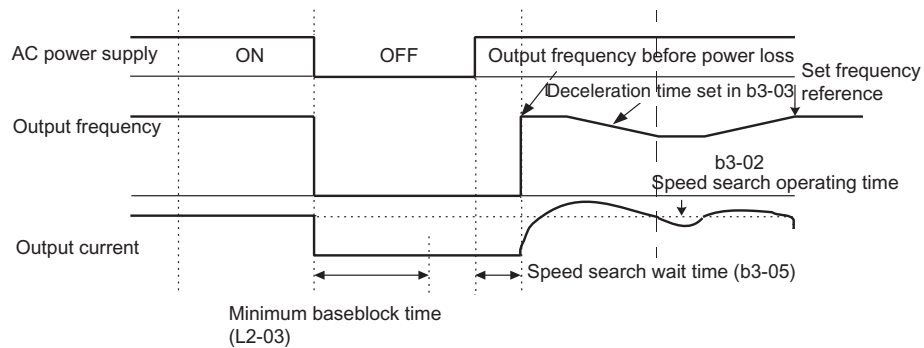


Fig. 14 Speed Search (Current Detection Method) after momentary power loss where the power loss time exceeds the minimum baseblock time

Setting of b3-01	Automatic Speed Search for all RUN commands	Automatic Speed Search after momentary power loss and baseblock	Speed Search Used for Run with programmed multi-function input
0	No	Yes - Speed Estimation	Yes - Speed Estimation
1	Yes - Speed Estimation	Yes - Speed Estimation	Yes - Speed Estimation
2	No	Yes - Current Detection	Yes - Current Detection
3	Yes - Current Detection	Yes - Current Detection	Yes - Current Detection

■ b3-02 Speed Search Deactivation Current

Setting Range: 0 to 200% of Drive rated output current

Factory Default: 120% of Drive rated output current

When using the current detection method of Speed Search, parameter b3-02 sets the current level that will determine when the search is complete and the rotor and output speeds match. When the output frequency is higher than the actual rotor speed the slip causes the current to be high. As the output frequency is lowered, the closer it comes to the rotor speed, the lower the current draw will be. When the output current drops below the level as set in b3-02 (100% = Drive Rated Current) the output frequency stops decreasing and normal operation resumes.

■ b3-03 Speed Search Deceleration Time

Setting Range: 0.1 to 10.0 Seconds

Factory Default: 2.0 Seconds

Parameter b3-03 sets the deceleration ramp used by the current detection method of Speed Search when searching for the motor's rotor speed. Even if Speed Search 2 is selected, for Speed Search at start, the time entered into b3-03 will be the time to decelerate from maximum frequency (E1-04) to minimum frequency (E1-09).

■ b3-05 Speed Search Delay Time

Setting Range: 0.0 to 20.0 Seconds

Factory Default: 0.2 Seconds

In cases where an output contactor is used between the Drive and the motor, extra waiting time is provided after power returns and before Speed Search is performed. This extra time allows for the contactor to operate. When Speed Search at start is used, b3-05 will serve as the lower limit of the Minimum Baseblock Time (L2-03).

■ b3-14 Bi-Directional Speed Search Selection

Setting	Description
0	Disabled
1	Enabled (<i>factory default</i>)

The b3-14 parameter can be used to turn off the bi-directional capabilities of the Speed Estimation form of Speed Search. By turning off the bi-directional capability, the speed search will only try to match the speed in the last known direction.

◆ b4 Delay Timers

The Drive has an internal timer function that operates independently from the Drive. A digital input must be programmed to be a timer start input by setting H1-0x= 18. A digital output must be programmed as a timer output by setting H2-0x= 12. (Not to be confused with the "Wait to Run Time" in b1-11)

■ b4-01 Timer Function ON-Delay Time

Setting Range: 0.0 to 3000.0 Seconds

Factory Default: 0.0 Seconds

The timer start input (H1-0x= 18) must be held on for at least the time specified in parameter b4-01 before the digital output programmed as the timer output will close. See Figure on following page for timing details.

■ b4-02 Timer Function OFF-Delay Time

Setting Range: 0.0 to 3000.0 Seconds

Factory Default: 0.0 Seconds

The timer start input (H1-0x= 18) must be held off for at least the time specified by b4-02 before the digital output programmed as the timer output will open. See Figure below for timing details.

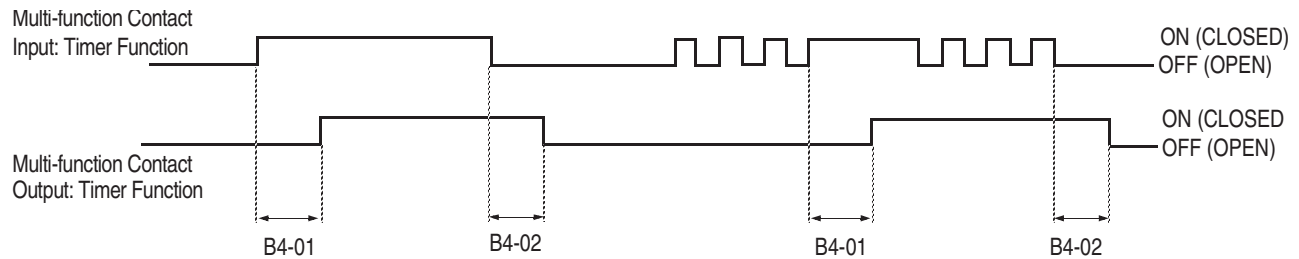


Fig. 15 Timing Diagram of Timer Function

◆ b5 PI Function

The capability to accept an analog signal as feedback for a PI (Proportional + Integral) control function is built into the Drive.

Speed Command / PI Setpoint

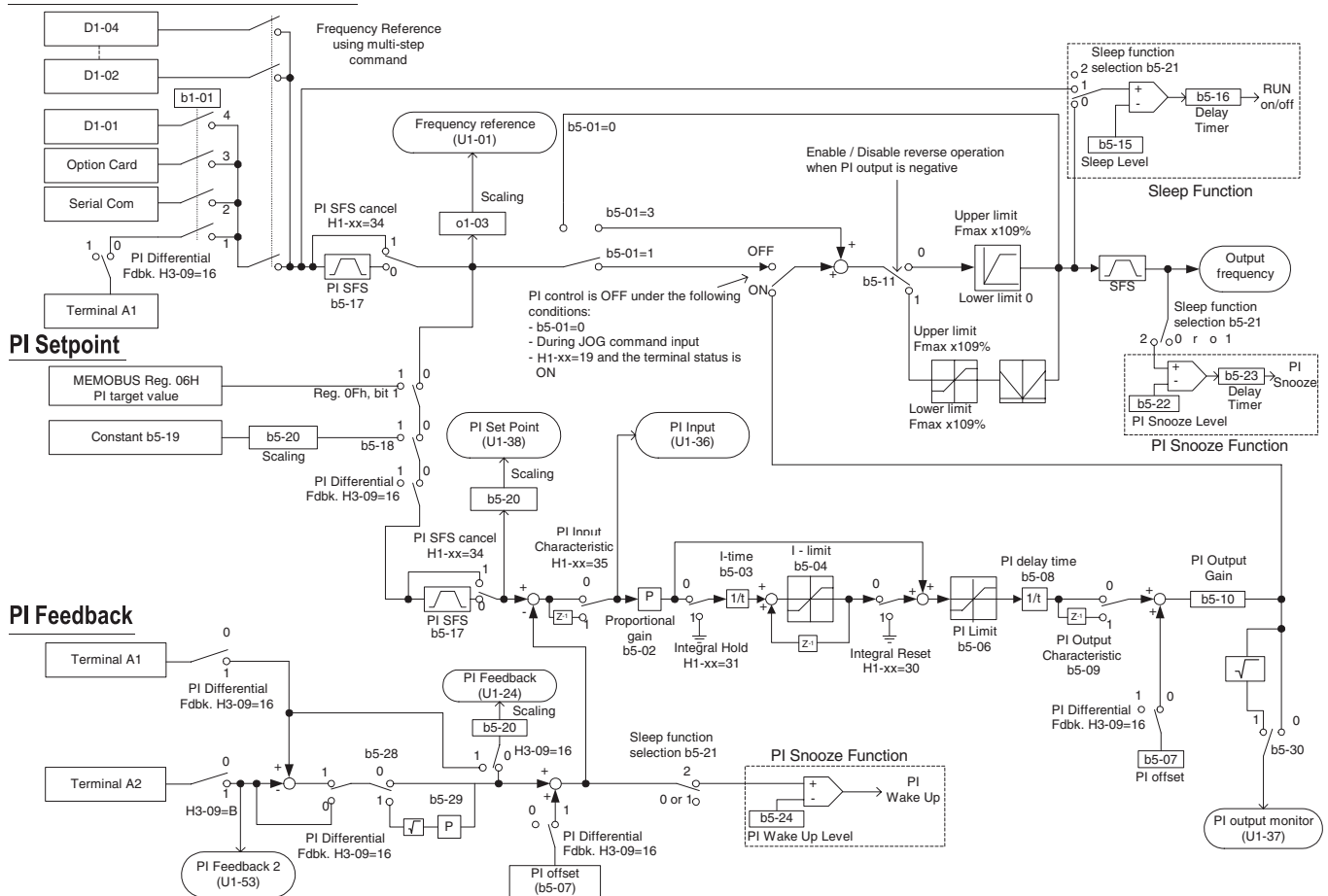


Fig. 16 PI Block Diagram
Programming 16

The analog feedback to the Drive for the PI control is via the A2 terminal. The Drive must be programmed (H3-09= “B: PI Feedback”) to use terminal A2 as feedback for the PI functionality of the Drive.

The PI setpoint can be configured to come from one of many different inputs or parameters. The table below describes the options for originating the PI setpoint.

Table 1 PI Setpoint Options			
The PI Setpoint will be read from:	If these conditions are true		
	Status of b5-18	Status of Modbus Register 0Fh bit 1	Status of b1-01
Parameter b5-19	= 1	N/A	N/A
Modbus Register 06H	= 0	ON	N/A
D1-01	= 0	OFF	= 0
Terminal A1	= 0	OFF	= 1
Serial Comm.	= 0	OFF	= 2
Option PCB	= 0	OFF	= 3

In some situations there are two feedback inputs. The drive can be programmed to maintain a set differential between two analog signals. If input A2 is configured as a “PI Differential Mode” (H3-09= “16: PI Differential”), then the Drive will maintain a set difference between the measurements read on inputs A1 and A2. This differential setpoint is programmed by parameter (b5-07).

■ b5-01 PI Mode

Setting	Description
0	Disabled (<i>factory default</i>)
1	Enabled
3	Fref+PI

The Drive can be used as a stand-alone PI controller. If PI functionality is selected by parameter b5-01, the Drive will adjust its output to cause the feedback from a transmitter to match the PI setpoint (b5-19). The setting of b5-01 will determine whether PI functionality is disabled (b5-01= “0: Disabled”), enabled (b5-01= “1: Enabled”), or enable with the output of the PI function used to trim a Speed Command (b5-01= “3: Fref+PI”).

■ b5-02 Proportional Gain Setting

Setting Range: 0.00 to 25.00

Factory Default: 2.00

The proportional gain will apply a straight multiplier to the calculated difference (error) between the PI Setpoint and the measured transmitter feedback at terminal A2. A large value will tend to reduce the error but may cause instability (oscillations) if too high. A small value may allow too much offset between the setpoint and feedback (See Figure 17 on following page).

■ b5-03 Integral Time Setting

Setting Range: 0.0 to 360.0 Seconds

Factory Default: 5.0 Seconds

The Integral factor of PI functionality is a time-based gain that can be used to eliminate the error (difference between the setpoint and feedback at steady state). The smaller the Integral Time set into b5-03, the more aggressive the Integral factor will be. To turn off the Integral Time, set b5-03= 0.00.

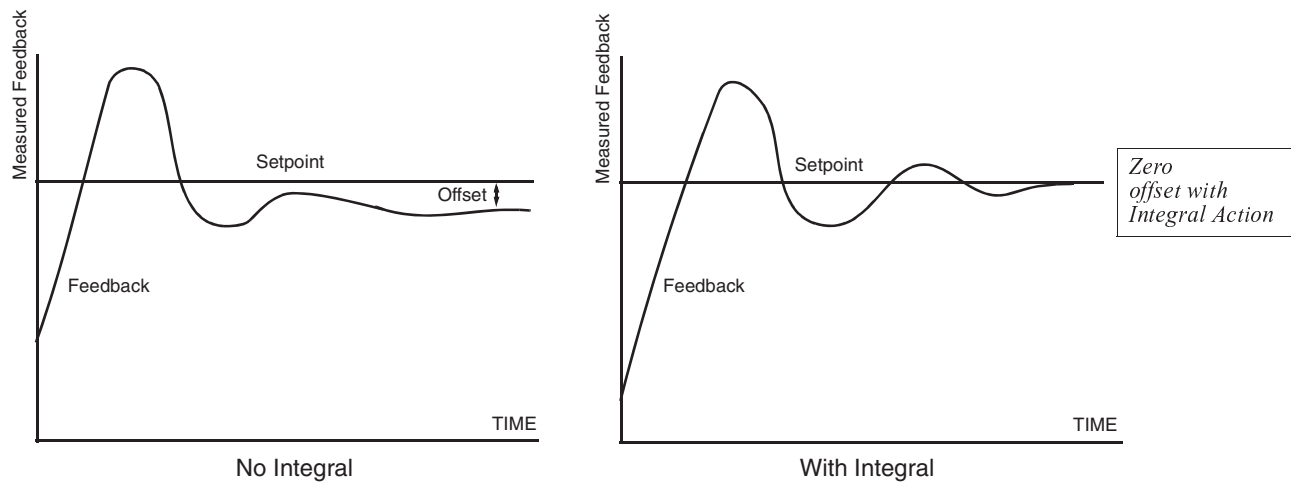


Fig. 17 PID Feedback Response Characteristics

■ b5-04 Integral Limit Setting

Setting Range: 0.0 to 100.0%

Factory Default: 100.0%

On some applications, especially those with rapidly varying loads, the output of the PI function may have large oscillations. To suppress these oscillations, a limit can be applied to the integral factor by programming b5-04.

■ b5-06 PI Output Limit

Setting Range: 0.0 to 100.0%

Factory Default: 100.0%

Places a cap on the output of the PI function. Limiting the PI function may help to prevent large overshoots in the Drive's response to error (the difference between the setpoint and the feedback).

■ b5-07 PI Offset Adjustment

Setting Range: -100.0% to +100.0%

Factory Default: 0.0%

The PI Offset Adjustment parameter has two different uses. Parameter b5-07 serves different functions depending on whether it is used on a standard PI loop or a Differential PI loop.

Parameter b5-07 causes an offset to be applied to the output of the PI function in a non-Differential PI loop. Every time the PI output is updated, the offset (b5-07) is summed with the PI output. This can be used to artificially kick-start a slow starting PI loop.

If the Drive is configured for Differential PI Regulation (H3-09= "16: PI differential"), then this parameter is the target setpoint for the differential to be maintained between the signal measured on analog input A1 and the signal measured on analog input A2.