

## F7 Drive Programming Manual

*This Manual  
also available on  
[www.drives.com](http://www.drives.com)*



Model: CIMR-F7U

Document Number: TM.F7.02



# Warnings and Cautions

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*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. The charge indicator LED will extinguish when the DC bus voltage is below 50Vdc. 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.

## **WARNING**

- The Drive is suitable for circuits capable of delivering not more than 100,000 RMS symmetrical Amperes, 240Vac maximum (200V Class) and 480Vac maximum (400V Class). Install adequate branch circuit short circuit protection per applicable codes. Failure to do so may result in equipment damage and/or personal injury. Refer to Appendix E for further details.
- 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 boards 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.

The Drives are designed and manufactured in accordance with applicable UL and cUL standards, and CE directives.

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, Electronic Equipment for Use in Power Installations

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)

The F7 series Drives comply with the provisions of the Low Voltage Directive 73/23/EEC as amended by 93/68/EEC. These Drives conform to the following standard: EN 50178: 1997-10.

Your supplier or Yaskawa representative must be contacted when using leakage current circuit breaker in conjunction with frequency inverters.

In certain systems it may be necessary to use additional monitoring and safety devices in compliance with the relevant safety and accident prevention regulations. The frequency inverter hardware must not be modified.

# Introduction

*This section describes the applicability of the manual.*

This manual is applicable to F7 Drives defined by model numbers of CIMR-F7U□□□□.

The F7 Drive is a Pulse Width Modulated Drive for AC 3-Phase induction motors. This type of Drive is also known as an Adjustable Frequency Drive, Variable Frequency Drive, AC Drive, AFD, ASD, VFD, VSD, and Inverter. In this manual, the F7 Drive will be referred to as the “Drive”.

The LCD keypad/operator is equipped with local/remote functions, 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” when enabled. Optional Drive Wizard software allows upload/download, as well as graphing and monitoring of Drive parameters from a PC for ease of Drive management.

This manual may describe trademarked equipment, which is the property of other companies, who are the registered owners.

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.F7.02.Programming...Manual included on CD ROM with product

TM.F7.01....Manual included on CD ROM with product

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

Option Instructions... Included on CD ROM with product

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](http://www.drives.com). The date shown on the rear cover is changed when revisions are made. The latest version of Drive software is also shown.

The Drive’s capacity is categorized based on two types of load characteristics: Heavy Duty and Normal Duty. See Table i.1 below for the differences between Heavy Duty and Normal Duty.

Parameter C6-01	Rated Output Current	Overload Capacity	Current Limit	Carrier Frequency	Maximum Output Frequency
0: Heavy Duty (default)	Standard rating (varies by model*)	150% for 1 min.	150%	Low (2kHz)	300Hz
2: Normal Duty	Extended rating (varies by model*)	Approx. 110% for 1 min. (varies by model*)	120%	High (varies by model*)	400Hz

\* See Drive Specifications

This manual references the various Drive capacities according to its model number CIMR-F7U□□□□. See Drive Output Specifications Table i.2 and Table i.3 on the following pages for rated capacities and Drive specifications.

# Drive Output Specifications

The standard Drive specifications are listed in the following tables.

## ◆ 208-240Vac

Table i.2 208-240Vac Drive Specifications																				
		208-240Vac											208-230Vac							
Model Number CIMR-F7U		20P4	20P7	21P5	22P2	23P7	25P5	27P5	2011	2015	2018	2022	2030	2037	2045	2055	2075	2090	2110	
Output ratings	Heavy Duty*1	Rated output capacity (kVA)	1.2	1.6	2.7	3.7	5.7	8.8	12.0	17.0	22.0	27.0	32.0	44.0	55.0	69.0	82.0	110.0	130.0	N/A
		Horsepower*2	0.5/0.75	2	2	3	5	7.5	10	15	20	25	30	40	50	60	75	100	125	
		Rated output current (A)	3.2	4.2	7.0	9.6	15.2	23.0	31.0	45.0	58.0	71	85.0	115.0	145.0	180.0	215	283.0	346.0	
		Overload capacity*3 (% of rated output current for 60 sec.)	150																	
		Current limit (% of rated output current)	150																	
		Carrier frequency*4	2kHz																	
		Maximum output frequency	300.0Hz																	
	Normal Duty*1	Rated output capacity (kVA)	1.4	1.8	3.0	4.1	6.4	8.8	12.0	18.0	23.0	29.0	34.0	44.0	62.0	73.0	82.0	120.0	140.0	160.0
		Horsepower*2	0.5/0.75	1	2	3	5	7.5	10	15	20	25	30	40	50/60	75	75	100/125	150	150
		Rated output current (A)	3.6	4.6	7.8	10.8	16.8	23.0	31.0	46.2	59.4	74.8	88.0	115.0	162.0	192.0	215	312.0	360.0	415.0
		Overload capacity*3 (% of rated output current for 60 sec.)	107	107	108	107	107	120	120	117	117	114	116	120	107	113	120	109	115	120
		Current limit (% of rated output current)	120																	
		Carrier frequency (kHz)*5	10	10	10	8	10	15	15	8	10	10	10	10	5	5	8	2	2	2
		Maximum output frequency	400.0Hz																	
Maximum output voltage	3-phase; 200, 208, 220, 230, or 240Vac (Proportional to input voltage)																			

\*1 The difference between Heavy Duty ratings and the Normal Duty ratings for the Drive are the rated input and output current, overload capacity, carrier frequency, current limit, and maximum output frequency. Parameter C6-01 must be set to value of "0" for Heavy Duty ratings and "2" for Normal Duty ratings. Factory default is Heavy Duty (C6-01=0).

\*2 Horsepower ratings are based on 230V or 460V NEC Table 430.150. The maximum applicable motor output is given for a standard 4-pole motor. When selecting the actual motor and Drive, be sure that the Drive's rated output current is appropriate for the motor's rated current.

\*3 Models 2110, 4220, 4300 have an overload rating of 120% of rated output current for 60 seconds.

\*4 2kHz is the Maximum carrier frequency value and default carrier frequency value for all models.

\*5 Each value shown is the Maximum carrier frequency and default carrier frequency.

# ◆ 480Vac

Table i.3 480Vac Drive Specifications

Model Number CIMR-F7U		40P4	40P7	41P5	42P2	43P7	44P0	45P5	47P5	4011	4015	4018	4022	
Output ratings	Heavy Duty*1	Rated output capacity (kVA)	1.4	1.6	2.8	4.0	5.8	6.6	9.5	13.0	18.0	24.0	30.0	34.0
		Horsepower*2	0.5/0.75	1	1.5/2	3	5	-	7.5	10	15	20	25	30
		Rated output current (A)	1.8	2.1	3.7	5.3	7.6	8.7	12.5	17.0	24.0	31.0	39.0	45.0
		Overload capacity*3 (% of rated output current for 60 sec.)	150											
		Current limit*2 (% of rated output current)	150											
		Carrier frequency*4	2kHz											
		Maximum output frequency	300.0Hz											
	Normal Duty*1	Rated output capacity (kVA)	1.4	1.6	2.8	4.0	5.8	6.6	9.5	13.0	21.0	26.0	30.0	38.0
		Horsepower*2	0.5/0.75	1	1.5/2	3	5	-	7.5	10	15/20	25	30	30
		Rated output current (A)	1.8	2.1	3.7	5.3	7.6	8.7	12.5	17.0	27.0	34.0	40.0	50.4
		Overload capacity*3 (% of rated output current for 60 sec.)	120	120	120	120	120	120	120	120	107	109	117	107
		Current limit (% of rated output current)	120											
		Carrier frequency (kHz)*5	15	15	15	15	15	15	15	15	8	10	10	10
		Maximum output frequency	400.0Hz											
Maximum output voltage		3-phase; 380, 400, 415, 440, 460, or 480Vac (Proportional to input voltage)												

Model Number CIMR-F7U		4030	4037	4045	4055	4075	4090	4110	4132	4160	4185	4220	4300	
Output ratings	Heavy Duty*1	Rated output capacity (kVA)	46.0	57.0	69.0	85.0	110.0	140.0	160.0	200.0	230.0	280.0	N/A	
		Horsepower*2	40	50	60	75	100	125/150	-	200	250	300		
		Rated output current (A)	60.0	75.0	91.0	112.0	150.0	180.0	216.0	260.0	304.0	370.0		
		Overload capacity*3 (% of rated output current for 60 sec.)	150											
		Current Limit (% of rated output current)	150											
		Carrier frequency*4	2kHz											
		Maximum output frequency	300.0Hz											
	Normal Duty*1	Rated output capacity (kVA)	51.0	59.0	73.0	95.0	120.0	140.0	180.0	200.0	230.0	315.0	390.0	510.0
		Horsepower*2	40/50	60	75	100	125	150	200	-	250	300/350	400/450	500+
		Rated output current (A)	67.2	77.0	96.0	125.0	156.0	180.0	240.0	260.0	304.0	414.0	515.0	675.0
		Overload capacity*3 (% of rated output current for 60 sec.)	107	117	114	108	115	120	108	120	120	107	118	120
		Current Limit (% of rated output current)	120											
		Carrier frequency (kHz)*5	8	8	8	5	5	8	5	5	5	2	2	2
		Maximum output frequency	400.0Hz											
Maximum output voltage		3-phase, 380, 400, 415, 440, 460 or 480Vac (Proportional to input voltage)												

\*1 The difference between Heavy Duty ratings and the Normal Duty ratings for the Drive are the rated input and output current, overload capacity, carrier frequency, current limit, and maximum output frequency. Parameter C6-01 must be set to value of "0" for Heavy Duty ratings and "2" for Normal Duty ratings. Factory default is Heavy Duty (C6-01=0).

\*2 Horsepower ratings are based on 230V or 460V NEC Table 430.150. The maximum applicable motor output is given for a standard 4-pole motor. When selecting the actual motor and Drive, be sure that the Drive's rated output current is appropriate for the motor's rated current.

\*3 Models 2110, 4220, 4300 have an overload rating of 120% of rated output current for 60 seconds.

\*4 2kHz is the Maximum carrier frequency value and default carrier frequency value for all models.

\*5 Each value shown is the Maximum carrier frequency and default carrier frequency.

Notes:

# F7 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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# F7 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.

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## ◆ A1 Initialization

### ■ A1-00 Language Selection

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 : Português (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.

## ■ A1-02 Control Method Selection

Setting	Description
0	V/f Control without PG
1	V/f Control with PG
2	Open Loop Vector ( <i>factory default</i> )
3	Flux Vector (Closed Loop Vector)

The Control Method of the Drive can be selected in A1-02 to best suit the application.

V/f Control without PG - For general purpose and multiple motor applications.

V/f Control with PG - For general purpose applications requiring closed loop speed control.

Open Loop Vector - For applications requiring precise speed control, quick response, and higher torque at low speeds.

Flux Vector - For applications requiring very precise speed and torque control at wide speed range including zero speed. Uses an encoder feedback.

## ■ 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.

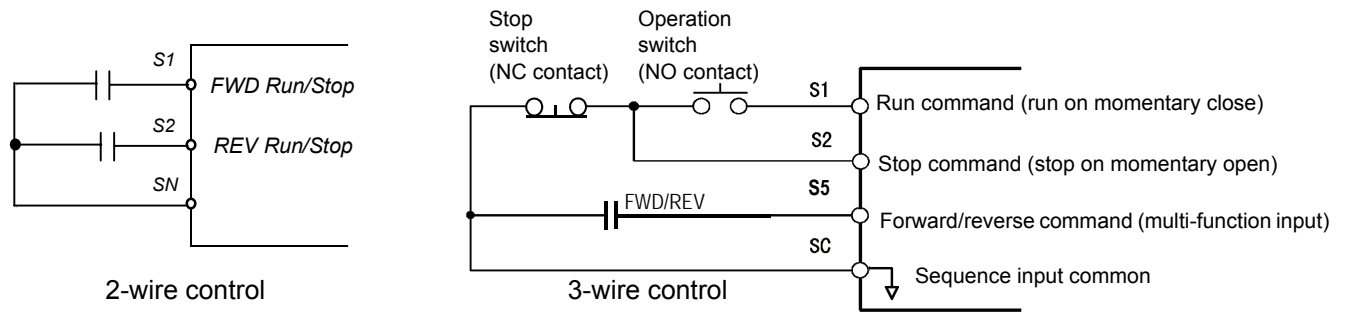


Fig. 1 2 & 3-Wire Control Wiring Examples

**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
o2-09	Initialization Specification 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.

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◆ **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 Hand/Auto changeover are located in this group.

### ■ b1-01 Frequency Reference Source Selection

Setting	Description
0	Operator - Digital Preset Speed U1-01 or d1-01 to d1-17
1	Terminals ( <i>factory default</i> ) - Analog Input Terminal A1 (or Terminal A2, see Parameter H3-09)
2	Serial Com - RS-422/485 Terminals R+, R-, S+ and S-
3	Option PCB - Option Board connected at 2CN
4	Pulse Input (Terminal RP)

In order to run the Drive and motor, the Drive must receive a Run command and a frequency reference. Parameter b1-01 specifies from where the frequency reference 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 frequency reference 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 frequency reference set by the digital operator:** Use the “Local” mode by pressing the LOCAL/REMOTE button or set b1-01= “0: Operator”. The frequency reference can then be entered into the U1-01 monitor parameter in the “-DRIVE-” Menu.

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

**If you want the Drive to receive the frequency reference 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 the option board to input a frequency reference:** Set b1-01= “3: Option PCB”, and plug a communication option board 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 communication system.

#### IMPORTANT

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

**If you want the Drive to follow a pulse input frequency reference:** Set b1-01= “4: Pulse Input”, and connect the pulse signal to terminal RP.

## ■ b1-02 Run Command Source Selection

Setting	Description
0	Operator - RUN and STOP keys on the Digital Operator
1	Terminals ( <i>factory default</i> ) - Terminals S1 or S2
2	Serial Com - Modbus RS-422/485 Terminals R+, R-, S+, and S-
3	Option PCB - Option Board connected on 2CN

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:** Use the “Local” mode by pressing the LOCAL/REMOTE button or set b1-02= “0: Operator”, and use the RUN and STOP key 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).

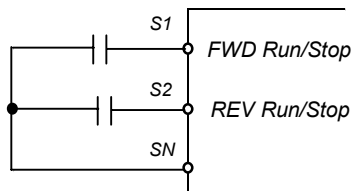


Fig. 2 2-Wire Control

**3-Wire Control** When any of the multi-function digital input parameters, H1-01 through H1-05, are 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 any time 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.

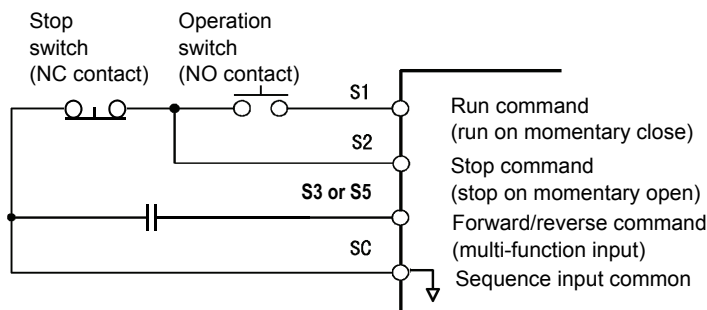


Fig. 3 3-Wire Control

**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 communication option board:** Set b1-02= “3: Option PCB”, and plug a communication option board into the 2CN port on the Control PCB. Consult the manual supplied with the option board for instructions on integrating the Drive into your communication system.

**IMPORTANT**

If b1-01= "3: Option PCB" but an option board 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 Selection**

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 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.

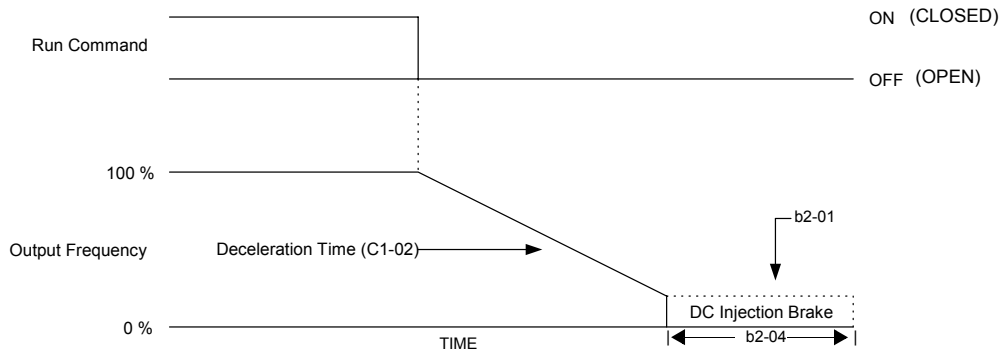


Fig. 4 Deceleration to Stop

The actual deceleration time can be determined by the following formula

$$\text{Time to Stop} = \frac{\text{Output Freq. at time of stop command}}{\text{Maximum Frequency (E1 - 04)}} \times \text{Setting of active Decel Time (C1 - 02, -04, -06 or -08)}$$

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.

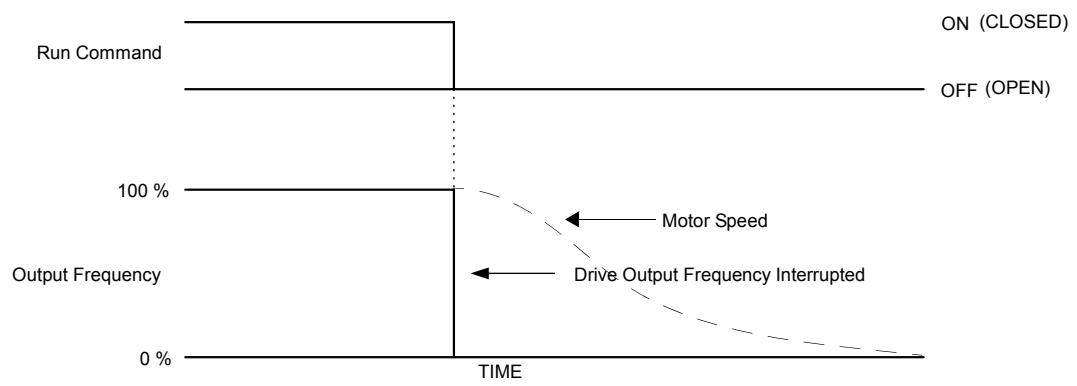


Fig. 5 Coast to Stop

**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.

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

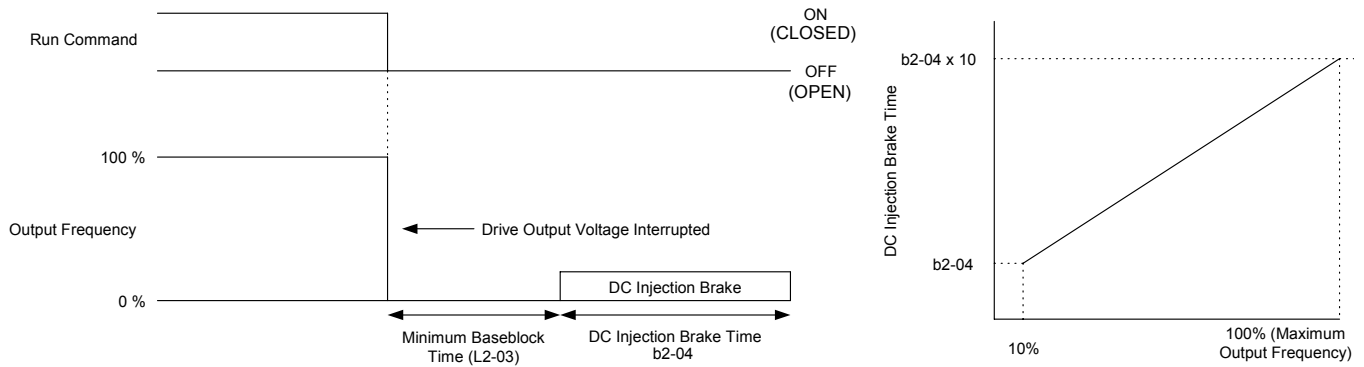


Fig. 6 DC Injection Braking to Stop

**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 (value of C1-02) expires, the Drive will not run and the Run command will need to be cycled before operation can occur. The time T (value of C1-02) is determined by the output frequency when the Run command is removed and the active deceleration time.

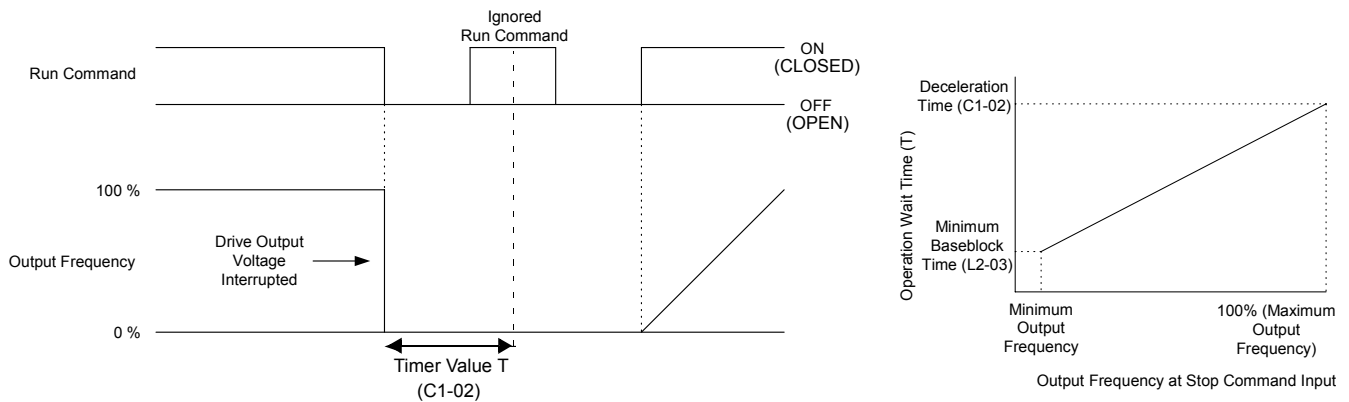


Fig. 7 Coast to Stop with Timer

## ■ b1-04 Reverse Operation Selection

Setting	Description
0	Reverse Enabled ( <i>factory default</i> )
1	Reverse Disabled
2	Exchange Phase (N/A if A1-02 = 1 or 3)

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 will cause the Drive to ignore any inputs for reverse operation. Setting parameter b1-04 to 2 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 “0: Reverse Enabled”. When b1-04= “1: Disabled”, reverse operation is prohibited and no exchanging of output phasing occurs.

## ■ b1-05 Minimum Output Frequency (E1-09) or Less Operation Selection

Setting	Description
0	Operates According to Frequency Reference ( <i>factory default</i> )
1	Output Shuts Off
2	Operates According to E1-09
3	Zero Speed

During flux vector control (A1-02 = 3), select an operation mode to be employed when the frequency reference (analog input) drops below the minimum output frequency (E1-09). During V/f or open loop vector control, Drive output to the motor is shut off (baseblock) when the output frequency drops below the minimum output frequency (E1-09).

## ■ b1-06 Digital Input Scan Time

Setting	Description
0	2ms - For 2 Scans
1	5ms - For 2 Scans ( <i>factory default</i> )

This parameter selects the microprocessor scan time for reading multi-function digital inputs (terminals S1 to S8). Set this parameter to “0: 2ms” for quick response and “1: 5ms” for noisy environments.

## ■ 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 switch 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 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 Auto 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”.

◆ **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”).

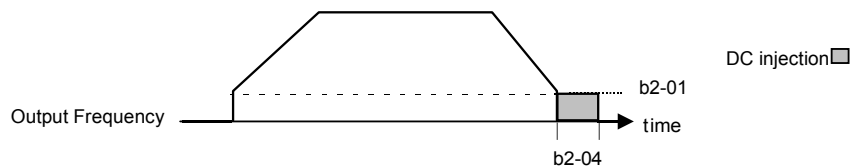


Fig. 8 DC Injection Braking During stopping

## ■ 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.

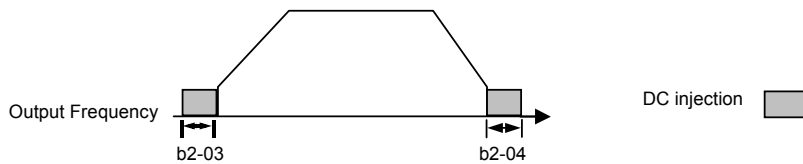


Fig. 9 DC Injection Braking During Starting and stopping

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.

## ■ b2-08 Magnetic Flux Compensation Capacity

Setting Range: 0 to 1000%

Factory Default: 0%

This parameter allows the magnetizing motor flux to be boosted when starting the motor. This parameter will facilitate a quick ramp-up of the torque reference and magnetizing current reference to reduce motor slip during start. A setting of 100% equals motor no-load current E2-03. This flux level will be applied below Minimum Output Frequency (E1-09) until the DC Injection Time at Start (b2-03) expires. This parameter is useful when starting motors that are relatively larger than the Drive, due to the requirement for increased magnetizing current. This parameter may also compensate for reduced starting torque due to motor circuit inefficiencies.

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## ◆ 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

Setting	Description
0	Speed Estimation Speed Search Disable
1	Speed Estimation Speed Search Enable
2	Current Detection Speed Search Disable ( <i>factory default</i> )
3	Current Detection Speed Search 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.

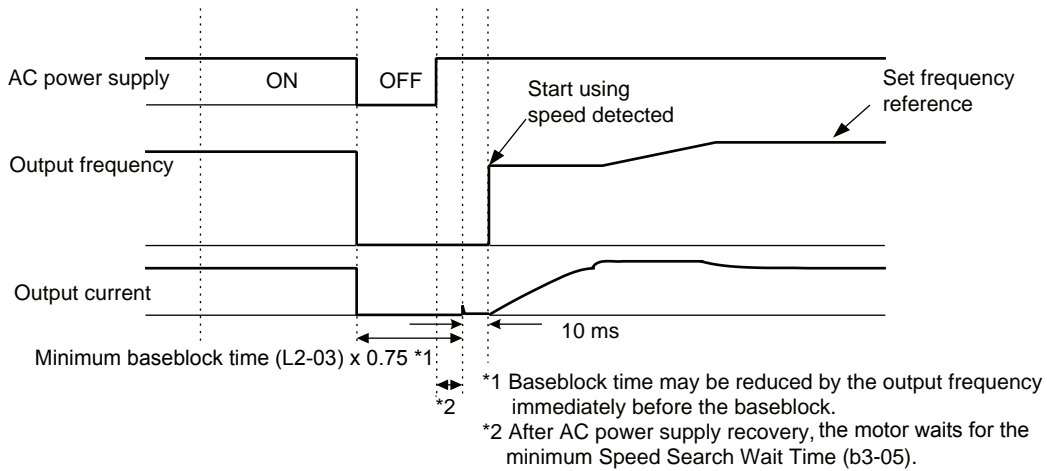


Fig. 10 Speed Search (Estimated Speed Method) after momentary power loss where the power loss time is less than the minimum baseblock time

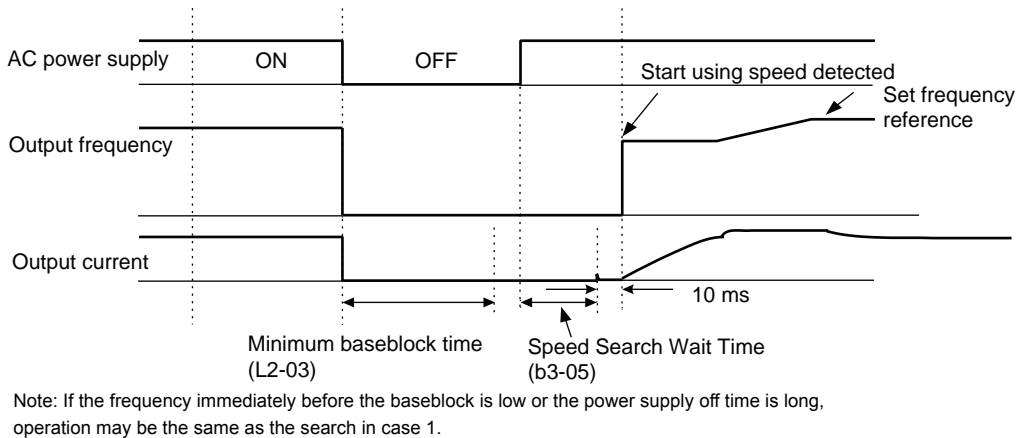


Fig. 11 Speed Search (Estimated Speed Method) after momentary power loss where the power loss time exceeds the minimum baseblock time

**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: SpdschrI 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.

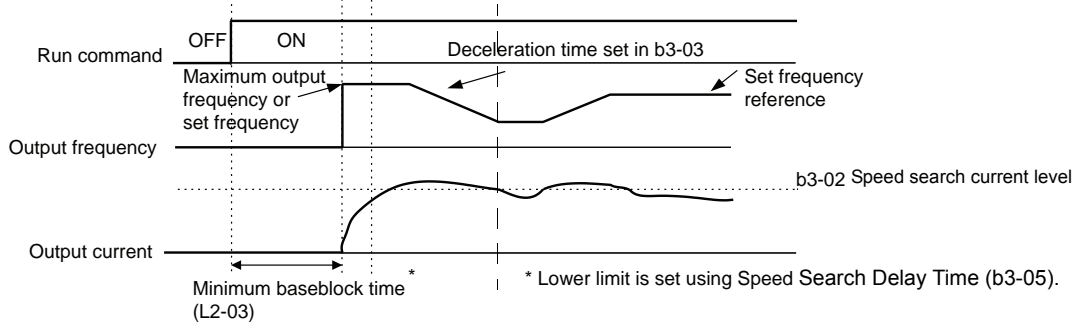


Fig. 12 Speed Search (Current Detection Method) at Startup

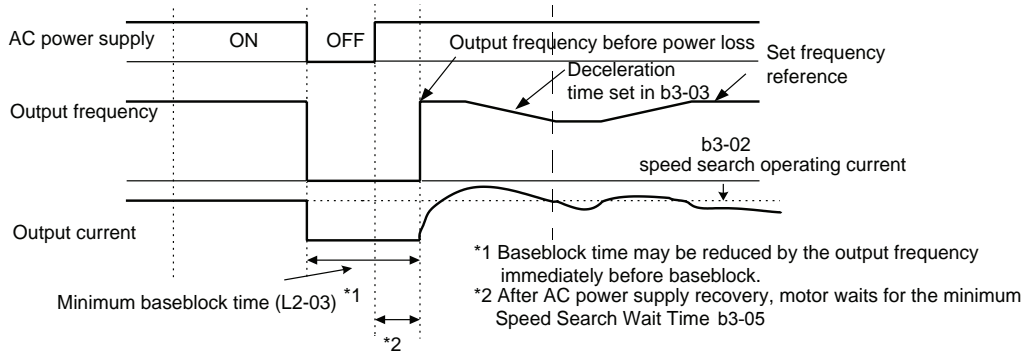


Fig. 13 Speed Search (Current Detection Method) - after momentary power loss where the power loss time is less than the minimum baseblock time

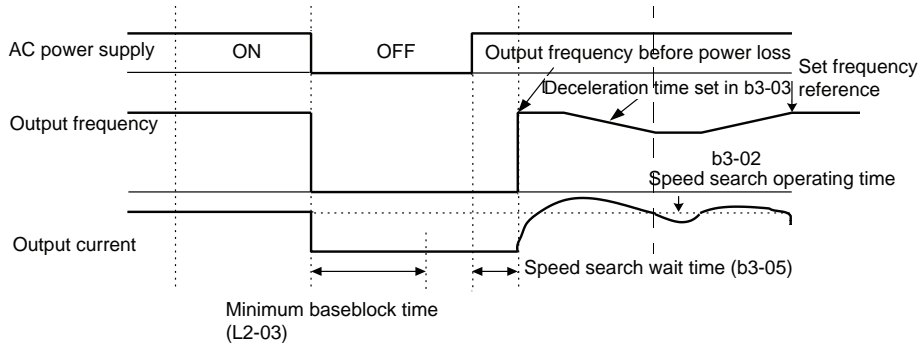


Fig. 14 Speed Search (Current Detection Method) - after momentary power loss where the power loss time exceeds the minimum baseblock time

Speed Search Settings and Methods		
Setting of b3-01	Automatic Speed Search at RUN command	Speed Search Method Used for Multi-function inputs, momentary power loss, baseblock, fault retry
0	No	Yes - Speed Estimation
1	Yes - Speed Estimation	Yes - Speed Estimation
2	No	Yes - Current Detection
3	Yes - Current Detection	Yes - Current Detection

Note: When parameter A1-02 = 0 (V/f control without PG) or 2 (open loop vector) the factory default setting is 2. When parameter A1-02 = 1 (V/f control with PG) the factory default setting is 3.

### ■ 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 (b3-01 = 2 or 3), 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.

Note: When parameter A1-02 = 0 (V/f control without PG) the factory default setting is 120. When parameter A1-02 = 2 (Open Loop Vector) the factory default setting is 100.

### ■ 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 (b3-01 = 2 or 3) 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).

### ■ b3-10 Speed Search Detection Compensation Gain

Setting Range: 1.00 to 1.20

Factory Default: 1.10

This parameter sets the gain for the frequency reference at which the Drive starts speed estimation speed search. It is used only when b3-01 = 0 or 1.

### ■ 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.

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## ◆ 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 below 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.

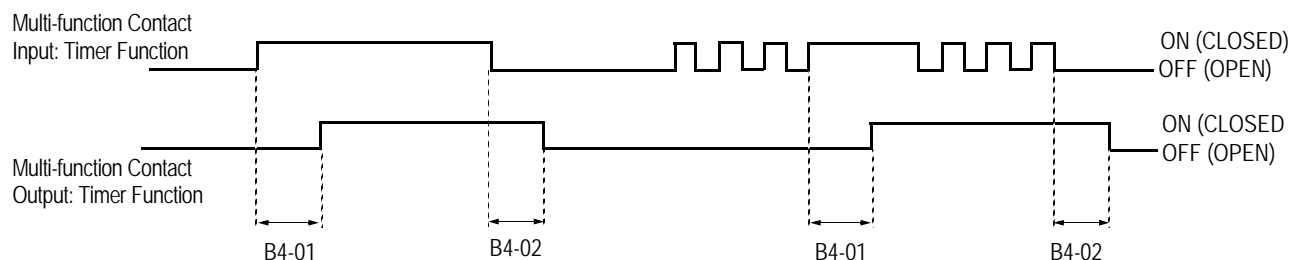


Fig. 15 Timing Diagram of Timer Function

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## ◆ b5 PID Function

The capability to accept an analog signal as feedback for a PID (Proportional + Integral + Derivative) control function is built into the Drive. The PID control function provides closed-loop control and regulation of a system variable such as temperature or pressure. A control signal based on the difference (or proportion) between a feedback signal and a desired setpoint is produced. Integration and derivative calculations are then performed on this signal, based upon the PID parameter settings (B5-01 to B5-19), to minimize deviation, for more precise control.

### ***Proportional - P***

PID refers to the type of action used to control modulating equipment such as valves or dampers. With proportional control, a control signal based on the difference between an actual condition and a desired condition is produced. The difference, such as that between an actual temperature and setpoint is the “error”. The inverter adjusts its output signal related directly to the error magnitude.

### ***Integral - I***

The integral action is designed to minimize offset. An integrating term is used to observe how long the error condition has existed, summing the error over time. Once the system has stabilized, the offset would be minimized.

## Derivative - D

Overshoot refers to a control loop tendency to overcompensate for an error condition, causing a new error in the opposite direction. Derivative action provides an anticipatory function that exerts a “braking” action on the control loop. When combined, the proportional, integral, and derivative actions provide quick response to error, close adherence to the setpoint, and control stability.

The analog feedback to the Drive for the PID control is via the A2 or A3 terminal. Set parameter H3-09 or H3-05 to “B: PID Feedback” to use terminal A2 or A3, respectively, as feedback for the PID functionality of the Drive. To use the analog input terminal A2 or A3 as the PID setpoint, set parameter H3-09 or H3-05 to “C: PID Setpoint,” respectively. The PID setpoint can be configured to come from one of many different inputs or parameters. The table below describes the options for originating the PID setpoint.

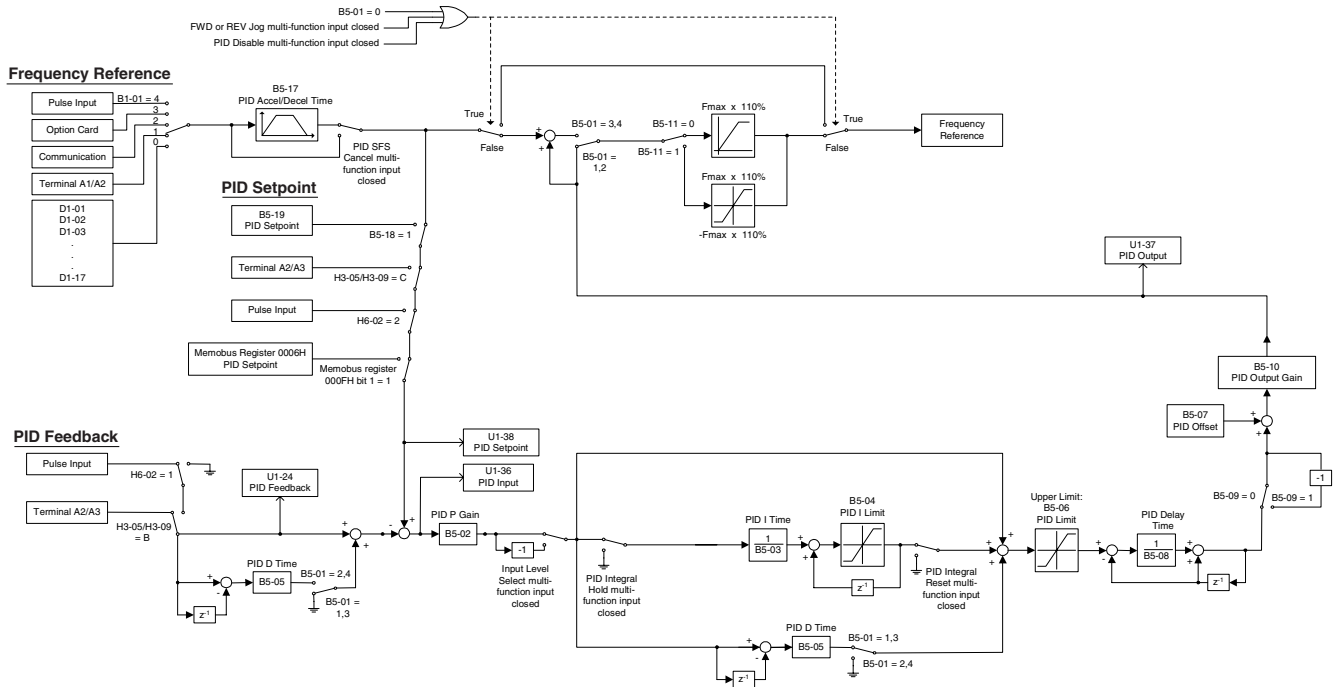


Fig. 16 PID Block Diagram

## ■ b5-01 PID Function Setting

Setting	Description
0	Disabled ( <i>factory default</i> )
1	D = Feedback
2	D = Feed-Forward
3	Frequency Reference + PID Output (D = Feedback)
4	Frequency Reference +PID Output (D = Feed-Forward)

The Drive can be used as a stand-alone PID controller. If PID functionality is selected by parameter b5-01, the Drive will adjust its output to cause the feedback from a transmitter to match the PID setpoint (b5-19). To enable PID control, set b5-01 to 1, 2, 3, or 4 according to the application.

## ■ 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 PID 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 below).

## ■ b5-03 Integral Time Setting

Setting Range: 0.0 to 360.0 Seconds

Factory Default: 5.0 Seconds

The Integral factor of PID 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.

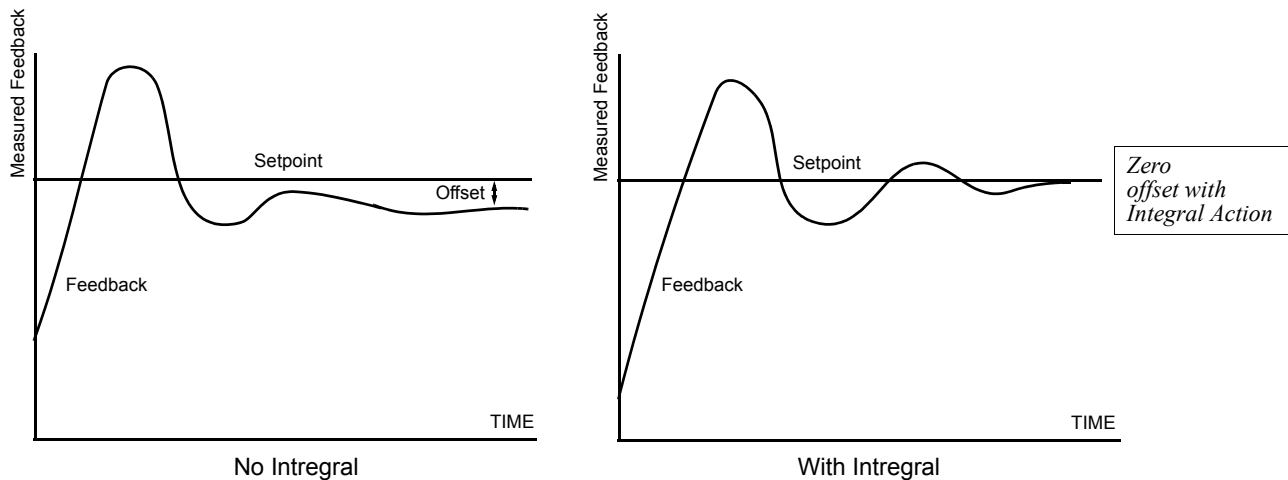


Fig. 17 PID Feedback Response Characteristics

## ■ 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 PID function may have large oscillations. To suppress these oscillations, a limit can be applied to the integrate factor by programming b5-04.

## ■ b5-05 Derivative Time Setting

Setting Range: 0.00 to 10.00 Seconds

Factory Default: 100.0%

The derivative calculation attempts to control the remaining overshoot left over after the proportion and integral calculations. If the system is approaching the intended value very rapidly, the derivative control produces a strong braking action to prevent overshoot. If the system is already stable with very little deviation change, derivative control has very little effect. The derivative time is used to dampen oscillations and reduce overshoot, thus improving stability. Setting the derivative time to a larger number produces more braking action in the control system. A setting of 0.00 disables derivative control.

### ■ b5-06 PID Output Limit

Setting Range: 0.0 to 100.0%

Factory Default: 100.0%

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

### ■ b5-07 PID Offset Adjustment

Setting Range: -100.0% to +100.0%

Factory Default: 0.0%

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

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

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

### ■ b5-08 PID Primary Delay Time Constant

Setting Range: 0.00 to 10.00 Seconds

Factory Default: 0.00 Seconds

Acts as a time based filter that lowers the responsiveness of the PID function, but also makes the function more stable when the setpoint varies rapidly or when the feedback is noisy.

### ■ b5-09 PID Output Level Selection

Setting	Description
0	Normal Output (direct acting) ( <i>factory default</i> )
1	Reverse Output (reverse acting)

Normally, the output of the PID function causes an increase in motor speed whenever the measured feedback is below the setpoint. This is referred to as direct acting response. However, if b5-09= "1: Reverse Output", the output of the PID function causes the motor to slow down when the feedback is below the setpoint. This is referred to as reverse acting response.

### ■ b5-10 PID Output Gain Setting

Setting Range: 0.0 to 25.0

Factory Default: 1.0

Applies a multiplier to the output of the PID function. Using the gain can be helpful when the PID function is used to trim the frequency reference. Increasing b5-10 causes the PID function to have a greater regulating affect on the frequency reference.

### ■ b5-11 PID Reverse Selection

Setting	Description
0	0 Limit ( <i>factory default</i> )
1	Reverse

Parameter b5-11 determines whether reverse operation is allowed while using PID control (b5-01≠0) and the PID output goes negative. The factory default setting will not allow the Drive to run in reverse when the PID output goes negative. Zero speed limit is automatic when reverse prohibit is selected using b1-04. (Refer also to b5-09).

### ■ b5-12 PID Feedback Reference Missing Detection Selection

Setting	Description
0	Disabled ( <i>factory default</i> )
1	Alarm
3	Fault

### ■ b5-13 PID Feedback Loss Detection Level

Setting Range: 0 to 100%  
 Factory Default: 0%

### ■ b5-14 PID Feedback Loss Detection Time

Setting Range: 0.0 to 25.0 Seconds  
 Factory Default: 1.0 Seconds

Loss of feedback can cause problems to a PID application. The Drive can be programmed to turn on a digital output whenever a loss of feedback occurs. Feedback Loss Detection is turned on by b5-12. When b5-12= “1: Alarm”, the Drive acknowledges the loss of feedback without stopping or turning on the fault output (MA-MB). If b5-12= “2: Fault”, the Drive coasts to a stop and turns on the fault output if the feedback is determined to be lost. The Drive interprets feedback loss whenever the feedback signal drops below the value of b5-13 and stays below that level for at least the time set into b5-14. See Figure below for timing details.

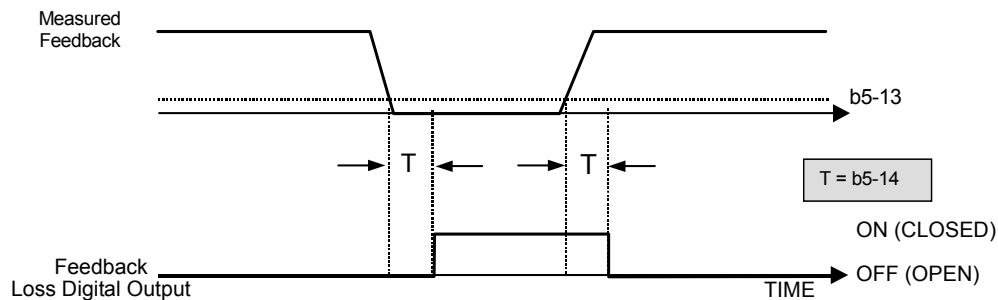


Fig. 18 Loss of PID Feedback Feature

### ■ b5-15 Sleep Function Start Level

Setting Range: 0.0 to 200.0 Hz  
 Factory Default: 0.0 Hz

### ■ b5-16 Sleep Delay Time

Setting Range: 0.0 to 25.5 Seconds  
 Factory Default: 0.0 Seconds

### ■ b5-17 PID Accel/Decel Time

Setting Range: 0.0 to 25.5 Seconds  
 Factory Default: 0.0 Seconds

This is a soft start function that is applied to the PID setpoint analog input. Instead of having nearly instantaneous changes in signal levels, there is a programmed ramp applied to level changes. When changing setpoints the error can be limited by gradually ramping the setpoint through the use of parameter b5-17.

### ■ b5-18 PID Setpoint Selection

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

In order to use parameter b5-19 as the PID Setpoint, set parameter b5-18= “1: Enabled”. If b5-18= “0: Disabled” the PID Setpoint will either be:

- Modbus Register 06H (If Register 0FH bit 1 is high)
- The active frequency reference (i.e. Determined by the setting of b1-01). See Table 1 “Setpoint Options”

### ■ b5-19 PID Setpoint Value

Setting Range: 0.00 to 100.00%  
 Factory Default: 0.00%

Parameter b5-19 is for a PID Setpoint value. When b5-18= “1: Enabled”, the value of b5-19 will take precedent over any other PID setpoint unless the Drive is set up for Differential Feedback, in which case, b5-18 and b5-19 have no affect on the PID function.

## ◆ b6 Reference Hold (Dwell)

The reference hold or dwell function is used to temporarily hold the output frequency at a set reference, for a set time, and then continue to ramp up. This function can be used when driving a permanent magnet motor, or a motor with a heavy starting load. This pause in acceleration allows the magnets in a permanent magnet motor to synchronize with the stator field of the motor, thus reducing traditionally high starting current.

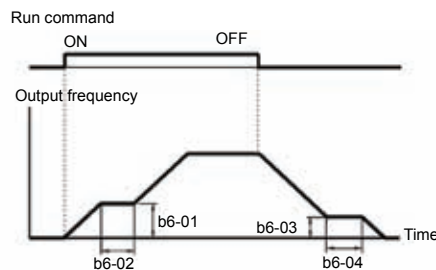


Fig. 19 Dwell Timing Chart

### ■ **b6-01 Dwell Reference at Start**

Setting Range: 0.0 to 400.0 Hz

Factory Default:0.0 Hz

Sets the dwell frequency reference during acceleration in units of 0.1 Hz.

### ■ **b6-02 Dwell Time at Start**

Setting Range: 0.0 to 10.0 Seconds

Factory Default:0.0 Seconds

Sets the amount of time that the frequency reference dwells during acceleration in units of 0.1 seconds.

### ■ **b6-03 Dwell Reference at Stop**

Setting Range: 0.0 to 400.0 Hz

Factory Default:0.0 Hz

Sets the dwell frequency reference during deceleration in units of 0.1 Hz.

### ■ **b6-04 Dwell Time at Stop**

Setting Range: 0.0 to 10.0 Seconds

Factory Default:0.0 Seconds

Sets the amount of time that the frequency reference dwells during deceleration in units of 0.1 seconds.

---

## ◆ **b7 Droop Control**

The droop control function reduces the motor speed based on the load torque of the motor.

### ■ **b7-01 Droop Control Level**

Setting Range: 0.0 to 100.0%

Factory Default:0.0%

Sets the amount of speed reduction as a percentage of maximum output frequency E1-04 when the motor is producing 100% of rated torque. The actual amount of motor speed reduction is based on the ratio of the amount of motor torque and the maximum output frequency E1-04.

### ■ **b7-02 Droop Control Delay Time**

Setting Range: 0.03 to 2.00 Seconds

Factory Default:0.05 Seconds

Sets the response time in response to load changes. Decreasing this setting will cause the response to become quicker; however, instability may occur.

---

## ◆ b8 Energy Savings

The energy savings function improves overall system operating efficiency by operating the motor at its highest efficiency. This is accomplished by continuously monitoring the motor load and adjusting the motor terminal voltage so that the motor always operates near its rated slip frequency. A motor is most efficient when operating near rated slip conditions.

### ■ b8-01 Energy Savings Selection

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

When the Energy Savings function is enabled (b8-01= “1: Enabled”), the Drive reduces the output voltage to the motor below the voltage value specified by the programmed V/f pattern whenever the motor load is light. Since torque is reduced during this voltage reduction, the voltage has to return to normal levels once the load returns. The energy savings is realized through improved motor efficiency. The reduced output voltage causes increased rotor slipping even with a light load. A motor is most efficient when operating fully loaded (i.e. operating at rated slip).

### ■ b8-02 Energy Saving Control Gain

Setting Range: 0.0 to 10.0

Factory Default: 1.0

The output voltage during energy saving operation is the product of the normal V/f settings (E1-03 to E1-13) and the energy saving gain. The output voltage decreases and recovers according to the energy saving control filter time constant b8-03. As the energy saving gain increases, the output voltage increases also.

Note: When parameter A1-02 = 2 (Open Loop Vector) the factory default setting is 0.7. When parameter A1-02 = 3 (Flux Vector) the factory default setting is 1.0.

### ■ b8-03 Energy Saving Control Filter Time Constant

Setting Range: 0.00 to 10.00

Factory Default: Model Dependent

Parameter b8-03 sets the response time of the energy saving function. Decreasing this setting will cause the response to become quicker; however, instability may occur if it is decreased too much.

Note: For Drive models F7U2055 to 2100 and F7U4055 to 4300 the factory default setting is 2.00 when parameter A1-02 = 2 (Open Loop Vector) and 0.05 when parameter A1-02 = 3 (Flux Vector). For all other Drive models the factory default setting is 0.50 when parameter A1-02 = 2 (Open Loop Vector) and 0.01 when parameter A1-02 = 3 (Flux Vector).

### ■ b8-04 Energy Saving Coefficient Value

Setting Range: 0.0 to 655.0

Factory Default: Model Dependent

Parameter b8-04 is used in maximizing motor efficiency. The factory setting will be Drive capacity dependant but can be adjusted in small amounts while viewing the kW monitor (U1-08) and running the Drive to minimize the output kW. A larger value typically results in less voltage to the motor and less energy consumption. Too large a value will cause the motor to stall.

## ■ **b8-05 Power Detection Filter Time**

Setting Range: 0 to 2000 ms

Factory Default: 20 ms

The Energy Saving function will search out the lowest output voltage in order to achieve minimum output power usage. Parameter b8-05 determines how often the output power (kW) is measured and the output voltage is adjusted.

## ■ **b8-06 Search Operation Voltage Limit**

Setting Range: 0 to 100 %

Factory Default: 0%

Once Energy Savings is enabled and the optimal energy saving coefficient value has been set, the programmer can have the Drive further search out the proper voltage to achieve the lowest output power by making minute changes to the output voltage and measuring the output power every b8-05 ms. Parameter b8-06 sets limits to the range over which the voltage will be adjusted in order to minimize the power output. Settings too large a value may allow the motor to stall if the load is applied abruptly.

If b8-06= 0, then the optimum voltage search operation is disabled (but not Energy Savings itself).

---

## ◆ **b9 Zero Servo**

The zero servo function is enabled when the multi-function contact input is set to zero servo command (H1-0x = “72”). The motor position is then memorized when motor speed feedback is less than the zero speed level (B2-01).

### ■ **b9-01 Zero Servo Gain**

Setting Range: 0 to 100

Factory Default: 5

Sets the zero-servo position loop gain. When adjusting the gain, the higher the setting, the quicker the response. However, if the gain is set too high, it can cause overshoot and a possible runaway condition.

### ■ **b9-02 Zero Servo Completion Width**

Setting Range: 0 to 16383 Pulses

Factory Default: 10 Pulses

The function of b9-02 is to set the number of pulses used for the multi-function contact output (H2-0x = “33”). During zero servo, the multi-function output will be closed until the number set into b9-02 has been completed. After the number of pulses has been completed, the multi-function output changes to the open state.

---

## ◆ **C1 Acceleration/Deceleration**

### ■ **C1-01 Acceleration Time 1**

#### **C1-02 Deceleration Time 1**

#### **C1-03 Acceleration Time 2**

#### **C1-04 Deceleration Time 2**

#### **C1-05 Acceleration Time 3**

#### **C1-06 Deceleration Time 3**

## C1-07 Acceleration Time 4

## C1-08 Deceleration Time 4

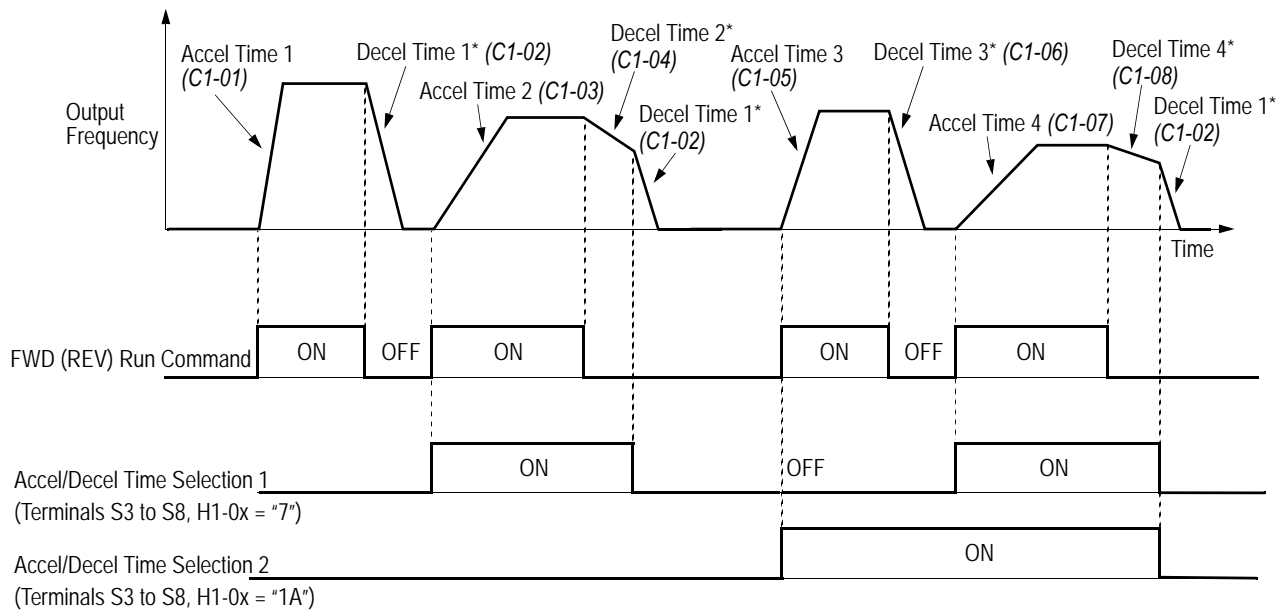
Setting Range: 0.0 to 6000.0 Seconds

Factory Default: 10.0 Seconds

Note: Setting range may be 0.00 to 600.00 or 0.0 to 6000.0 depending on the setting of parameter C1-10.

Acceleration time sets the time necessary for the output frequency to accelerate from 0Hz to maximum output frequency (E1-04). Deceleration time sets the time necessary for the output frequency to decelerate from the maximum output frequency (E1-04) to 0Hz.

C1-01 and C1-02 are the factory default active accel/decel “pair”. Other accel/decel pairs (C1-03 to C1-08) exist that can be activated by a multi-function digital input (H1-0x= 7 and 1A). Alternatively, the active accel/decel pair can be switched from accel/decel pair 1 (C1-01 and C1-02) to accel/decel pair 4 (C1-07 and C1-08) by a switch over frequency as programmed in parameter C1-11.



\* When “deceleration to stop” is selected (B1-03 = “0”)

Fig. 20 Timing Diagram of Accel / Decel Time Change

When any of the multi-function contact input selections (H1-01 to H1-06) are set to “7” and “1A”, up to four accel/decel times can then be selected by opening or closing the appropriate accel/decel time selection commands (terminals 3 to 8).

Accel/decel Time Selection 1 Multi-function Input Setting = "7"	Accel/decel Time Selection 2 Multi-function Input Setting = "1A"	Accel Time	Decel Time
Open or not set	Open or not set	C1-01	C1-02
Closed	Open or not set	C1-03	C1-04
Open or not set	Closed	C1-05	C1-06
Closed	Closed	C1-07	C1-08

## ■ C1-09 Fast Stop Time

Setting Range: 0.0 to 6000.0 Seconds

Factory Default: 10.0 Seconds

A special deceleration parameter is available for use with emergency or fault operations. Parameter C1-09 will set a special deceleration that can be operated by closing a digital input configured as H1-0x= 15 or H1-0x= 17. A digital input configured as H1-0x= 15 will look for a switch closure before initiating the Fast Stop operation. A digital input configured as H1-0x= 17 will look for the switch opening before initiating the Fast Stop operation.

Unlike a standard deceleration time, once the Fast Stop operation is initiated even momentarily, the Drive cannot be re-operated until the deceleration is complete, the Fast Stop input is cleared, and the Run command is cycled.

## ■ C1-10 Accel / Decel Time Setting Unit

Setting	Description
0	0.01 sec - Accel/decel time (C1-01 to C1-09) setting range is in units of 0.01 second. Accel/decel time setting range: 0.00 to 600.00 sec).
1	0.1 sec ( <i>factory default</i> ) - Accel/decel time (C1-01 to C1-09) setting range is in units of 0.1 second. Accel/decel time setting range: 0.0 to 6000.0sec.

If any of the parameters C1-01 to C1-09 are set to 600.1 seconds or more, C1-10 cannot be set to 0.

## ■ C1-11 Accel/Decel Switch Frequency

Setting Range: 0.0 to 200.0 Hz

Factory Default: 0.0 Hz

The Drive can be programmed to automatically switch between the two sets of Accel/Decel parameters on the fly. No digital input is required. If parameter C1-11 is set to a frequency other than zero, the Drive will use Acceleration 1 and Deceleration 1 whenever the output frequency is equal to or above the value of C1-11 and use Acceleration 4 and Deceleration 4 whenever the output frequency is below the value of C1-11.

A multi-function input programmed as “Multi-Acc/Dec 1” and “Multi-Accel/Dec 2” will have priority over C1-11. For example, if the output frequency is greater than the value of C1-11 but a digital input configured as “Multi-Acc/Dec 1” is closed then Acceleration 2 and Deceleration 2 are active.

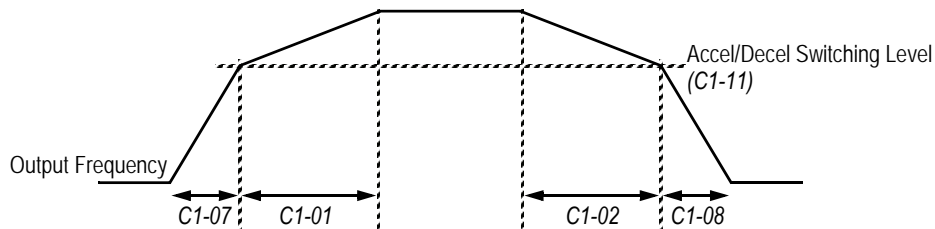


Fig. 21 Accel/Decel Switch Frequency Operation

## ◆ C2 S-Curve Accel / Decel

- C2-01 S-Curve Characteristic at Accel Start
- C2-02 S-Curve Characteristic at Accel End
- C2-03 S-Curve Characteristic at Decel Start

Setting Range:0.00 to 2.50 Seconds

Factory Default:0.20 Seconds

### C2-04 S-Curve Characteristic at Decel End

Setting Range:0.00 to 2.50 Seconds

Factory Default:0.00 Seconds

Parameters C2-01 and C2-02 will affect the acceleration rate of the output frequency in order to reduce shock to the load. The S-curve addition to the acceleration profile can ramp the acceleration rate from a 0 to the rate specified by the active Acceleration Time (C1-01,C1-03, C1-05, or C1-07) and back to 0.

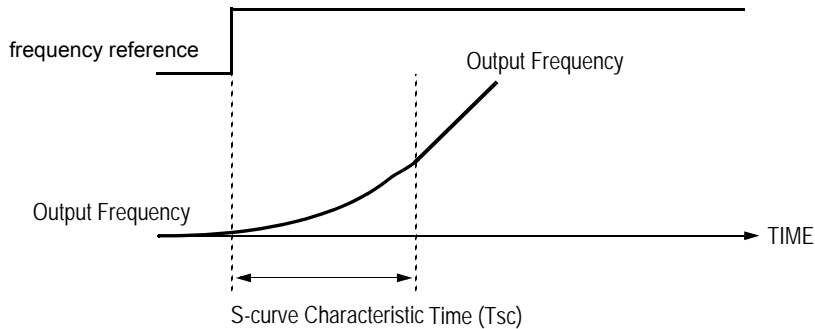


Fig. 22 S-curve Characteristic Timing Diagram

The S-Curve transition into and out of the active acceleration rate can be programmed independently. C2-01 will ramp up the acceleration from no acceleration up to the rate of C1-01 or active acceleration time. C2-02 will ramp the acceleration rate from the rate of C1-01 or active deceleration time back down to no acceleration (constant speed). The use of S-Curve characteristics will lengthen the overall acceleration time as follows:

$$\text{Overall Acceleration Time} = \text{Active Acceleration Time} + \frac{(C2 - 01) + (C2 - 02)}{2}$$

The following figure shows FWD/REV run switching during deceleration to stop.

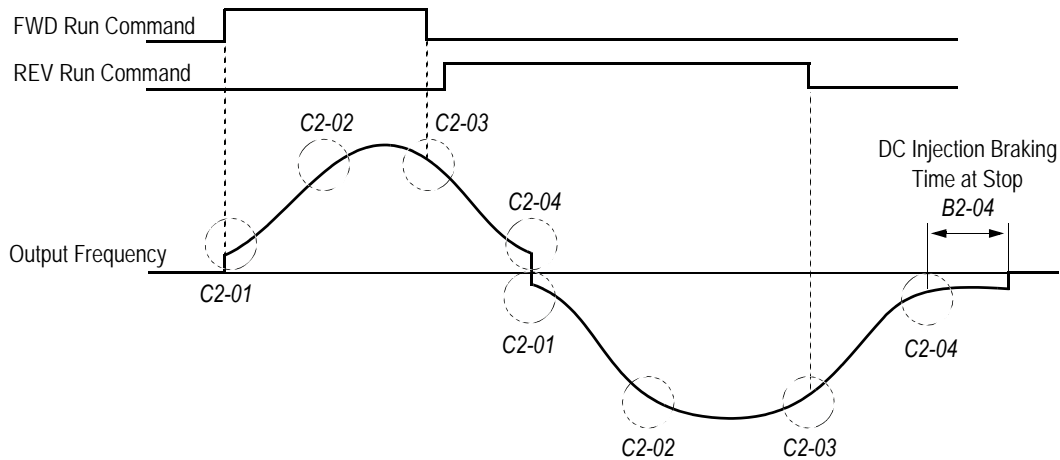


Fig. 23 S-Curve Timing Diagram - FWD / REV Operation

## ◆ C3 Motor-Slip Compensation

As the load becomes larger, the motor speed is reduced and motor slip increases. The slip compensation function keeps the motor speed constant even under varying load conditions.

### ■ C3-01 Slip Compensation Gain

Setting Range: 0.0 to 2.5

Factory Default: 1.0

This function controls the output frequency in response to the load's torque demand. Increase the set value in one tenth (0.1) increments when operating at low speeds; decrease the set value as the motor speed increases.

During flux vector control, this gain compensates for motor slip caused by changes in temperature. Normally, this setting does not have to be modified.

Note: Default factory setting will be 0.0 when parameter A1-02=0 (V/f control without PG). When parameter A1-02=2 (Open Loop Vector) or 3 (Flux Vector) the default factory setting will be 1.0.

### ■ C3-02 Slip Compensation Primary Delay Time

Setting Range: 0 to 10000 ms

Factory Default: 200 ms

Adjust the slip compensation delay time when motor speed is unstable or speed response is slow. Increase the set value in 10ms increments when operating at low speeds; decrease the set value as the motor speed increases.

Note: Default factory setting will be 2000 ms when parameter A1-02=0 (V/f control without PG). When parameter A1-02=2 (Open Loop Vector) the default factory setting will be 200 ms.

### ■ C3-03 Slip Compensation Limit

Setting Range: 0 to 250%

Factory Default: 200%

Sets the slip compensation limit as a percentage of motor rated slip (E2-02).

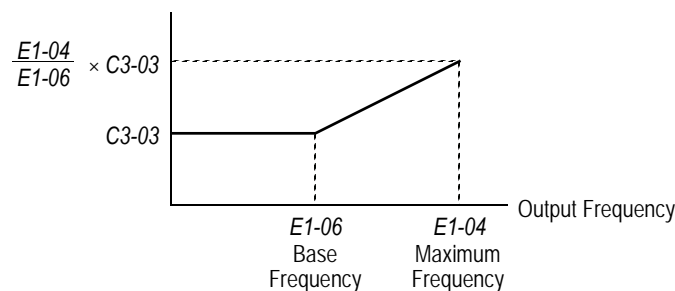


Fig. 24 Slip Compensation Limit Adjustment

### ■ C3-04 Slip Compensation Selection During Regeneration

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

Determines whether slip compensation is enabled or disabled during regenerative operation.

### ■ C3-05 Output Voltage Limit Operation Selection

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

Determines if the motor flux is automatically decreased when output voltage saturation occurs in the constant horsepower region.

---

## ◆ C4 Torque Compensation

### ■ C4-01 Torque Compensation Gain

Setting Range: 0.00 to 2.50  
Factory Default: 1.00

### ■ C4-02 Torque Compensation Primary Delay Time

Setting Range: 0 to 10000 ms  
Factory Default: 200 ms

The Torque Compensation function compensates for insufficient torque production at start-up and during low speed operation. The Drive will detect increases in the motor load by monitoring the output current and compensate by increasing the output voltage. The increased output voltage leads to an increase in usable torque.

Parameter C4-01 sets the aggressiveness of the compensation for IR (resistive) and IL (inductive) losses in the motor windings, which are more pronounced at lower speeds. Normally C4-01 does not need to be changed but may require adjustment in the following cases:

- If the Drive to motor cable is long, increase C4-01
- If the motor capacity is smaller than the Drive capacity, increase C4-01
- If the low speed motor performance is unstable, decrease C4-01.
- If the output current level exceeds the Drive's rated current while operating at low speeds, increase C4-01

Parameter C4-02 determines how quickly the Torque Compensation function will react to situations of insufficient torque. Again, C4-02 will not normally require adjustment except for the following situations:

- If the motor vibrates, increase C4-02
- If the motor response is sluggish (and possibly stalls), decrease C4-02

Note: Default factory setting will be 200 ms when parameter A1-02=0 (V/f control without PG) or 1 (V/f control with PG). When parameter A1-02=2 (Open Loop Vector) the default factory setting will be 20 ms.

**IMPORTANT** | Performing Auto-tuning can enhance low speed performance.

### ■ C4-03 Torque Compensation at Forward Start

Setting Range: 0.0 to 200.0 %  
 Factory Default: 0.0 %

This parameter may improve the motor performance during start. This feature functions only when starting a motor in the forward direction. Torque reference and motor flux can be ramped up quickly to improve speed response during start. A setting of 0.0 disables this feature.

### ■ C4-04 Torque Compensation at Reverse Start

Setting Range: -200.0 to 0.0 %  
 Factory Default: 0.0 %

This parameter may improve the motor performance during start. This feature functions only when starting a motor in the reverse direction. Torque reference and motor flux can be ramped up quickly to improve speed response during start. A setting of 0.0 disables this feature.

### ■ C4-05 Torque Compensation Time Constant

Setting Range: 0 to 200 ms  
 Factory Default: 10 ms

This parameter functions with C4-03 and C4-04. This parameter is the time delay that will be applied to the Torque Compensation parameters C4-03 and C4-04. A setting of less than 4 milliseconds (ms) causes this filter to be disabled.

## ◆ C5 ASR Tuning

The automatic speed regulator (ASR) provides optimum performance during changes in motor speed or load, when speed feedback is provided.

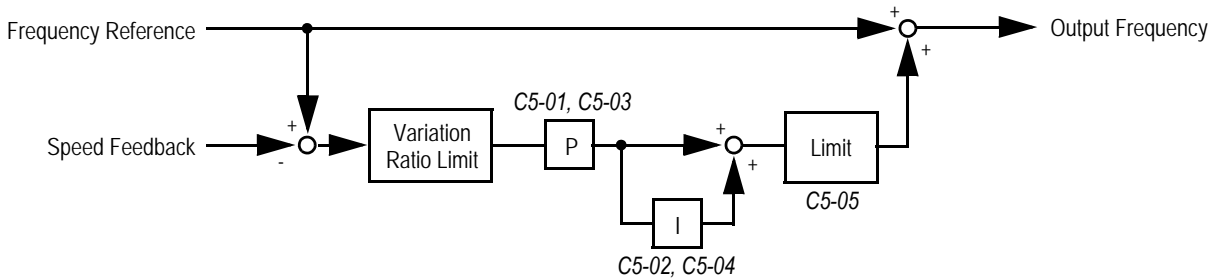


Fig. 25 ASR Block Diagram (V/f Control with PG)

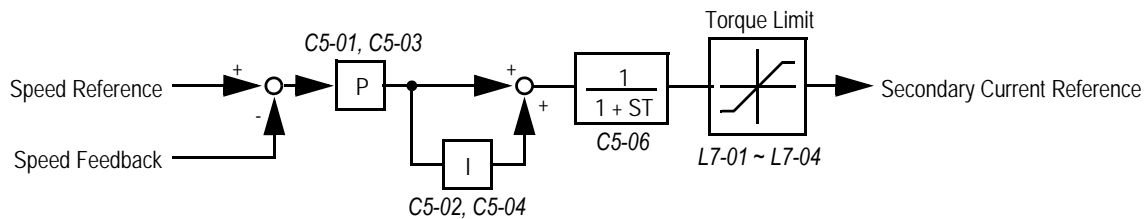


Fig. 26 ASR Block Diagram (Flux Vector Control)

### ■ C5-01 ASR Proportional Gain 1

Setting Range: 1.00 to 300.0  
Factory Default: 20.00

The ASR proportional gain 1 adjusts the speed in response to speed deviation, and softens the effect of changes in load. Speed response increases as the proportional gain is increased. However, the load may become unstable if the ASR proportional gain is set too high.

Note: When parameter A1-02=1 (V/f control with PG) the factory default setting is 0.20. When parameter A1-02=3 (Flux Vector) the factory default setting is 20.00.

### ■ C5-02 ASR Integral Time 1

Setting Range: 0.000 to 10.000 sec  
Factory Default: 0.500 sec

The ASR integral time 1 adjusts the Drive's response time to changes in load. Speed response increases as the integral time is decreased. However, the load may become unstable if the ASR integral time is set too low.

Note: When parameter A1-02=1 (V/f control with PG) the factory default setting is 0.200. When parameter A1-02=3 (Flux Vector) the factory default setting is 0.500.

### ■ C5-03 ASR Proportional Gain 2

Setting Range: 1.00 to 300.0  
Factory Default: 20.00

The ASR proportional gain 2 is an additional proportional gain adjustment that can be enabled by either a multi-function contact input (H1-0x = 77) or the ASR switching frequency (C5-07).

Note: When parameter A1-02=1 (V/f control with PG) the factory default setting is 0.02. When parameter A1-02=3 (Flux Vector) the factory default setting is 20.00.

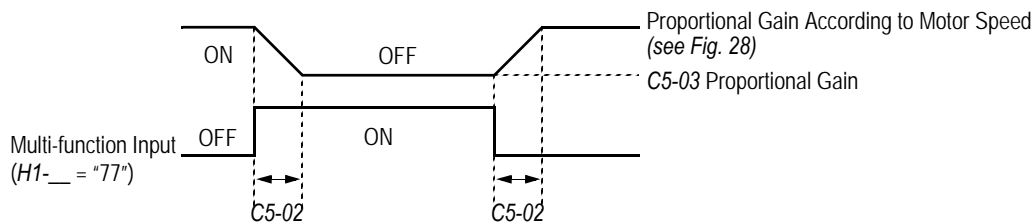


Fig. 27 ASR Multi-function Input Timing Diagram

### ■ C5-04 ASR Integral Time 2

Setting Range: 0.000 to 10.000 sec  
Factory Default: 0.500 sec

The ASR integral time 2 is an additional integral time adjustment that can be enabled by the ASR switching frequency (C5-07).

Note: When parameter A1-02=1 (V/f control with PG) the factory default setting is 0.050. When parameter A1-02=3 (Flux Vector) the factory default setting is 0.500.

### ■ C5-05 ASR Limit

Setting Range: 0.0 to 20.0 %  
 Factory Default: 5.0 %

Sets ASR frequency compensation limit as a percentage of maximum output frequency (E1-04). This function is enabled when V/f control with PG feedback is selected as the control method (A1-02).

### ■ C5-06 ASR Delay Time

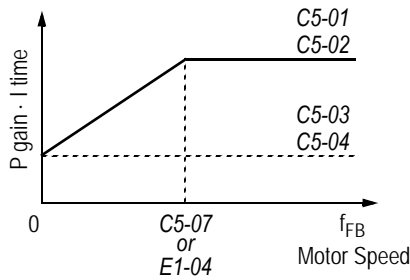
Setting Range: 0.000 to 0.500 sec  
 Factory Default: 0.004 sec

This parameter sets the filter time constant for the time from the speed loop to the torque command output. Mechanical backlash in an application causes secondary current ( $I_2$ ) reference variations in the motor's rotor. This condition can prevent the adjustment of ASR parameters. The output delay time constant is used to control these secondary current ( $I_2$ ) reference variations.

### ■ C5-07 ASR Switching Frequency

Setting Range: 0.0 to 400.0 Hz  
 Factory Default: 20.0 Hz

Sets frequency to change ASR proportional gain and integral time constant in units of 0.1Hz when flux vector control is selected.



$$f_{FB} = \frac{P \cdot N}{120}$$

where:  
 P = Number of Motor Poles  
 N = Motor RPM

\* When C5-07 = "0", proportional gain 1 (C5-01) and integral time 1 (C5-02) are selected.

Fig. 28 ASR Switching Frequency Level

Notes:

1. When C5-07 = 0, proportional gain 1 (C5-01) and integral time 1 (C5-02) are selected.
2. During V/f control with PG feedback (A1-02 = 1), the frequency switching level becomes the maximum output frequency (E1-04).
3. The multi-function input "77: ASR Gain Switch" has priority over the ASR switch frequency (C5-07).

### ■ C5-08 ASR Integral Limit

Setting Range: 0 to 400 %  
 Factory Default: 400 %

Parameter C5-08 adjusts the amount of integral control of the automatic speed regulator in the Flux Vector control mode (A1-02 = 3). Setting parameter C5-08 to zero will make the ASR control proportional. Setting C5-08 to greater than 0% will make the ASR control proportional and sets the ASR integral upper limit as a percentage of rated torque of the connected motor.

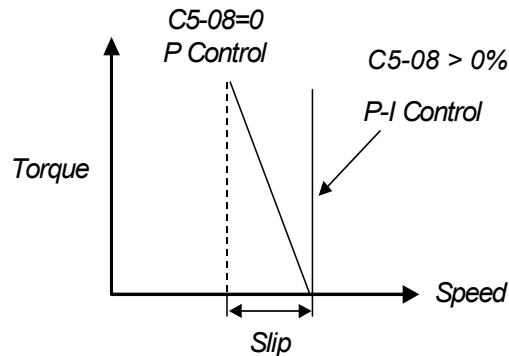


Fig. 29 ASR Integral Limit Function

## ◆ C6 Carrier Frequency

### ■ C6-01 Normal Duty Selection

Setting	Description
0	Heavy Duty ( <i>factory default</i> )
1	Normal Duty 1
2	Normal Duty 2

The Drive's capacity is categorized based on three types of load characteristics: Heavy Duty, Normal Duty 1, and Normal Duty 2. The F7 User's and Programming Manual will only provide details on Heavy Duty and Normal Duty, where Normal Duty = Normal Duty 2 rating. Normal Duty 1 and Normal Duty 2 is only referenced wherever parameter C6-01 selections are mentioned in the manuals. This section explains the differences between Heavy Duty, Normal Duty 1, and Normal Duty 2. Adjustment of parameter C6-01 will affect the Drive's rated current, overload capacity, current limit, carrier frequency, and maximum output frequency.

The table below describes the general differences between Heavy Duty, Normal Duty 1, and Normal Duty 2. The Drive's nameplate shows the Heavy Duty and Normal Duty 2 current ratings. Normal Duty 1 is not printed on the nameplate, but its current rating is the same as Heavy Duty (HD).

Normal Duty 1 is the only rating that allows the carrier frequency to be increased above factory default setting. When the carrier frequency (C6-02) is set above the factory default setting in Normal Duty 1 (C6-01 = 1), the Drive's output current must be derated. Please consult Yaskawa for details on derating.

Parameter C6-01	Rated Output Current	Overload Capacity	Current Limit	Carrier Frequency	Maximum Output Frequency
0: Heavy Duty (default)	Heavy Duty (HD) Nameplate Rating (varies by model*)	150% for 1 min.	150%	Low (2kHz)	300 Hz
1: Normal Duty 1	Heavy Duty (HD) Nameplate Rating (varies by model*)	120% for 1 min.	120%	High (varies by model*)	400 Hz
2: Normal Duty 2	Normal Duty (ND) Nameplate Rating (varies by model*)	Approx. 110% for 1 min. (varies by model*)	120%	Moderate (varies by model*)	400 Hz

\* See specification in the F7 Drive Users Manual (TM.F7.01) for details.

### ■ C6-02 Carrier Frequency Selection

Setting	Description
0	Low Noise
1	Fc=2.0 kHz
2	Fc=5.0 kHz
3	Fc=8.0 kHz
4	Fc=10.0 kHz
5	Fc=12.5 kHz
6	Fc=15.0 kHz
F	Program

\*The factory default setting is model dependent

Parameter C6-02 sets the switching frequency of the Drive's output transistors. It can be changed in order to reduce audible noise and also reduce leakage current. Cases that may require adjustment to the C6-02 are:

- If the wiring length between the Drive and the motor is long, decrease the carrier frequency

Wiring Length	164 ft or less	328 ft or less	Over 328 ft
C6-02 (carrier frequency) setting	1 to 6 (15 kHz max.)	1 to 4 (10 kHz max.)	1 to 2 (5 kHz max.)

- If speed and torque are inconsistent at low speeds, decrease the carrier frequency
- If leakage current from the Drive is large, decrease the carrier frequency
- If the audible motor noise is too great, increase the carrier frequency (may require Drive current derating)

When parameter C6-02 is set to “0: Low Noise” the Drive uses a carrier frequency of 2 kHz and reduces the motor audible noise by approximately 5 dB. over the conventional 2 kHz setting (C6-02= 1). The Drive modulates the nominal PWM pattern to achieve the lower noise. This setting is normally used with high starting torque loads that are frequently started and stopped or, applications where leakage current needs to be minimized and motor audible noise is important.

If parameter C6-01 = “0: Heavy Duty”, C6-02 can only be set to 0 or 1.

208V-240V Drives 1						480V Drives 1					
Model CIMR-F7U	C6-02 Carrier Frequency (kHz)	C6-03 Carrier Frequency Max. (kHz)	C6-04 Carrier Frequency Min. (kHz)	C6-05 Carrier Frequency Gain	Nominal HP	Model CIMR-F7U	C6-02 Carrier Frequency (kHz)	C6-03 Carrier Frequency Max. (kHz)	C6-04 Carrier Frequency Min. (kHz)	C6-05 Carrier Frequency Gain	Nominal HP
20P4	4 (10.0)	4 (10.0)	4 (10.0)	0	0.5/0.75	40P4	6 (15.0)	6 (15.0)	6 (15.0)	0	0.5/0.75
20P7	4 (10.0)	4 (10.0)	4 (10.0)	0	1	40P7	6 (15.0)	6 (15.0)	6 (15.0)	0	1
21P5	4 (10.0)	4 (10.0)	4 (10.0)	0	1.5/2	41P5	6 (15.0)	6 (15.0)	6 (15.0)	0	1.5/2
22P2	3 (8.0)	3 (8.0)	3 (8.0)	0	3	42P2	6 (15.0)	6 (15.0)	6 (15.0)	0	3
23P7	4 (10.0)	4 (10.0)	4 (10.0)	0	5	43P7	6 (15.0)	6 (15.0)	6 (15.0)	0	5
25P5	6 (15.0)	6 (15.0)	6 (15.0)	0	7.5	45P5	6 (15.0)	6 (15.0)	6 (15.0)	0	7.5
27P5	6 (15.0)	6 (15.0)	6 (15.0)	0	10	47P5	6 (15.0)	6 (15.0)	6 (15.0)	0	10
2011	3 (8.0)	3 (8.0)	3 (8.0)	0	15	4011	3 (8.0)	3 (8.0)	3 (8.0)	0	15/20
2015	4 (10.0)	4 (10.0)	4 (10.0)	0	20	4015	4 (10.0)	4 (10.0)	4 (10.0)	0	25
2018	4 (10.0)	4 (10.0)	4 (10.0)	0	25	4018	4 (10.0)	4 (10.0)	4 (10.0)	0	30
2022	4 (10.0)	4 (10.0)	4 (10.0)	0	30	4030	3 (8.0)	3 (8.0)	3 (8.0)	0	40/50
2030	4 (10.0)	4 (10.0)	4 (10.0)	0	40	4037	3 (8.0)	3 (8.0)	3 (8.0)	0	60
2037	2 (5.0)	2 (5.0)	2 (5.0)	0	50	4045	3 (8.0)	3 (8.0)	3 (8.0)	0	75
2045	2 (5.0)	2 (5.0)	2 (5.0)	0	60	4055	2 (5.0)	2 (5.0)	2 (5.0)	0	100
2055	3 (8.0)	3 (8.0)	3 (8.0)	0	75	4075	2 (5.0)	2 (5.0)	2 (5.0)	0	125
2075	1 (2.0)	1 (2.0)	1 (2.0)	0	75/100	4090	3 (8.0)	3 (8.0)	3 (8.0)	0	150
2090	1 (2.0)	1 (2.0)	1 (2.0)	0	125	4110	2 (5.0)	2 (5.0)	2 (5.0)	0	200
2110	1 (2.0)	1 (2.0)	1 (2.0)	0	150	4160	2 (5.0)	2 (5.0)	2 (5.0)	0	250
						4185	1 (2.0)	1 (2.0)	1 (2.0)	0	300/350
						4220	1 (2.0)	1 (2.0)	1 (2.0)	0	450
						4300	1 (2.0)	1 (2.0)	1 (2.0)	0	500+

### ■ C6-03 Carrier Frequency Upper Limit

#### C6-04 Carrier Frequency Lower Limit

Setting Range: 0.4 to 15.0 kHz  
 Factory Default: Model Dependent

### ■ C6-05 Carrier Frequency Proportional Gain

Setting Range: 0 to 99  
 Factory Default: 0

It is possible to configure the Drive such that the carrier frequency will automatically increase as the output frequency is raised (synchronous carrier). A synchronous carrier can be used by setting parameter C6-02 = "F: Program". The profile of the carrier frequency is show below and can be configured to the users specification by setting the carrier frequency upper and lower limits (C6-03 and C6-04 respectively) and a carrier frequency proportional gain (C6-05).

If parameter C6-01 = "0: Heavy Duty", parameters C6-03 cannot be changed and parameters C6-04 and C6-05 are not displayed.

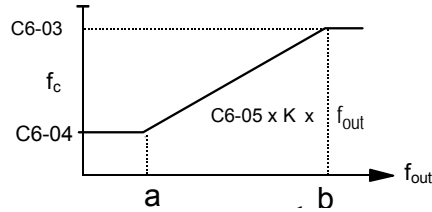


Fig. 30 Synchronous Carrier Frequency Characteristics

The frequencies that correspond to the breakpoints a and b will be determined by the value of  $K$  given in the table below and the following formulas:

Conditions	$K$ Value
$C6-03 > 10.0\text{kHz}$	8
$10.0\text{kHz} \geq C6-03 > 5.0\text{kHz}$	4
$C6-03 \leq 5.0\text{kHz}$	2

$$a = \frac{C6-04}{C6-05 \times K}$$

$$b = \frac{C6-03}{C6-05 \times K}$$

**IMPORTANT** | If  $C6-05 > 6$  and  $C6-04 > C6-03$  the Drive will fault and display an OPE11 error.

## ◆ d1 Preset References

- d1-01 Frequency Reference 1
- d1-02 Frequency Reference 2
- d1-03 Frequency Reference 3
- d1-04 Frequency Reference 4
- d1-05 Frequency Reference 5
- d1-06 Frequency Reference 6
- d1-07 Frequency Reference 7
- d1-08 Frequency Reference 8
- d1-09 Frequency Reference 9
- d1-10 Frequency Reference 10
- d1-11 Frequency Reference 11

- d1-12 Frequency Reference 12**
- d1-13 Frequency Reference 13**
- d1-14 Frequency Reference 14**
- d1-15 Frequency Reference 15**
- d1-16 Frequency Reference 16**

Setting Range: 0.00 to E1-04 Value  
 Factory Default: 0.00 Hz

**■ d1-17 Jog Frequency Reference**

Setting Range: 0.00 to E1-04 Value  
 Factory Default: 6.00 Hz

The Drive can be programmed to utilize digital inputs to change between 16 presets speeds and a jog speed. It is a two-step process to set the Drive up for preset speeds. First, d1-01 through d1-16 and d1-17 must be programmed with the desired preset speeds and the desired jog speed, respectively. Next, up to four terminals S3 through S8 need to be programmed (via parameters H1-01 to H1-06) and wired (to normally open contacts) as “3: Multi-step Speed Reference 1”, “4: Multi-step Speed Reference 2”, “5: Multi-step Speed Reference 3”, “32: Multi-step Speed Reference 4”, and “6: Jog Frequency”.

Table 4 Multi-step Speed Operation Timing Diagram

Preset Speed	Multi-step Reference 1	Multi-step Reference 2	Multi-step Reference 3	Multi-step Reference 4	Jog Reference	Details
1	OFF	OFF	OFF	OFF	OFF	Frequency Reference 1 (d1-01) or Analog Input A1
2	ON	OFF	OFF	OFF	OFF	Frequency Reference 2 (d1-02) or Analog Input A2 or A3 Aux Reference 1
3	OFF	ON	OFF	OFF	OFF	Frequency Reference 3 (d1-03) or Analog Input A2 or A3 Aux Reference 2
4	ON	ON	OFF	OFF	OFF	Frequency Reference 4 (d1-04)
5	OFF	OFF	ON	OFF	OFF	Frequency Reference 5 (d1-05)
6	ON	OFF	ON	OFF	OFF	Frequency Reference 6 (d1-06)
7	OFF	ON	ON	OFF	OFF	Frequency Reference 7 (d1-07)
8	ON	ON	ON	OFF	OFF	Frequency Reference 8 (d1-08)
9	OFF	OFF	OFF	ON	OFF	Frequency Reference 9 (d1-09)
10	ON	OFF	OFF	ON	OFF	Frequency Reference 10 (d1-10)
11	OFF	ON	OFF	ON	OFF	Frequency Reference 11 (d1-11)
12	ON	ON	OFF	ON	OFF	Frequency Reference 12 (d1-12)
13	OFF	OFF	ON	ON	OFF	Frequency Reference 13 (d1-13)
14	ON	OFF	ON	ON	OFF	Frequency Reference 14 (d1-14)
15	OFF	ON	ON	ON	OFF	Frequency Reference 15 (d1-15)
16	ON	ON	ON	ON	OFF	Frequency Reference 16 (d1-16)
JOG	-	-	-	-	ON*	Jog Frequency (d1-17)

\* The Jog Frequency input is given priority over the multi-step speeds.

As shown in the above table, it is possible to use analog inputs in place of Frequency Reference 1, Frequency Reference 2, or Frequency Reference 3.

- If b1-01= “1: Terminals” then the analog input A1 will be used instead of Frequency Reference 1 for the first preset speed. If b1-01= “0: Operator”, then Frequency Reference 1 (d1-01) will be used.
- If H3-05 or H3-09= “2: Aux Reference 1” then the analog input A3 or A2, respectively, will be used instead of Frequency Reference 2 for the second preset speed. If H3-05 or H3-09 ≠ 2 then Frequency Reference 2 (d1-02) will be used.

- If H3-05 or H3-09= “3: Aux Reference 2” then the analog input A3 or A2, respectively will be used instead of Frequency Reference 3 for the third preset speed. If H3-05 or H3-09 ≠ 3 then Frequency Reference 3 (d1-03) will be used.

**IMPORTANT**

The programming of d1-01 through d1-04 and d1-17 will be affected by the setting of o1-03. The programming of these parameters will be in the units specified by Display Scaling parameter (o1-03).

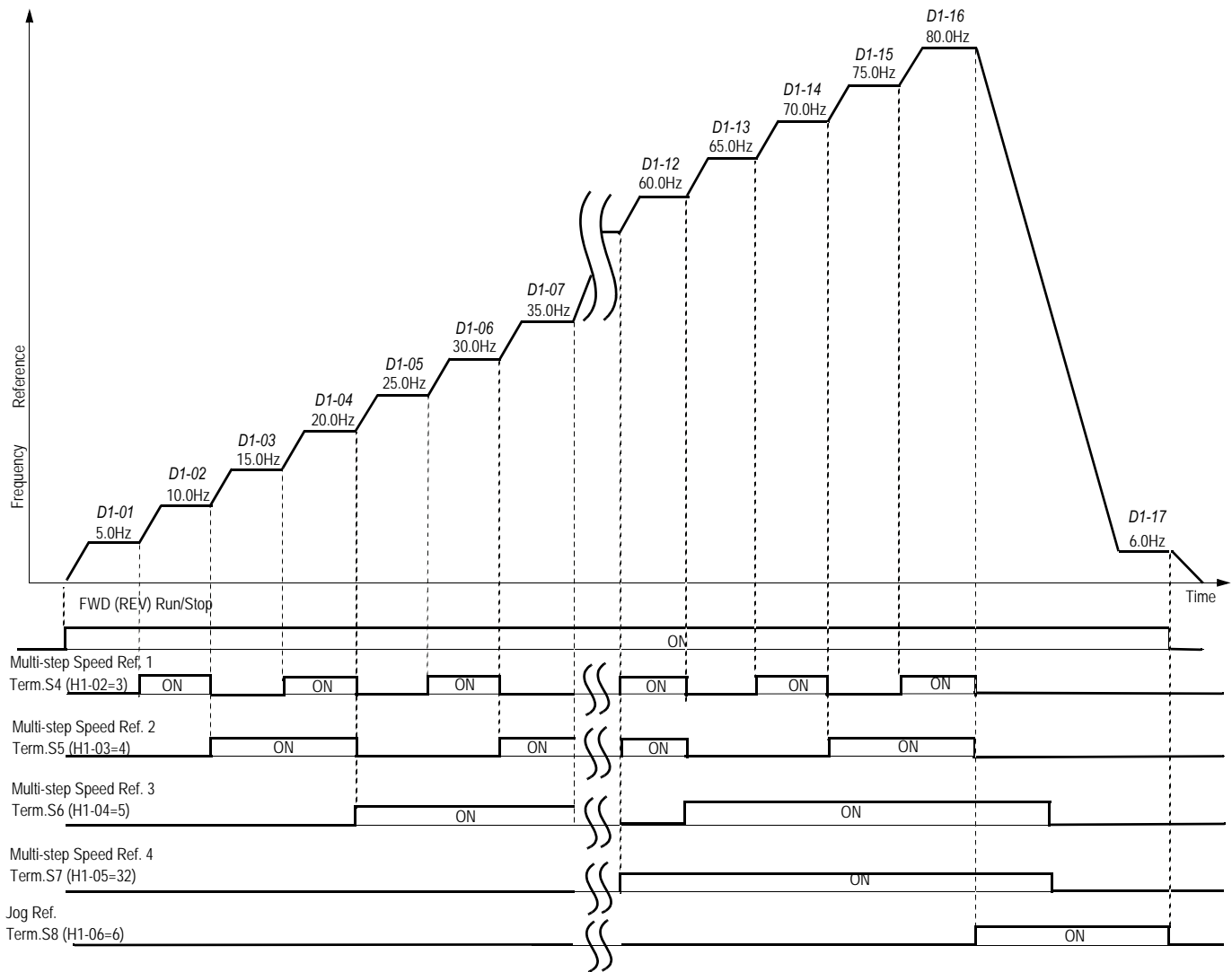


Fig. 31 Preset Reference Timing Diagram

**■ d1-17 Jog Frequency Reference**

Setting Range: 0.00 to E1-04 Value

Factory Default: 6.00 Hz

The Drive can be programmed to utilize digital inputs to change between four presets speeds and a jog speed. It is a two-step process to set the Drive up for preset speeds. First, d1-01 through d1-04 and d1-17 must be programmed with the desired preset speeds and the desired jog speed, respectively. Next, up to three of the Drive's digital inputs (Terminals S3 through S8) need to be programmed (via parameters H1-01 to H1-06) and wired (to normally open contacts) as Multi-step Speed Reference 1, Multi-step Speed Reference 2, and Jog Frequency.

As shown in the above table, it is possible to use analog inputs in place of Frequency Reference 1 and Frequency Reference 2.

- If b1-01= "1: Terminals" then the analog input A1 will be used instead of Frequency Reference 1 for the first preset speed. If b1-01= "0: Operator", then Frequency Reference 1 will be used.
- If H3-09= "2: Aux Reference" then the analog input A2 will be used instead of Frequency Reference 2 for the second preset speed. If H3-09≠2 then Frequency Reference 2 will be used.

**IMPORTANT**

The programming of d1-01 through d1-04 and d1-17 will be affected by the setting of o1-03. The programming of these parameters will be in the units specified by Display Scaling parameter (o1-03).

## ◆ d2 Reference Limits

### ■ d2-01 Frequency Reference Upper Limit

Setting Range: 0.0 to 110.0%  
 Factory Default: 100.0%

### ■ d2-02 Frequency Reference Lower Limit

Setting Range: 0.0 to 110.0%  
 Factory Default: 0.0%

The use of parameters d2-01 and d2-02 places limitations on the frequency reference that the Drive will accept. The parameters are set in units of percentage of the maximum frequency (E1-04) and cause dead bands on any remote frequency reference input. By entering upper or lower frequency limits, the Drive programmer can prevent operation of the Drive above or below levels that may cause resonance and or equipment damage.

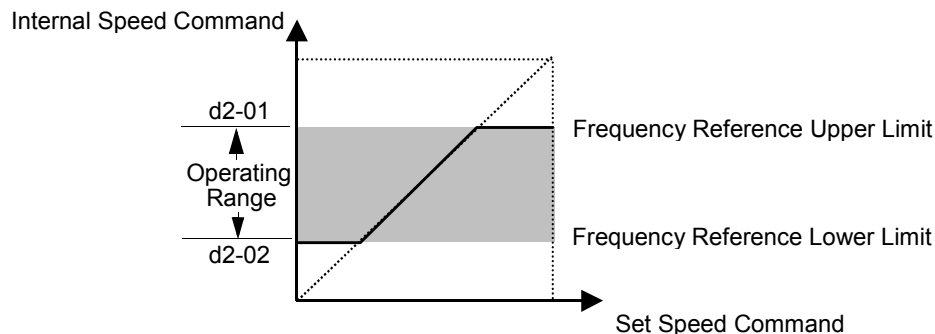


Fig. 32 Frequency Reference Upper and Lower Limit Effects on the frequency reference

### ■ d2-03 Master Speed Reference Lower Limit

Setting Range: 0.0 to 110.0%

Factory Default: 0.0%

Unlike Frequency Reference Lower Limit (d2-02) which will affect the frequency reference no matter where it is sourced from (i.e. analog input, preset speed, jog speed, etc.), the Master Speed Reference Lower Limit (d2-03) sets a low speed threshold that will only affect the analog input (terminals A1, A2, and A3) that is the active master speed frequency. This parameter allows a minimum speed to be programmed for the master reference while allowing a lower speed to be set as a jog reference. If the frequency referenced by the active master speed frequency is below the setting of d2-03, then the Drive will operate at the speed specified by d2-03.

## ◆ d3 Jump Frequencies

### ■ d3-01 Jump Frequency 1

### d3-02 Jump Frequency 2

### d3-03 Jump Frequency 3

Setting Range: 0.0 to 200.0 Hz

Factory Default: 0.0 Hz

### ■ d3-04 Jump Frequency Width

Setting Range: 0.0 to 20.0 Hz

Factory Default: 1.0 Hz

In order to avoid continuous operation at a speed that causes resonance in driven machinery, the Drive can be programmed with jump frequencies that will not allow continued operation within specific frequency ranges. If a speed is commanded that falls within a dead band, or Jump Frequency, the Drive will clamp the frequency reference just below the dead band and only accelerate past it when the commanded speed rises above the upper end of the dead band, for increasing references. Similarly, the Drive will clamp the frequency reference just above the dead band and only decelerate past it when the command speed falls below the lower end of the dead band, for decreasing references.

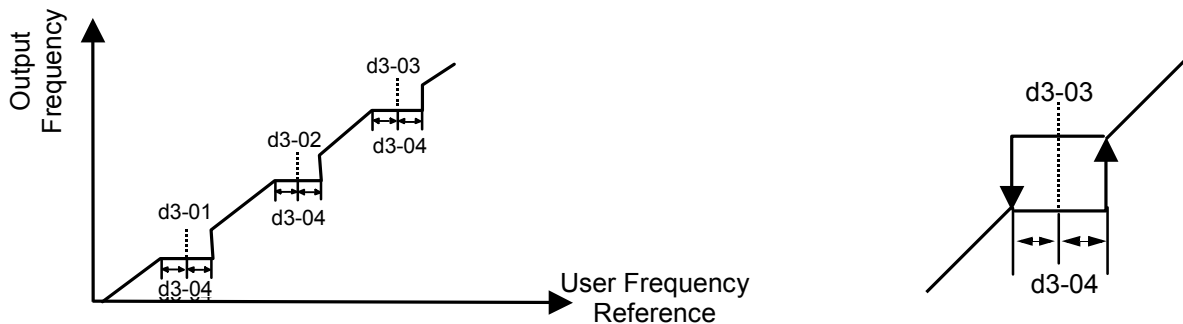


Fig. 33 Jump Frequency Characteristics

Setting the center point of the dead band with the d3-01 through d3-03 parameters and setting the width of the dead band with parameter d3-04 determine the dead band characteristics. The programmer can set up to three Jump Frequencies. If multiple Jump Frequencies are programmed the following rule applies:

$$d3-01 \leq d3-02 \leq d3-03$$

## ◆ d4 Sequence

### ■ d4-01 MOP Reference Memory

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

The Drive offers the capacity to change the frequency reference much the way a Motor Operated Potentiometer (MOP) would. Using programmed digital inputs configured as MOP Increase (H1-0x= 10) and MOP Decrease (H1-0x= 11), the Drive will increase the frequency reference whenever the MOP Increase input is closed and decrease the frequency reference whenever the MOP Decrease is closed. The frequency reference will remain constant whenever both inputs are open or closed.

Parameter d4-01 determines whether the last frequency reference, before the Run command was removed, is remembered even if the power is cycled to the Drive. If d4-01= “0: Disabled”, then when a new Run command is issued the Drive’s frequency reference will be 0 rpm. If d4-01= “1: Enabled”, then the frequency reference will be the last commanded speed before the Run command was removed. See figure below.

### ■ d4-02 Trim Control Level

Setting Range: 0 to 100% of Maximum Speed  
Factory Default: 10% of Maximum Speed

Using digital inputs, the Drive can add or subtract a set percentage of the maximum output frequency (E1-04) to or from the frequency referenced by the analog input. Parameter d4-02 sets the percentage that will be used to trim the frequency reference. Once the applicable digital input that is configured as either the Trim Control Increase (H1-0x= 1C) or Trim Control Decrease (H1-0x= 1D) is re-opened, the speed will go back to the speed determined by the analog reference.

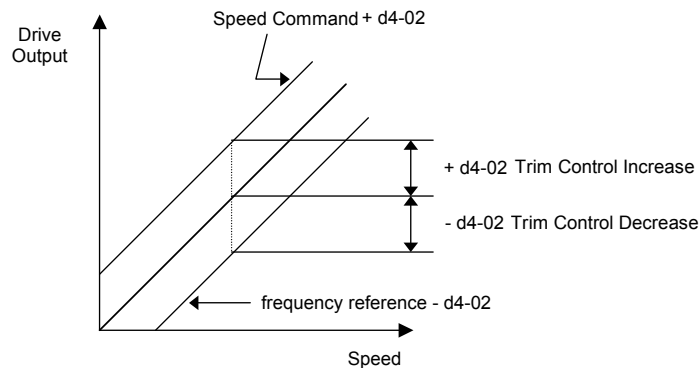


Fig. 34 Trim Control Effect on frequency reference

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## ◆ d5 Torque Control

### ■ d5-01 Torque Control Selection

Setting	Description
0	Speed Control ( <i>factory default</i> )
1	Torque Control

Selects between speed and torque control during flux vector operation (A1-03 = 3). Torque reference is set via analog input terminal A2 or A3 when it is set for “torque reference” (H3-09 or H3-05 = 13, respectively). Torque reference is set as a percentage of motor rated torque.

To switch between speed and torque control using a contact closure, set parameter d5-01 = 0 and set one of the multi-function contact inputs to “71: speed/torque control change” (H1-0x = 71).

### ■ d5-02 Torque Reference Delay Time

Setting Range: 0 to 1000 ms  
Factory Default: 0 ms

Sets the torque reference delay time to correct for noise in the torque control signal or the responsiveness with the host controller. When oscillation occurs during torque control, increase the set value.

### ■ d5-03 Speed Limit Selection

Setting	Description
1	Analog Input ( <i>factory default</i> ) - Limited by the output of the soft starter (b1-01 selection and active acceleration / deceleration and S-curve settings.)
2	Program Setting - Limited by d5-04 setting

Sets the speed limit command method for the torque control method.

### ■ d5-04 Speed Limit

Setting Range: -120 to 120 %  
Factory Default: 0 %

Sets the speed limit during torque control as a percentage of the maximum output frequency (E1-04). This function is enabled when d5-03 is set to 2. Directions are as follows:

- + run command direction
- run command opposite direction

### ■ d5-05 Speed Limit Bias

Setting Range: 0 to 120 %  
Factory Default: 10 %

Sets the speed limit bias as a percentage of maximum output frequency (E1-04). Bias is given to the specified speed limit. It can be used to adjust the margin for the speed limit.

## ■ d5-06 Speed / Torque Control Switchover Timer

Setting Range: 0 to 1000 ms

Factory Default: 0 ms

This parameter sets the delay time from inputting the multi-function input “speed/torque control change” (from ON to OFF or OFF to ON) until the control is actually changed. This function is enabled when the multi-function input “speed/torque control change” (H1-0x = 71) is set. While in the speed / torque control switching timer, the analog inputs hold the value present when the “speed/torque control change” is received.

### Inputting Torque References and Torque Reference Directions

The torque reference can be set according to an analog input by setting parameter H3-09 (terminal A2 selection) or H3-05 (terminal A3 selection) to “13: Torque Reference” or “14: Torque Compensation”. The torque reference input methods are listed in the table below.

The direction of the torque output from the motor will be determined by the sign of the analog input signal. It does not depend on the direction of the run command. The direction of torque will be as follows:

Positive analog reference: Torque reference for forward motor rotation (counter-clockwise as viewed from the motor output shaft)

Negative analog reference: Torque reference for reverse motor rotation (clockwise as viewed from the motor output shaft)

Table 5 Torque Reference

Torque Reference Input Method	Reference Source	Parameter Setting	Remarks
Voltage Input (0 to +/- 10 V)	Terminal A3 - AC	H3-04 = 1 H3-05 = 13	Set H3-04 to 0 for a 0 to 10V torque reference. To switch the torque reference between positive and negative torque, set a multi-function digital input to 78.
	Terminal A2 - AC (turn off pin 2 of SW1)	H3-08 = 1 H3-09 = 13	Set H3-08 to 0 for a 0 to 10V torque reference. To switch the torque reference between positive and negative torque, set a multi-function digital input to 78. The input can be used for torque compensation by setting H3-09 to 14.
Current Input (4 to 20 mA)	Terminal A2 - AC (turn off pin 2 of SW1)	H3-08 = 2 H3-09 = 13	To switch the torque reference between positive and negative torque, set a multi-function digital input to 78. The input can be used for torque compensation by setting H3-09 to 14.
Option Board (AI-14B) (0 to +/-10 V)	TC2 - TC4	F2-01 = 0 H3-08 = 1 H3-09 = 13	The input can be used for torque compensation by setting H3-09 to 14.

Note: If the analog input level is 0 to 10 V or 4 to 20 mA, a forward torque reference will only be applied. To apply reverse torque reference, use an analog input level of -10 to 10 V or switch the direction using a multi-function input set to “78: polarity reverse command”.

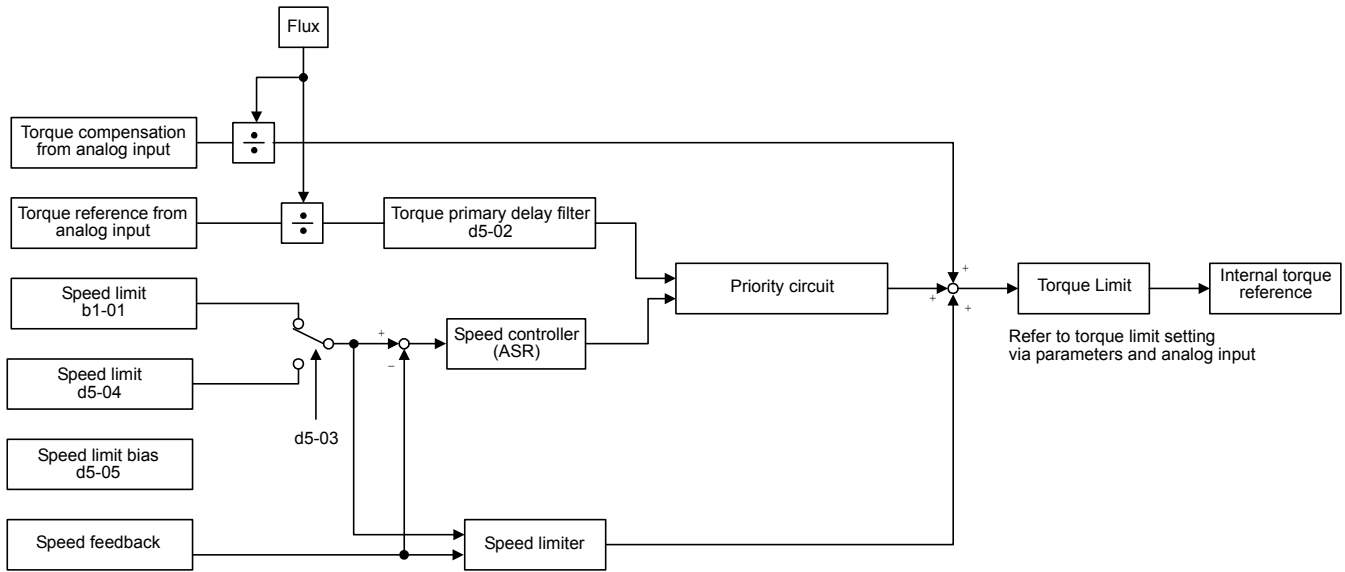


Fig. 35 Torque Control Block Diagram

### Speed Limiter and Priority Circuit (Speed Limit Function)

If the external torque reference and load are not balanced during torque control, the motor will accelerate in either the forward or reverse direction. The speed limit function is used to limit the speed to a specified value, which consists of the speed limiter circuit and priority circuit.

There are two ways to set a speed limit: using an input from an analog input terminal and setting a speed limit in d5-04. The input methods for speed limit are listed in the following table.

Table 6 Speed Limit			
Speed Limit Input Method	Reference Source	Parameter Setting	Remarks
Voltage Input (0 to +/- 10 V)	Set in d5-04	d5-03 = 2	-
	Terminal A1 - AC	d5-03 = 1 b1-01 = 1 H3-01 = 1	Set H3-01 to 0 if the speed limit is always to be positive.
	Terminal A2 - AC	d5-03 = 1 b1-01 = 0 H3-08 = 1 H3-09 = 1	The value will be added to the value input on A1 to set the speed limit. Set H3-03 to 0 if the speed limit input on A2 is always to be positive. Turn OFF (V side) pin 2 of switch S1 on the terminal board.
	Terminal A3 - AC	d5-03 = 1 b1-01 = 0 H3-04 = 1 H3-05 = 1	The value will be added to the value input on A1 to set the speed limit. Set H3-07 to 0 if the speed limit input on A3 is always to be positive.
Current Input (4 to 20 mA)	Terminal A2 - AC	d5-03 = 1 b1-01 = 0 H3-08 = 2 H3-09 = 1	The value will be added to the value input on A1 to determine the speed limit. Turn ON pin 2 of switch S1 on the terminal board.
Option Board (AI-14B) (0 to +/-10 V)	TC1 - TC4	d5-03 = 1 b1-01 = 3 F2-01 = 0	If H3-009 is set to 0, the sum of the input between TC2 and TC4 will be added to the input between TC1 and TC4 to determine the speed limit.

The direction in which speed is controlled is determined by the sign of the speed limit signal and the direction of the run command.

Positive voltage applied: The speed in the forward direction will be limited for forward operation.

Negative voltage applied: The speed in the reverse direction will be limited for reverse operation.

If the direction of the motor rotation and the command direction are not the same, speed will be limited to zero as long as d5-05 is set to zero. The direction of the run command determines the polarity of the speed limit.

Example:

$F_{max} - E1-04 = 60 \text{ Hz}$

Speed limit bias - d5-05 = 10%

No load on motor - Drive will always run up to speed limit

Run Direction	Torque Reference	Output Frequency
FWD	100%	46Hz
FWD	-100%	-6Hz
REV	100%	6Hz
REV	-100%	-46Hz

### Speed Limit Bias Setting

The speed limit bias can be set to limit both the forward and reverse speed to the same value. This differs from the operation of the speed limit bias setting. To use the speed limit bias, set d5-04 to 0 and set the bias in d5-05 as a percentage of the maximum output frequency.

To set 50% forward and reverse speed limits, set the speed limit setting to 0 (d5-03 = 2, d5-04 = 0, and d5-05 = 50). The range of torque control will be from -50% to 50% of the maximum output speed.

When using both the speed limit and the speed limit bias, the range of torque control will be positive and negative speed limits with the speed limit bias added to each.

The range of torque control when the forward speed limit is 50% and the speed limit bias is 10% as shown in the following figure. This figure does not take the priority circuit into account.

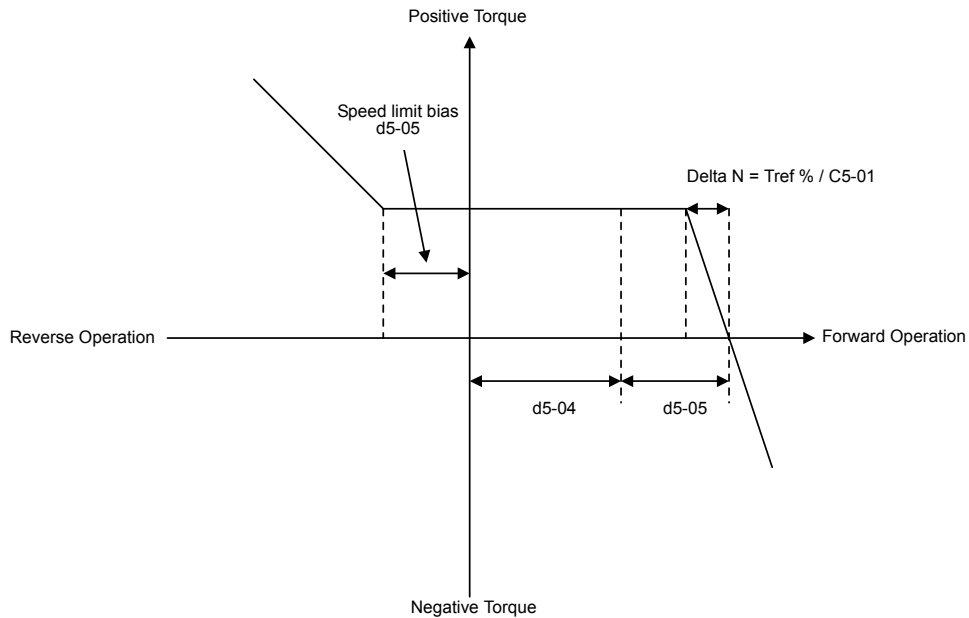


Fig. 36 Speed Limit Bias Setting

## Torque Limit Operation Examples

Operation examples will be described separately for winding operation, in which the speed and motor torque are in the same directions, and rewinding operation, in which the speed and motor torque are in opposite directions.

### Winding Operation

In a winding operation, the line (speed) and torque generated by the motor are in the same direction. For the winding operation, both the speed limit and the torque reference input are positive. The motor will accelerate when the torque reference input is larger than the load and will decelerate when it is smaller than the load. If the motor turns faster than the speed limit, a negative compensation value is output from the speed limiter circuit. When the speed then drops below the speed limit, a positive compensation value is output. The torque compensation is proportional to the ASR proportional gain. When the sum of the torque reference and the torque compensation output by the speed limiter is the same as the actual load, the motor will stop accelerating and run at a constant speed.

### Rewinding Operation

In a rewinding operation, the line (speed) and torque generated by the motor are in the opposite directions. (In this example, it is assumed that the line speed is positive and the torque reference input is negative.) For the rewinding operation, the speed limit is positive and the torque reference input is negative. If the motor turns faster than the speed limit, a negative compensation value is output. If the speed is zero or is below the speed limit, a zero compensation value is output. In this way, the output from the speed limiter is used to maintain the motor speed between zero and the speed limit. When the sum of the torque reference and the torque compensation output by the speed limiter is the same as the actual load, the motor will stop accelerating and run at a constant speed.

Table 7 Torque Control Example					
		Winding Operation		Rewinding Operation	
Configuration					
Direction of Motor Rotation		Forward	Reverse	Forward	Reverse
Reference Polarity	Torque Reference (TREF)	+	-	-	+
	Speed Limit (NLIM)	+	-	+	-
Torque Profile					

The following figure shows the timing diagram of speed/torque selection.

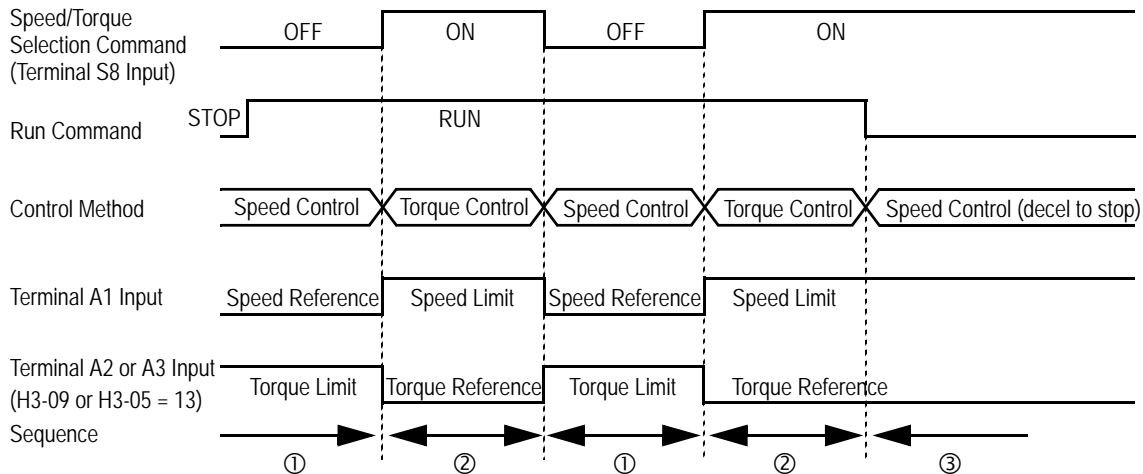


Fig. 37 Speed / Torque Control Selection Timing Diagram

### Timing Diagram Description

- ① When the speed/torque control selection contact is OFF, speed control is activated.
  - Speed reference during speed control depends on the frequency reference selection (B1-01) setting. To use terminal A1 or A2 as the master frequency reference, set b1-01 to “1”.
  - Torque limit during speed control is the smaller of the absolute value of terminal A3 torque limit, or the values set in the torque limit parameters (L7-01 to L7-04).
  - When a stop command is given during speed control, speed control is maintained and the smaller of the absolute value of terminal A3 torque limit, or the values set in the torque limit parameters (L7-01 to L7-04), is used as the torque limit. Then the motor decelerates to stop.
- ② When the speed/torque control selection contact is ON, torque control is activated.
  - Speed limit during torque control is the master frequency reference at terminal A1 or A2 when speed limit selection (D5-03) is set to “1”, and is the speed limit value (D5-04) when D5-03 = “2”, regardless of the frequency reference selection (B1-01) setting.
  - During torque control, the terminal A2 or A3 analog input value becomes the torque reference.
- ③ By giving a stop command during torque control, operation changes to speed control automatically, and the motor decelerates to stop. The torque limit during deceleration to stop becomes the values set in the torque limit parameters (L7-01 to L7-04).

Note: The control mode actually changes after the speed/torque control selection command changes and after the reference delay timer (D5-06) elapses. Terminal A1 speed reference/speed limit and the terminal A2 or A3 torque limit/torque reference are stored in the inverter until the time set to D5-06 elapses.

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## ◆ d6 Field Weakening

### ■ d6-01 Magnetic Field Weakening Level

Setting Range: 0 to 100 %

Factory Default: 80 %

The output voltage during magnetic field weakening operation is the product of the normal V/f settings (E1-03 to E1-13) and the magnetic field weakening level. The output voltage decreases and recovers in the voltage recovery time (L2-04). The level is set as a percentage taking the voltage set in the V/f pattern as 100%. The magnetic field weakening function is only enabled when a multi-function input “field weakening command” is closed (H1-0x = 63).

### ■ d6-02 Magnetic Field Weakening Frequency

Setting Range: 0.0 to 400.0 Hz

Factory Default: 0.0 Hz

Sets the lower limit of the frequency range where field weakening control is valid. The field weakening command is valid only at frequencies above this setting and only when output frequency is in agreement with the current output frequency (speed agree).

### ■ d6-03 Magnetic Field Forcing Function Selection

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

Sets the magnetic field forcing function.

---

## ◆ E1 V/f Pattern

### ■ E1-01 Input Voltage Setting

Setting Range: 155.0V to 255.0V (240V Models)  
310.0V to 510.0V (480V Models)

Factory Defaults: 240.0V (240V Models)  
480.0V (480V Models)

Set the Input Voltage parameter (E1-01) to the nominal voltage of the connected AC power supply. This parameter adjusts the levels of some protective features of the Drive (i.e. Overvoltage, Stall Prevention, etc.). E1-01 also serves as the Maximum/Base Voltage used by the Preset V/Hz curves (E1-03= 0 to E).

#### WARNING

DRIVE INPUT VOLTAGE (NOT MOTOR VOLTAGE) MUST BE SET IN E1-01 FOR THE PROTECTIVE FEATURES OF THE DRIVE TO FUNCTION PROPERLY. FAILURE TO DO SO MAY RESULT IN EQUIPMENT DAMAGE AND/OR PERSONAL INJURY.

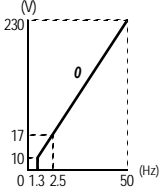
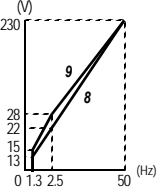
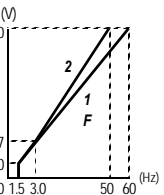
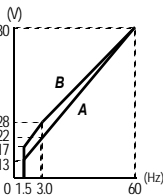
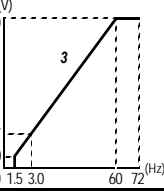
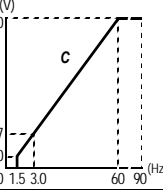
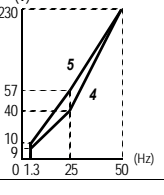
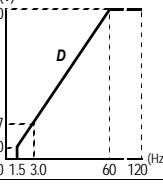

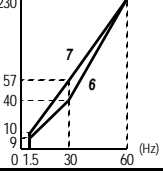
### ■ E1-03 V/f Pattern Selection

Setting	Description
0	50 Hz
1	60 Hz Saturation
2	50 Hz Saturation
3	72 Hz
4	50 Hz VT1
5	50 Hz VT2
6	60 Hz VT1
7	60 Hz VT2
8	50 Hz HST1
9	50 Hz HST2
A	60 Hz HST1
B	60 Hz HST2
C	90 Hz
D	120 Hz
E	180 Hz (not supported at this time)
F	Custom V/f ( <i>factory default, with parameter values per setting 1</i> )
FF	Custom w/o limit

The Drive operates utilizing a set V/f pattern to determine the appropriate output voltage level for each commanded speed. There are 15 different preset V/f patterns to select from with varying voltage profiles, saturation levels (frequency at which maximum voltage is reached), and maximum frequencies.

There are also settings for Custom V/f patterns that will allow the programmer to manually set (“Customize”) the V/f pattern using parameters E1-04 through E1-13.

Using parameter E1-03, the programmer can select one of the preset V/f patterns or chose between a custom V/f pattern with an upper voltage limit (E1-03= “F: Custom V/F”) and a custom V/f pattern without a voltage limit (E1-03= “FF: Custom w/o limit”).

Table 8 Preset V/f Patterns								
	Specifications	E1-03	V/f Pattern *1		Specifications	E1-03	V/f Pattern *1	
General-purpose	50Hz	0		High Starting Torque *2	High Starting Torque 1	8		
	60Hz Saturation	1			High Starting Torque 2	9		
	50Hz Saturation	2			High Starting Torque 1	A		
	72Hz	3			High Starting Torque 2	B		
Variable Torque	50Hz	Variable Torque 1		High Speed Operation	90Hz	C		
		Variable Torque 2			5	120Hz	D	
	60Hz	Variable Torque 1	6					
		Variable Torque 2	7					

If one of the custom V/f patterns is selected, then parameters E1-04 through E1-13 will determine the V/f pattern.

**IMPORTANT**

When a factory Initialization is performed, the setting of E1-03 is unaffected but the settings of E1-04 through E1-13 are returned to their factory default settings.

■ **E1-04 Maximum Output Frequency**

Setting Range: 0.0 to 400.0 Hz

Factory Default: 60.0 Hz

### ■ E1-05 Maximum Output Voltage

Setting Range: 0.0 to 255.0V (240V Models)  
0.0 to 510.0V (480V Models)

Factory Defaults: 230.0V (240V Models)  
480.0V (480V Models)

### ■ E1-06 Base Frequency

Setting Range: 0.0 to 400.0 Hz  
Factory Default: 60.0 Hz

### ■ E1-07 Mid Output Frequency A

Setting Range: 0.0 to 400.0 Hz  
Factory Default: 3.0 Hz

### ■ E1-08 Mid Output Voltage A

Setting Range: 0.0 to 255.0V (240V Models)  
0.0 to 510.0V (480V Models)

Factory Defaults: 12.6V (240V Models)  
25.2V (480V Models)

### ■ E1-09 Minimum Output Frequency

Setting Range: 0.0 to 400.0 Hz  
Factory Default: 0.5 Hz

### ■ E1-10 Minimum Output Voltage

Setting Range: 0.0 to 255.0V (240V Models)  
0.0 to 510.0V (480V Models)

Factory Defaults: 2.3V (240V Models)  
4.6V (480V Models)

### ■ E1-11 Mid Output Frequency B

Setting Range: 0.0 to 400.0 Hz  
Factory Default: 0.0 Hz

### ■ E1-12 Mid Output Voltage B

#### E1-13 Base Voltage

Setting Range: 0.0 to 255.0V (240V Models)  
0.0 to 510.0V (480V Models)

Factory Defaults: 0.0V (240V Models)  
0.0V (480V Models)

To set up a custom V/f pattern, program the points shown in the diagram below using parameters E1-04 through E1-13. Be sure that the following condition is true:

$$E1-09 \leq E1-07 \leq E1-06 \leq E1-11 \leq E1-04$$

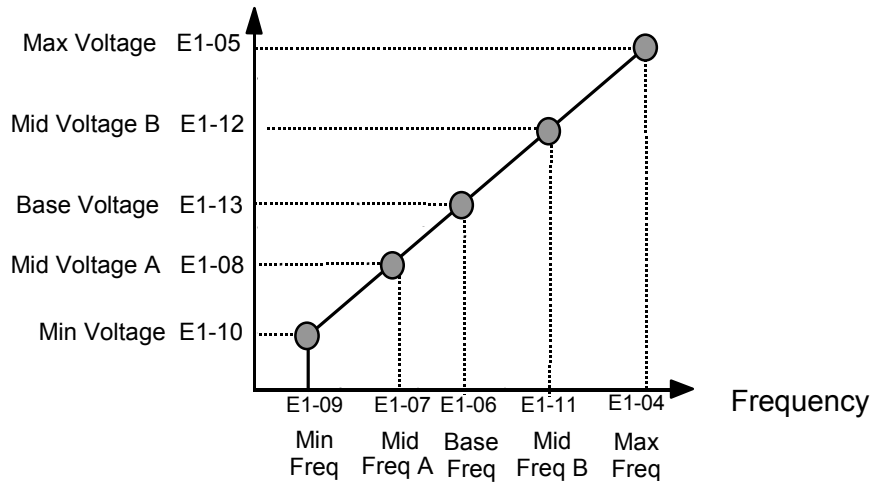


Fig.38 Custom V/f Pattern Programming Curve

Increasing the voltage in the V/f pattern increases the available motor torque. However, when setting a custom V/f pattern, increase the voltage gradually while monitoring the motor current, to prevent:

- Drive faults as a result of motor over-excitation
- Motor overheating or excessive vibration

Table 9 V/f Pattern Default Settings for Drive Capacity 0.4~1.5kW for 240V Class										
Parameter No.	Name	Unit	Factory Setting							
E1-03	V/f Pattern Selection	—	0	1	2	3	4	5	6	7
E1-04	Max Output Frequency	Hz	50.0	60.0	60.0	72.0	50.0	50.0	60.0	60.0
E1-05	Max Output Voltage	V	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0
E1-06	Base Frequency	Hz	50.0	60.0	50.0	60.0	50.0	50.0	60.0	60.0
E1-07	Mid Output Frequency A	V	2.5	3.0	3.0	3.0	25.0	25.0	30.0	30.0
E1-08	Mid Output Voltage A	V	17.2	17.2	17.2	17.2	40.2	57.5	40.2	57.5
E1-09	Min Output Frequency	Hz	1.3	1.5	1.5	1.5	1.3	1.3	1.5	1.5
E1-10	Mid Output Voltage	V	10.3	10.3	10.3	10.3	9.2	10.3	9.2	10.3
E1-11	Mid Output Frequency B	Hz	0	0	0	0	0	0	0	0
E1-12	Mid Output Voltage B	V	0	0	0	0	0	0	0	0
E1-13	Base Voltage	V	0	0	0	0	0	0	0	0

For 480V class units, the value is twice that of 240V class units.

Table 9 V/f Pattern Default Settings for Drive Capacity 0.4~1.5kW for 240V Class (Continued)

Parameter No.	Name	Unit	Factory Setting							
			8	9	A	B	C	D	E	F
E1-03	V/f Pattern Selection	—	8	9	A	B	C	D	E	F
E1-04	Max. Output Frequency	Hz	50.0	50.0	60.0	60.0	90.0	120.0	180.0	60.0
E1-05	Max. Output Voltage	V	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0
E1-06	Base Frequency	Hz	50.0	50.0	60.0	60.0	60.0	60.0	60.0	60.0
E1-07	Mid. Output Frequency A	V	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0
E1-08	Mid. Output Voltage A	V	21.8	27.6	21.8	27.6	17.2	17.2	17.2	17.2
E1-09	Min. Output Frequency	Hz	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5
E1-10	Mid. Output Voltage	V	12.6	14.9	12.6	17.2	10.3	10.3	10.3	10.3
E1-11	Mid Output Frequency B	Hz	0	0	0	0	0	0	0	0
E1-12	Mid Output Voltage B	V	0	0	0	0	0	0	0	0
E1-13	Base Voltage	V	0	0	0	0	0	0	0	0

For 480V class units, the value is twice that of 240V class units.

Table 10 V/f Pattern Default Settings for Drive Capacity 2.2~45kW for 240V Class

Parameter No.	Name	Unit	Factory Setting							
			0	1	2	3	4	5	6	7
E1-03	V/f Pattern Selection	—	0	1	2	3	4	5	6	7
E1-04	Max. Output Frequency	Hz	50.0	60.0	60.0	72.0	50.0	50.0	60.0	60.0
E1-05	Max. Output Voltage	V	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0
E1-06	Base Frequency	Hz	50.0	60.0	50.0	60.0	50.0	50.0	60.0	60.0
E1-07	Mid. Output Frequency A	V	2.5	3.0	3.0	3.0	25.0	25.0	30.0	30.0
E1-08	Mid. Output Voltage A	V	16.1	16.1	16.1	16.1	40.2	57.5	40.2	57.5
E1-09	Min. Output Frequency	Hz	1.3	1.5	1.5	1.5	1.3	1.3	1.5	1.5
E1-10	Mid. Output Voltage	V	8.0	8.0	8.0	8.0	6.9	8.0	6.9	8.0
E1-11	Mid Output Frequency B	Hz	0	0	0	0	0	0	0	0
E1-12	Mid Output Voltage B	V	0	0	0	0	0	0	0	0
E1-13	Base Voltage	V	0	0	0	0	0	0	0	0

For 480V class units, the value is twice that of 240V class units.

Table 10 V/f Pattern Default Settings for Drive Capacity 2.2~45kW for 240V Class (Continued)

Parameter No.	Name	Unit	Factory Setting							
			8	9	A	B	C	D	E	F
E1-03	V/f Pattern Selection	—	8	9	A	B	C	D	E	F
E1-04	Max. Output Frequency	Hz	50.0	50.0	60.0	60.0	90.0	120.0	180.0	60.0
E1-05	Max. Output Voltage	V	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0
E1-06	Base Frequency	Hz	50.0	50.0	60.0	60.0	60.0	60.0	60.0	60.0
E1-07	Mid. Output Frequency A	V	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0
E1-08	Mid. Output Voltage A	V	20.7	26.4	20.7	26.4	16.1	16.1	16.1	16.1
E1-09	Min. Output Frequency	Hz	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5
E1-10	Mid. Output Voltage	V	10.3	12.6	10.3	14.9	8.0	8.0	8.0	8.0
E1-11	Mid Output Frequency B	Hz	0	0	0	0	0	0	0	0
E1-12	Mid Output Voltage B	V	0	0	0	0	0	0	0	0
E1-13	Base Voltage	V	0	0	0	0	0	0	0	0

For 480V class units, the value is twice that of 240V class units.

Table 11 V/f Pattern Default Settings for Drive Capacity 55~300kW for 240V Class

Parameter No.	Name	Unit	Factory Setting							
			0	1	2	3	4	5	6	7
E1-03	V/f Pattern Selection	—	0	1	2	3	4	5	6	7
E1-04	Max. Output Frequency	Hz	50.0	60.0	60.0	72.0	50.0	50.0	60.0	60.0
E1-05	Max. Output Voltage	V	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0
E1-06	Max. Voltage Frequency	Hz	50.0	60.0	50.0	60.0	50.0	50.0	60.0	60.0
E1-07	Mid. Output Frequency A	V	2.5	3.0	3.0	3.0	25.0	25.0	30.0	30.0
E1-08	Mid. Output Voltage A	V	13.8	13.8	13.8	13.8	40.2	57.5	40.2	57.5
E1-09	Min. Output Frequency	Hz	1.3	1.5	1.5	1.5	1.3	1.3	1.5	1.5
E1-10	Mid. Output Voltage	V	6.9	6.9	6.9	6.9	5.7	6.9	5.7	6.9
E1-11	Mid Output Frequency B	Hz	0	0	0	0	0	0	0	0
E1-12	Mid Output Voltage B	V	0	0	0	0	0	0	0	0
E1-13	Base Voltage	V	0	0	0	0	0	0	0	0

For 480V class units, the value is twice that of 240V class units.

Table 11 V/f Pattern Default Settings for Drive Capacity 55~300kW for 240V Class (Continued)

Parameter No.	Name	Unit	Factory Setting							
			8	9	A	B	C	D	E	F
E1-03	V/f Pattern Selection	–	8	9	A	B	C	D	E	F
E1-04	Max. Output Frequency	Hz	50.0	50.0	60.0	60.0	90.0	120.0	180.0	60.0
E1-05	Max. Output Voltage	V	240.0	240.0	240.0	240.0	240.0	240.0	240.0	240.0
E1-06	Base Frequency	Hz	50.0	50.0	60.0	60.0	60.0	60.0	60.0	60.0
E1-07	Mid. Output Frequency A	V	2.5	2.5	3.0	3.0	3.0	3.0	3.0	3.0
E1-08	Mid. Output Voltage A	V	17.2	23.0	17.2	23.0	13.8	13.8	13.8	13.8
E1-09	Min. Output Frequency	Hz	1.3	1.3	1.5	1.5	1.5	1.5	1.5	1.5
E1-10	Mid. Output Voltage	V	8.0	10.3	8.0	12.6	6.9	6.9	6.9	6.9
E1-11	Mid Output Frequency B	Hz	0	0	0	0	0	0	0	0
E1-12	Mid Output Voltage B	V	0	0	0	0	0	0	0	0
E1-13	Base Voltage	V	0	0	0	0	0	0	0	0

For 480V class units, the value is twice that of 240V class units.

## ◆ E2 Motor Setup

### ■ E2-01 Motor Rated Current

Setting Range: Model Dependent  
Factory Default: Model Dependent

The Motor Rated Current parameter (E2-01) is used by the Drive to protect the motor and for proper Vector control when using Open Loop Vector or Flux Vector control methods (A1-02 = 2 or 3). The motor protection parameter L1-01 is enabled by default. Set E2-01 to the full load amps (FLA) stamped on the motor's nameplate.

During Auto-tuning, it is required for the operator to enter the motor's rated current (T1-04) in the Auto-Tuning menu. If the Auto-tuning operation completes successfully (T1-02 = 0), the value entered into T1-04 will automatically be written into E2-01.

### ■ E2-02 Motor Rated Slip

Setting Range: Model Dependent  
Factory Default: Model Dependent

This parameter sets the motor rated slip frequency in units of 0.01Hz. If the rotational Auto-tuning operation completes successfully, this value is automatically calculated. The default setting varies depending on the drive model number (o2-04). The following

equation to calculate the motor rated slip frequency based on motor nameplate data:

$$f_s = f - \frac{(N \cdot P)}{120}$$

where:

$f_s$  : slip frequency (Hz)  
 $f$  : rated frequency (Hz)  
 $N$  : rated motor speed (rpm)  
 $P$  : number of motor poles

### ■ E2-03 No Load Current

Setting Range: Model Dependent  
Factory Default: Model Dependent

Set E2-03 to the motor no-load current at rated voltage and rated frequency. If the rotational Auto-tuning operation completes successfully (T1-02 = 0), this value is automatically calculated. Consult the motor manufacturer for the proper value if the no load current is not stated on the motor nameplate.

### ■ E2-04 Number of Motor Poles

Setting Range: 2 to 48  
Factory Default: 4

This parameter sets the number of motor poles. During auto-tuning, it is required for the operator to enter the number of motor poles (T1-06) in the Auto-Tuning menu. If the Auto-tuning operation completes successfully (T1-02 = 0, 1, or 2), the value entered into T1-06 will automatically be written into E2-04.

### ■ E2-05 Motor Line-to-Line Resistance

Setting Range: 0.0000 to 65.000  $\Omega$   
Factory Default: 9.842  $\Omega$

Sets the line-to-line resistance of the motor's stator winding. If the Auto-tuning operation completes successfully (T1-02 = 0, 1, or 2), this value is automatically calculated. Remember this value must be entered as line-line and not line neutral.

$$E2-05 = \left( \frac{\text{Phase-to-phase Resistance at Insulation Class Temperature}}{\text{Insulation Class Temperature}} \right) \times \frac{273 + (25 + \text{insulation class temperature}) / 2}{273 + \text{insulation class temperature}}$$

Where: Insulation class temperature is in  $^{\circ}\text{C}$

### ■ E2-06 Motor Leakage Inductance

Setting Range: 0.0 to 40.0 %  
Factory Default: Model Dependent

Sets the voltage drop due to motor leakage inductance as a percentage of motor rated voltage. If the rotational Auto-tuning operation completes successfully (T1-02 = 0), this value is automatically calculated.

### ■ E2-07 Motor Iron-core Saturation Coefficient 1

Setting Range: 0.00 to 0.50  
Factory Default: 0.50

This parameter sets the motor iron saturation coefficient at 50% of the magnetic flux. If the rotational Auto-tuning operation completes successfully (T1-02 = 0), this value is automatically calculated.

## ■ E2-08 Motor Iron-core Saturation Coefficient 2

Setting Range: 0.50 to 0.75  
Factory Default: 0.75

This parameter sets the motor iron saturation coefficient at 75% of the magnetic flux. If the rotational Auto-tuning operation completes successfully (T1-02 = 0), this value is automatically calculated.

## ■ E2-09 Motor Mechanical Loss

Setting Range: 0.0 to 10.0 %  
Factory Default: 0.0 %

This parameter sets to the motor mechanical loss as a percentage of motor rated power (kW) capacity. Adjust this setting in the following circumstances:

- When torque loss is large due to motor bearing friction.
- When the torque loss in the load is large.

## ■ E2-10 Motor Iron Loss for Torque Compensation

Setting Range: 0 to 65535 W  
Factory Default: Model Dependent

This parameter sets the motor iron loss in watts (W)

## ■ E2-11 Motor Rated Output

Setting Range: 0.00 to 650.00 kW  
Factory Default: Model Dependent

This parameter sets the motor rated power in kilowatts (kW). If the rotational Auto-tuning operation completes successfully (T1-02 = 0), this value is automatically calculated.

1 horsepower = 0.746 kilowatts

## ■ E2-12 Motor Iron-core Saturation Coefficient 3

Setting Range: 0.0 to 1.60  
Factory Default: 1.30

This parameter sets the motor iron saturation coefficient at 130% of the magnetic flux. If the rotational Auto-tuning operation completes successfully (T1-02 = 0), this value is automatically calculated.

---

## ◆ E3 V/F Pattern 2

### ■ E3-01 Motor 2 Control Method Selection

Setting	Description
0	V/f Control without PG
1	V/f Control with PG
2	Open Loop Vector ( <i>factory default</i> )
3	Flux Vector (Closed Loop Vector)

The Drive has the capability to control 2 motors independently. A second motor may be selected using a multi-function contact input (H1-0x = 16). This parameter select the control method for motor 2. The control method for motor 1 is selected via parameter A1-02.

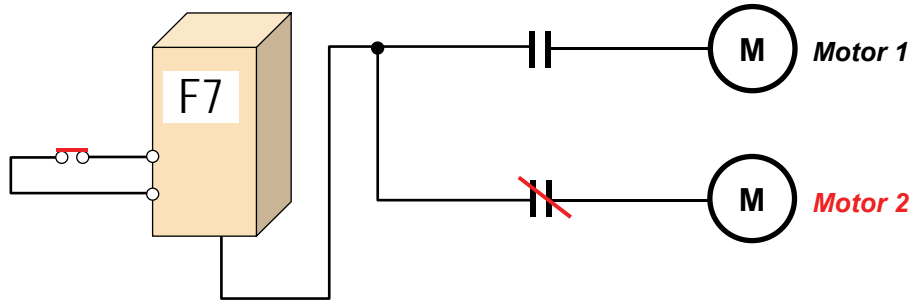


Fig. 39 Two Motor Switching Set-up

The following is a list of parameters that become effective when motor 2 is selected.  
E3-08E

Table 12 Motor 2 Parameters			
V/f Pattern 2		Motor Setup 2	
E3-01	Control Method 2	E4-01	Motor Rated FLA
E3-02	Max Frequency	E4-02	Motor Rated Slip
E3-03	Max Voltage	E4-03	No-Load Current
E3-04	Base Frequency	E4-04	Number of Motor Poles
E3-05	Mid Frequency	E4-05	Terminal Resistance
E3-06	Mid Voltage	E4-06	Leakage Inductance
E3-07	Min Frequency	E4-07	Motor Rated Power
E3-08	Min Voltage	-	-

■ **E3-02 Motor 2 Maximum Output Frequency**

Setting Range: 0.0 to 400.0 Hz  
Factory Default: 60.0 Hz

■ **E3-03 Motor 2 Maximum Output Voltage**

Setting Range: 0.0 to 255.0V (240V Models)  
0.0 to 510.0V (480V Models)

Factory Defaults: 230.0V (240V Models)  
480.0V (480V Models)

■ **E3-04 Motor 2 Base Frequency**

Setting Range: 0.0 to 400.0 Hz  
Factory Default: 60.0 Hz

### ■ E3-05 Motor 2 Mid Output Frequency A

Setting Range: 0.0 to 400.0 Hz  
Factory Default: 3.0 Hz

### ■ E3-06 Motor 2 Mid Output Voltage VA

Setting Range: 0.0 to 255.0V (240V Models)  
0.0 to 510.0V (480V Models)

Factory Defaults: 12.6V (240V Models)  
25.2V (480V Models)

### ■ E3-07 Motor 2 Minimum Output Frequency

Setting Range: 0.0 to 400.0 Hz  
Factory Default: 0.5 Hz

### ■ E3-08 Motor 2 Minimum Output Voltage

Setting Range: 0.0 to 255.0V (240V Models)  
0.0 to 510.0V (480V Models)

Factory Defaults: 2.3V (240V Models)  
4.6V (480V Models)

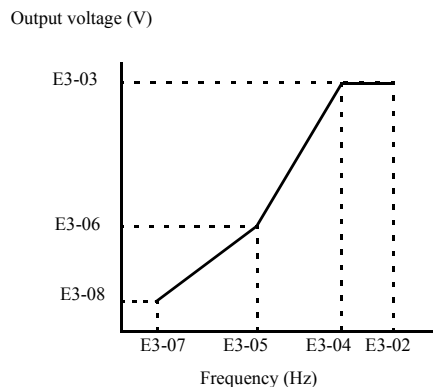


Fig. 40 Motor 2 V/f Curve

To set V/f characteristics in a straight line, set the same values for E3-05 and E3-07. In this case, the setting for E3-06 will be disregarded. Be sure that the four frequencies are set in the following manner or else an OPE10 fault will occur:

$$E3-07 \leq E3-05 < E3-04 \leq E3-02$$

---

## ◆ E4 Motor Setup 2

### ■ E4-01 Motor 2 Rated Current

Setting Range: Model Dependent  
Factory Default: Model Dependent

The Motor Rated Current parameter (E2-01) is used by the Drive to protect the motor and for proper Vector control when using Open Loop Vector or Flux Vector control methods (E3-01 = 2 or 3). The motor protection parameter L1-01 is enabled by default. Set E2-01 to the full load amps (FLA) stamped on the motor's nameplate.

During Auto-tuning, it is required for the operator to enter the motor's rated current (T1-04) in the Auto-Tuning menu. If the Auto-tuning operation completes successfully (T1-02 = 0), the value entered into T1-04 will automatically be written into E4-01.

## ■ E4-02 Motor 2 Rated Slip

Setting Range: Model Dependent

Factory Default: Model Dependent

This parameter sets the motor rated slip frequency in units of 0.01Hz. If the rotational Auto-tuning operation completes successfully, this value is automatically calculated. The default setting varies depending on the drive model number (o2-04). The following equation to calculate the motor rated slip frequency based on motor nameplate data:

$$f_s = f - \frac{(N \cdot P)}{120}$$

where:

$f_s$  : slip frequency (Hz)

$f$  : rated frequency (Hz)

$N$  : rated motor speed (rpm)

$P$  : number of motor poles

## ■ E4-03 Motor 2 No Load Current

Setting Range: Model Dependent

Factory Default: Model Dependent

Set E4-03 to the motor no-load current at rated voltage and rated frequency. If the rotational Auto-tuning operation completes successfully (T1-02 = 0), this value is automatically calculated. Consult the motor manufacturer for the proper value if the no load current is not stated on the motor nameplate.

## ■ E4-04 Motor 2 Number of Poles

Setting Range: 2 to 48

Factory Default: 4

This parameter sets the number of motor poles. During auto-tuning, it is required for the operator to enter the number of motor poles (T1-06) in the Auto-Tuning menu. If the Auto-tuning operation completes successfully (T1-02 = 0, 1, or 2), the value entered into T1-06 will automatically be written into E4-04.

## ■ E4-05 Motor 2 Line-to-Line Resistance

Setting Range: 0.0000to 65.000  $\Omega$

Factory Default: 9.842  $\Omega$

Sets the line-to-line resistance of the motor's stator winding. If the Auto-tuning operation completes successfully (T1-02 = 0, 1, or 2), this value is automatically calculated. Remember this value must be entered as line-line and not line neutral.

$$E2-05 = \left( \frac{\text{Phase-to-phase Resistance at}}{\text{Insulation Class Temperature}} \right) \times \frac{273 + (25 + \text{insulation class temperature}) / 2}{273 + \text{insulation class temperature}}$$

Where: Insulation class temperature is in  $^{\circ}\text{C}$

## ■ E4-06 Motor 2 Leakage Inductance

Setting Range: 0.0 to 40.0 %  
Factory Default: Model Dependent

Sets the voltage drop due to motor leakage inductance as a percentage of motor rated voltage. If the rotational Auto-tuning operation completes successfully (T1-02 = 0), this value is automatically calculated.

## ■ E4-07 Motor Rated Output

Setting Range: 0.00 to 650.00 kW  
Factory Default: Model Dependent

This parameter sets the motor rated power in kilowatts (kW). If the rotational Auto-tuning operation completes successfully (T1-02 = 0), this value is automatically calculated.

---

## ◆ F1 PG Option Setup

### ■ F1-01 PG Pulses / Revolution

Setting Range: 0 to 60000  
Factory Default: 1024

This parameter sets the number of PG pulses per one revolution of the encoder (pulse generator) when using PG option board on the Drive.

### ■ F1-02 Operation Selection at PG Open Circuit (PGO)

Setting	Description
0	Ramp to Stop - Decelerate to stop using active deceleration time.
1	Coast to Stop ( <i>factory default</i> )
2	Fast-stop - Decelerate to stop using the deceleration time in C1-09.
3	Alarm Only - Drive continues operation.

This parameter sets the stopping method when a PG open circuit fault (PGO) occurs according to the PGO detection time set in parameter F1-14.

### ■ F1-03 Operation Selection at Overspeed (OS)

Setting	Description
0	Ramp to Stop - Decelerate to stop using active deceleration time.
1	Coast to Stop ( <i>factory default</i> )
2	Fast-stop - Decelerate to stop using the deceleration time in C1-09.
3	Alarm Only - Drive continues operation.

This parameter sets the stopping method when a overspeed fault (OS) occurs according to the OS detection level and detection time set in parameter F1-08 and F1-09, respectively.

## ■ F1-04 Operation Selection at Speed Deviation (DEV)

Setting	Description
0	Ramp to Stop - Decelerate to stop using active deceleration time.
1	Coast to Stop
2	Fast-stop - Decelerate to stop using the deceleration time in C1-09.
3	Alarm Only - Drive continues operation. ( <i>factory default</i> )

This parameter sets the stopping method when a speed deviation fault (DEV) occurs according to the OS detection level and detection time set in parameter F1-08 and F1-09, respectively.

## ■ F1-05 PG Rotation Selection

Setting	Description
0	Forward = Counter Clock-wise - Phase A leads with forward run command. ( <i>factory default</i> )
1	Forward = Clock-wise - Phase B leads with forward run command.

This parameter sets the relationship between motor rotation direction and PG polarity. The motor rotation direction applies when viewing the motor shaft from the load side.

## ■ F1-05 PG Division Rate

Setting Range: 1 to 132

Factory Default: 1

This parameter sets the division ratio for the pulse monitor of the PG-B2 encoder feedback option board. This function is not available with the PG-X2 option board.

$$\text{Division Ratio} = (1 + n) / m$$

where  $n = 0$  to  $1$  and  $m = 1$  to  $32$

The first digit of the value of F1-06 stands for  $n$ , the second and the third digit stand for  $m$  (from left to right).

Example:

$$\text{F1-05} = \underline{1} \underline{16}$$

$n = 1$        $m = 16$

$$\text{Division Ratio} = (1 + 1) / 16 = 0.125$$

The possible division ratio settings are:

$$1/32 \leq \text{F1-06} \leq 1$$

## ■ F1-07 Integral Function During Accel / Decel Selection

Setting	Description
0	Disable - Integral function is not used during accel or decel. ( <i>factory default</i> )
1	Enable - Integral function is used at all times.

This parameter enables or disables the speed control (ASR) integral operation during acceleration or deceleration.

## ■ F1-08 Overspeed Detection Level

Setting Range: 0 to 120 %

Factory Default: 115 %

### ■ F1-09 Overspeed Detection Delay Time

Setting Range: 0.0 to 2.0 seconds

Factory Default: 0.0 seconds

Parameter F1-08 sets the motor overspeed detection level as a percentage of maximum output frequency (E1-04) for the overspeed fault (OS). Parameter F1-09 sets the elapsed time from when an overspeed condition is detected to when a fault occurs. See figure below.

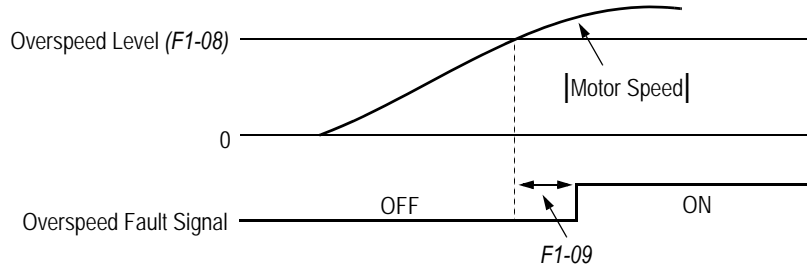


Fig. 41 Overspeed Detection Timing Diagram

A fault signal is output to stop operation after the absolute value of the motor speed exceeds the set value of F1-08 and after the time set to F1-09 elapses. The stopping method is set by F1-03.

When parameter A1-02 = 1 (V/f with PG) the factory default setting will be 1.0. When parameter A1-02 = 3 (Flux Vector) the factory setting will be 0.0.

### ■ F1-10 Excessive Speed Deviation Detection Level

Setting Range: 0 to 50 %

Factory Default: 10 %

### ■ F1-11 Excessive Speed Deviation Detection Delay Time

Setting Range: 0.0 to 10.0 seconds

Factory Default: 0.5 seconds

Parameter F1-10 sets the speed deviation detection level as a percentage of maximum output frequency (E1-04) for the speed deviation fault (DEV). Parameter F1-11 sets the elapsed time from when an speed deviation condition is detected to when a fault occurs. See figure below.

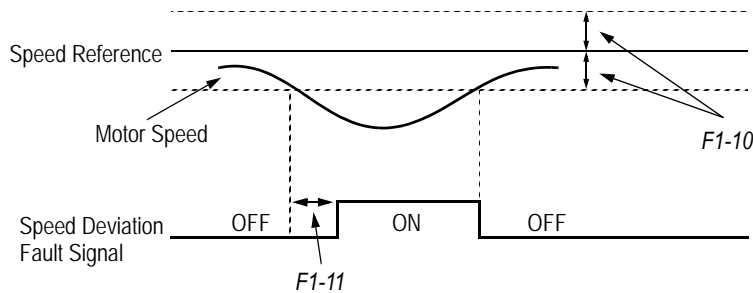


Fig. 42 Speed Deviation Detection Timing Diagram

A fault signal is output to stop operation after the deviation between speed reference and the motor speed exceeds the set value of F1-10 and after the time set to F1-11 elapses. The stopping method is set by F1-04. Also, detection is not activated while accelerating/decelerating or during torque control.

## ■ F1-12 Number of PG Gear Teeth 1

## ■ F1-13 Number of PG Gear Teeth 2

Setting Range: 0 to 1000

Factory Default: 0

Parameter F1-12 and F1-13 sets the gear ratio between the motor shaft and the encoder (PG) according to the following formula:

$$\text{No. of Motor RPM's} = \frac{\text{No. of PG Output Pulses} \times 60}{\text{PG Pulses/Revolution (F1-01)}} \times \frac{\text{No. of Teeth Gear 2 (F1-13)}}{\text{No. of Teeth Gear 1 (F1-12)}}$$

A gear ratio of 1 will be used if either of these parameters is set to zero. This function is not available in Flux Vector control (A1-02 = 3).

## ■ F1-14 PG Open-Circuit (PGO) Detection Time

Setting Range: 0.0 to 10.0 seconds

Factory Default: 2.0 seconds

Parameter F1-14 sets the time from when the pulse generator (PG) signal is missing to when the fault signal is displayed on the Drive. The stopping method when a “PGO” fault is detected is selected by parameter F1-02. If a speed reference is commanded, but the motor is physically locked, a “PGO” fault will occur even though the PG is connected to the Drive.

---

## ◆ F2 AI-14 Setup

### ■ F2-01 AI-14 Input Selection

Setting	Description
0	3-Channel Individual (channel 1: terminal A1, channel 2: terminal A2, channel 3: terminal A3) ( <i>factory default</i> )
1	3-Channel Addition (Summed values of channels 1, 2, and 3 is the frequency reference)

This parameter selects the function for channel 1, 2, and 3 when AI-14B analog input reference option board is used.

When the 3-channel individual input is used, parameter b1-01 is automatically set to “1” (frequency reference from control circuit terminal). The option/inverter reference selection, which is selected by a multi-function contact input (H1-0x = “2”), is disabled when using the AI-14B option.

---

## ◆ F3 DI-08, 16 Setup

### ■ F3-01 DI-08 / DI-16H2 Input Selection

Setting	Description
0	BCD 1% Unit ( <i>factory default</i> )
1	BCD 0.1% Unit
2	BCD 0.01% Unit
3	BCD 1Hz. Unit
4	BCD 0.1Hz. Unit
5	BCD 0.01Hz Unit
6	BCD (5-digit) 0.01 Hz. Unit (for DI-16H2 only)
7	Binary Input

This parameter sets the function of the DI-08 or the DI-16H2 digital input option board. When o1-03 is set to 2 or higher, the input will be BCD, and the units will change to the o1-03 setting.

---

## ◆ F4 AO-08, 12 Setup

### ■ F4-01 AO-08 / AO-12 Channel 1 Monitor Selection

Setting Range: 1 to 45  
Factory Default: 2

This parameter sets the number of the monitor item to be output (U1-0x) for channel 1 of the AO-08 or AO-12 analog output option board. The following settings cannot be set:  
4, 10 to 14, 25, 28, 29, 31, 34, 39, 40, 41.

### ■ F4-02 AO-08 / AO-12 Channel 1 Gain

Setting Range: 0.0 to 1000.0 %  
Factory Default: 100.0 %

This parameter sets the gain for channel 1 of the AO-08 or AO-12 analog output option board.  
Example: Set F4-02 = 50 % to output 100% at 5.0 Volts.

### ■ F4-03 AO-08 / AO-12 Channel 2 Monitor Selection

Setting Range: 1 to 45  
Factory Default: 2

This parameter sets the number of the monitor item to be output (U1-xx) for channel 2 of the AO-08 or AO-12 analog output option board. The following settings cannot be set:  
4, 10 to 14, 25, 28, 29, 31, 34, 39, 40, 41.

### ■ F4-04 AO-08 / AO-12 Channel 2 Gain

Setting Range: 0.0 to 1000.0 %  
Factory Default: 100.0 %

This parameter sets the gain for channel 2 of the AO-08 or AO-12 analog output option board.  
Example: Set F4-02 = 50 % to output 100% at 5.0 Volts.

### ■ F4-05 AO-08 / AO-12 Channel 1 Output Bias

### ■ F4-06 AO-08 / AO-12 Channel 2 Output Bias

Setting Range: -110.0 to 110.0 %  
Factory Default: 0.0 %

Parameters F4-05 and F4-06 respectively set channel 1 and channel 2 bias of the AO-08 or AO-12 analog output option board.  
Example: Set F4-05 = 50% to output 0% at 5.0V output.

### ■ F4-07 AO-12 Channel 1 Signal Level

### ■ F4-08 AO-12 Channel 2 Signal Level

Setting	Description
0	0 to 10 Vdc ( <i>factory default</i> )
1	-10 to +10 Vdc

Parameters F4-07 and F4-08 respectively set channel 1 and channel 2 signal level of the AO-12 analog output option board.

---

## ◆ F5 DO-02, 08 Setup

### ■ F5-01 DO-02 / DO-08 Channel 1 Output Selection

Setting Range: 0 to 38  
Factory Default: 0

### ■ F5-02 DO-02 / DO-08 Channel 2 Output Selection

Setting Range: 0 to 38  
Factory Default: 1

### ■ F5-03 DO-08 Channel 3 Output Selection

Setting Range: 0 to 38  
Factory Default: 2

### ■ F5-04 DO-08 Channel 4 Output Selection

Setting Range: 0 to 38  
Factory Default: 4

### ■ F5-05 DO-08 Channel 5 Output Selection

Setting Range: 0 to 38  
Factory Default: 6

### ■ F5-06 DO-08 Channel 6 Output Selection

Setting Range: 0 to 38  
Factory Default: 37

### ■ F5-07 DO-08 Channel 7 Output Selection

Setting Range: 0 to 38  
Factory Default: F

### ■ F5-08 DO-08 Channel 8 Output Selection

Setting Range: 0 to 38  
Factory Default: F

These parameters set the digital output function number for channel 1 when digital output DO-02 or DO-08 option board is used. See H2 parameter group for possible selections.

Parameters F5-01 and F5-02 set the digital output function number for channel 1 and 2, respectively when DO-02 or DO-08 digital output option board is used.

Parameters F5-03 to F5-08 set the digital output function number for channels 3 to 8 when DO-08 digital output option board is used.

## ■ F5-09 DO-08 Output Mode Selection

Setting	Description
0	8-Channel Individual Outputs ( <i>factory default</i> )
1	Binary Code Output
2	8-Channel Selected - output according to F5-01 to F5-08 settings

This parameter sets the function of the DO-08 digital output option board.

---

## ◆ F6 Communication Option Setup

### ■ F6-01 Operation Selection After Communication Error

Setting	Description
0	Ramp to Stop
1	Coast to Stop ( <i>factory default</i> )
2	Fast-Stop
3	Alarm Only

If a communication option board is attached to the Drive at the 2CN connector, the Drive will automatically monitor the card for any type of communication errors. F6-01 is applicable no matter whether a run command or frequency reference is coming via the option board, digital operator, or terminal input. The setting of F6-01 determines whether the communication error is seen as a fault or an alarm. If F6-01=“3: Alarm Only”, then the fault output is not energized upon a communication error. All other settings of F6-01 cause the fault output to energize. The setting of F6-01 does not apply to any of the embedded communication protocols used at the RS-485/422 terminals on the removable terminal board.

### ■ F6-02 Option PCB External Fault Detection Selection

Setting	Description
0	Always Detected ( <i>factory default</i> )
1	Detected only during operation

### ■ F6-03 Option PCB External Fault stopping Method

Setting	Description
0	Ramp to Stop
1	Coast to Stop ( <i>factory default</i> )
2	Fast-Stop
3	Alarm Only

If an external fault is received from the communication option board, the settings of F6-02 and F6-03 will determine the Drive operation in reaction to the fault signal. Parameter F6-02 will determine if the external fault is always recognized (F6-02=“0: Always Detected”) or only recognized when the Run command is active (F6-02=“1: Detected only during operation”). Once the fault is recognized, parameter F6-03 will determine the operation of the Drive. If parameter F6-03 is set to anything other than “3”, the Drive will fault and a stopping sequence is begun. If F6-03=“3: Alarm Only”, then the external fault is treated like an alarm. Operation will continue and an EF0 fault will flash on the digital operator.

## ■ F6-04 Trace Sampling from Communication Option Board

Setting Range: 0 to 60000

Factory Default: 0

This parameter sets the sample trace for the CP-916 option board.

## ■ F6-05 Current Scaling via Communication Option PCB

Setting	Description
0	Displayed in Amps ( <i>factory default</i> )
1	100%/8192 (12-bit binary number with 8192 = 100% Drive Rated Current)

A communication option card can read the Drive's DPRAM to access the current monitor. The format of the current reading in the DPRAM will be determined by parameter F6-05.

F6-05= "0: A Display" → Current is a decimal number corresponding to actual Amperes

F6-05= "1: 100%/8192 (Drive Rated Current)" → Current reading is a number where  
8192 = 100% of Drive rated output current

## ■ F6-06 Torque Reference / Limit Selection from Communications Option Board

Setting	Description
0	Disabled - torque reference / limit from option board disabled ( <i>factory default</i> )
1	Enabled - torque reference / limit from option board enabled

This parameter allows the torque reference and/or torque limit to come from the communications option board.

---

## ◆ H1 Digital Inputs

### ■ H1-01 Terminal S3 Function Selection

#### H1-02 Terminal S4 Function Selection

#### H1-03 Terminal S5 Function Selection

#### H1-04 Terminal S6 Function Selection

#### H1-05 Terminal S7 Function Selection

#### H1-06 Terminal S8 Function Selection

Setting Range: 0 to 78

Factory Default: H1-01= "24: External Fault"

H1-02= "14: Fault Reset"

H1-03= "3: Multi-Step Ref 1" (2-Wire)

"0: 3-Wire Control" (3 Wire)

H1-04= "4: Multi-Step Ref 2" (2 Wire)

"3: Multi-Step Ref 1" (3 Wire)

H1-05= "6: Jog Freq Ref" (2 Wire)

"4: Multi-Step Ref 2" (3 Wire)

H1-06= "8: External BaseBlock N.O."

The Drive has 6 multi-function contact digital inputs. By programming parameters H1-01 through H1-06, the user can assign specific functions to each input. Below is a table with a complete list of all of the digital input functions according to control method (A1-02). Not all functions are available for all control methods. Following the table is a more detailed description of each of the functions.

Table 13 Multi-Function Input Selection					
Parameter Setting	Function	Control Method (A1-02)			
		V/f	V/f with PG	Open Loop Vector	Flux Vector
0	3-Wire Control	0	0	0	0
1	Local/Remote Selection	0	0	0	0
2	Option/Inverter Selection	0	0	0	0
3	Multi-Step Frequency Reference 1 (factory default, H1-03)	0	0	0	0
4	Multi-Step Frequency Reference 2 (factory default, H1-04)	0	0	0	0
5	Multi-Step Frequency Reference 3	0	0	0	0
6	Jog Frequency Reference (factory default, H1-05)	0	0	0	0
7	Accel/Decel Time Selection 1	0	0	0	0
8	External Baseblock N.O. (factory default, H1-06)	0	0	0	0
9	External Baseblock N.C.	0	0	0	0
A	Accel/Decel Ramp Hold	0	0	0	0
B	External Overheat Alarm (OH2)	0	0	0	0
C	Terminal A2 Enable	0	0	0	0
D	V/f Control with PG Disabled	X	0	X	X
E	ASR Integral Reset	X	0	X	0
F	Terminal Not Used	0	0	0	0
10	MOP Increase	0	0	0	0
11	MOP Decrease	0	0	0	0
12	Forward Jog	0	0	0	0
13	Reverse Jog	0	0	0	0
14	Fault Reset (factory default, H1-02)	0	0	0	0
15	Fast-Stop N.O.	0	0	0	0
16	Motor 2 Selection	0	0	0	0
17	Fast-Stop N.C.	0	0	0	0
18	Timer Function	0	0	0	0
19	PID Disable	0	0	0	0
1A	Accel/Decel Time Selection 2	0	0	0	0
1B	Program Lockout	0	0	0	0
1C	Trim Control Increase	0	0	0	0
1D	Trim Control Decrease	0	0	0	0
1E	Reference Sample Hold	0	0	0	0
20	External Fault, Normally Open, Always Detected, Ramp To Stop	0	0	0	0
21	External Fault, Normally Closed, Always Detected, Ramp To Stop	0	0	0	0
22	External Fault, Normally Open, During Run, Ramp To Stop	0	0	0	0
23	External Fault, Normally Closed, During Run, Ramp To Stop	0	0	0	0
24	External Fault, Normally Open, Always Detected, Coast to Stop (factory default, H1-01)	0	0	0	0
25	External Fault, Normally Closed, Always Detected, Coast To Stop	0	0	0	0
26	External Fault, Normally Open, During Run, Coast To Stop	0	0	0	0
27	External Fault, Normally Closed, During Run, Coast To Stop	0	0	0	0
28	External Fault, Normally Open, Always Detected, Fast-Stop	0	0	0	0
29	External Fault, Normally Closed, Always Detected, Fast-Stop	0	0	0	0
2A	External Fault, Normally Open, During Run, Fast-Stop	0	0	0	0
2B	External Fault, Normally Closed, During Run, Fast-Stop	0	0	0	0
2C	External Fault, Normally Open, Always Detected, Alarm Only	0	0	0	0
2D	External Fault, Normally Closed, Always Detected, Alarm Only	0	0	0	0
2E	External Fault, Normally Open, During Run, Alarm Only	0	0	0	0
2F	External Fault, Normally Closed, During Run, Alarm Only	0	0	0	0
30	PID Integral Reset	0	0	0	0
31	PID Integral Hold	0	0	0	0
32	Multi-Step Reference 4	0	0	0	0
34	PID Soft Starter Cancel	0	0	0	0

Table 13 Multi-Function Input Selection (Continued)					
Parameter Setting	Function	Control Method (A1-02)			
		V/f	V/f with PG	Open Loop Vector	Flux Vector
35	PID Input (Error) Polarity Change	O	O	O	O
60	DC Injection Braking	O	O	O	O
61	Speed Search 1	O	X	O	X
62	Speed Search 2	O	X	O	X
63	Field Weakening Command (Energy Savings)	O	O	X	X
64	Speed Search 3	O	O	O	O
65	Kinetic Energy Braking Ridethru N.C.	O	O	O	O
66	Kinetic Energy Braking Ridethru N.O	O	O	O	O
67	Communication Test Mode	O	O	O	O
68	High Slip Braking	O	O	X	X
69	Jog 2	O	O	O	O
6A	Drive Enable	O	O	O	O
71	Speed/Torque Control Selection	X	X	X	O
72	Zero Servo Command	X	X	X	O
77	ASR Gain Switch	X	X	X	O
78	Polarity Reversing Command for External Torque Control	X	X	X	O

**Function: 3-Wire Control**

**Setting: 0**

When one of the digital inputs is programmed for 3-Wire control, that input becomes a Forward/Reverse directional input. Whenever the input is open, the Drive will be set for forward rotation of the motor shaft. If the input is closed, then the motor shaft will rotate in the reverse direction whenever there is a Run input. The S1 and S2 digital inputs will function as a Run and Stop input respectively.

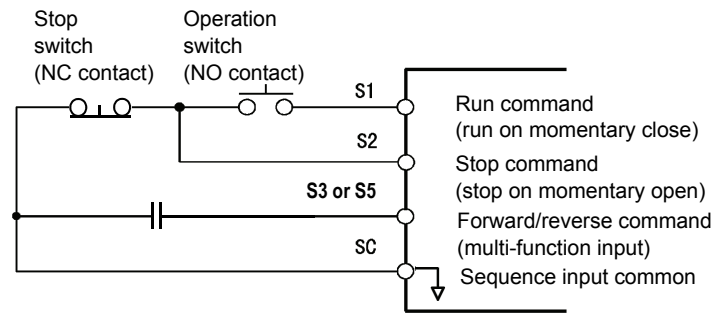


Fig. 43 Terminal Configuration for 3-Wire Control

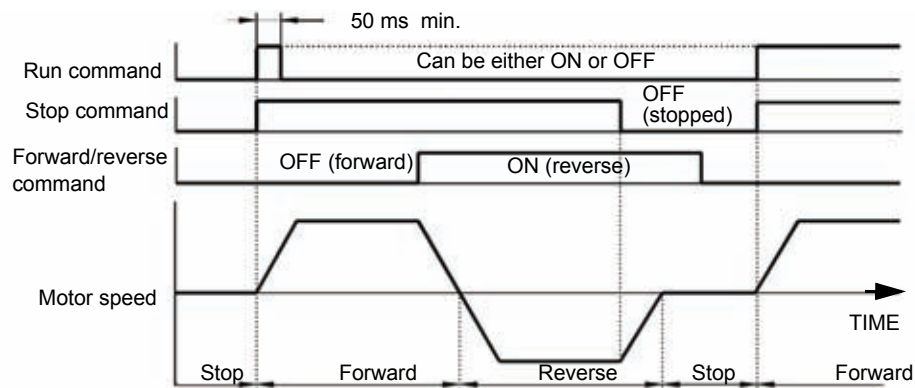


Fig. 44 3-Wire Control Timing Diagram

**IMPORTANT**

As long as the S1(Run Command) input is applied in for at least 50 ms the Run command will latch internally in the Drive.

**Function: Local/Remote Selection****Setting: 1**

Selects the operation mode, only when the Drive is stopped.

Local: Operation according to frequency reference and run command from digital operator.

Remote: Operation according to frequency reference and run command set by parameter b1-01 and b1-02, respectively.

Note: When local/remote selection is set by a multi-function contact input terminal, LOCAL/REMOTE key on the digital operator key is disabled.

**Function: Option/Inv Selection 1****Setting: 2**

The Option/Inv Selection function allows the user to select the source for the Run and frequency references between either the Drive's terminals or an optional communication board. When a digital input is programmed for the Option/Inv Selection function (H1-0x= 2) that input will function as follows:

Table 14 Digital Input Functions	
Option/Inv Selection Input Status	Run and frequency reference Source
OPEN	From the control circuit and analog input terminals
CLOSED	From the Communications Option Board

To switch the command source between the option card and the terminals be sure to program the following parameters:

- Set b1-01 (Frequency Reference Selection) to 1 (Terminals).
- Set b1-02 (Run Command Selection) to 1 (Terminals).
- Set H1-0x (Input Terminal Function Selection) to 2.

**IMPORTANT**

Switching between the different Reference and Run sources can only be done while the Drive is stopped.

**Function: Multi-step Reference 1****Setting: 3****Function: Multi-step Reference 2****Setting: 4****Function: Multi-step Reference 3****Setting: 5**

The Drive can be programmed to utilize digital inputs to change between 16 presets speeds and a jog speed. It is a two-step process to set the Drive up for preset speeds. First, d1-01 through d1-16 and d1-17 must be programmed with the desired preset speeds and the desired jog speed, respectively. Next, up to four terminals S3 through S8 need to be programmed (via parameters H1-01 to H1-06) and wired (to normally open contacts) as “3: Multi-step Speed Reference 1”, “4: Multi-step Speed Reference 2”, “5: Multi-step Speed Reference 3”, “6: Multi-step Speed Reference 4”, and “7: Jog Frequency”.

The following table details which reference is active based on the status of the Multi-step Ref 1 and Multi-step Ref 2 inputs:

Table 15 Multi-step Speed Operation Timing Diagram						
Preset Speed	Multi-step Reference 1	Multi-step Reference 2	Multi-step Reference 3	Multi-step Reference 42	Jog Reference	Details
1	OFF	OFF	OFF	OFF	OFF	Frequency Reference 1 (d1-01) or Analog Input A1
2	ON	OFF	OFF	OFF	OFF	Frequency Reference 2 (d1-02) or Analog Input A3
3	OFF	ON	OFF	OFF	OFF	Frequency Reference 3 (d1-03)
4	ON	ON	OFF	OFF	OFF	Frequency Reference 4 (d1-04)
5	OFF	OFF	ON	OFF	OFF	Frequency Reference 5 (d1-05)
6	ON	OFF	ON	OFF	OFF	Frequency Reference 6 (d1-06)
7	OFF	ON	ON	OFF	OFF	Frequency Reference 7 (d1-07)
8	ON	ON	ON	OFF	OFF	Frequency Reference 8 (d1-08)
9	OFF	OFF	OFF	ON	OFF	Frequency Reference 9 (d1-09)
10	ON	OFF	OFF	ON	OFF	Frequency Reference 10 (d1-10)
11	OFF	ON	OFF	ON	OFF	Frequency Reference 11 (d1-11)
12	ON	ON	OFF	ON	OFF	Frequency Reference 12 (d1-12)
13	OFF	OFF	ON	ON	OFF	Frequency Reference 13 (d1-13)
14	ON	OFF	ON	ON	OFF	Frequency Reference 14 (d1-14)
15	OFF	ON	ON	ON	OFF	Frequency Reference 15 (d1-15)
16	ON	ON	ON	ON	OFF	Frequency Reference 16 (d1-16)
JOG	-	-	-	-	ON*	Jog Frequency (d1-17)

\* The Jog Frequency input is given priority over the multi-step speeds.

The determination of whether the Preset Speed 1 will be the Frequency Reference 1 (d1-01 or the analog input A1) is determined by the status of b1-01. If b1-01= “1: Terminals”, the value of the input to A1 will determine the commanded speed when Preset Speed 1 is selected. If b1-01≠1, the setting of d1-01 will determine the commanded speed when Preset Speed 1 is selected.

The determination of Preset Speed 2 is made much the same way as Preset Speed 1 except that the setting of parameter H3-05 decides whether the analog input A3 or d1-02 is Preset Speed 2. If H3-05= “2: Aux Reference”, the value of the input to A3 will determine the commanded speed when Preset Speed 2 is selected. If H3-05≠2, the setting of d1-02 will determine the commanded speed when Preset Speed 2 is selected.

**Function: Jog Frequency Reference**

**Setting: 6**

When a digital input configured as Jog Freq Ref (H1-0x= 6) is Closed, the active frequency reference will be the setting of parameter d1-17 (Jog Frequency Reference). Closure of this digital input alone will not initiate a Jog motion, it will only change the frequency reference. An active Run input is necessary for actual jogging.

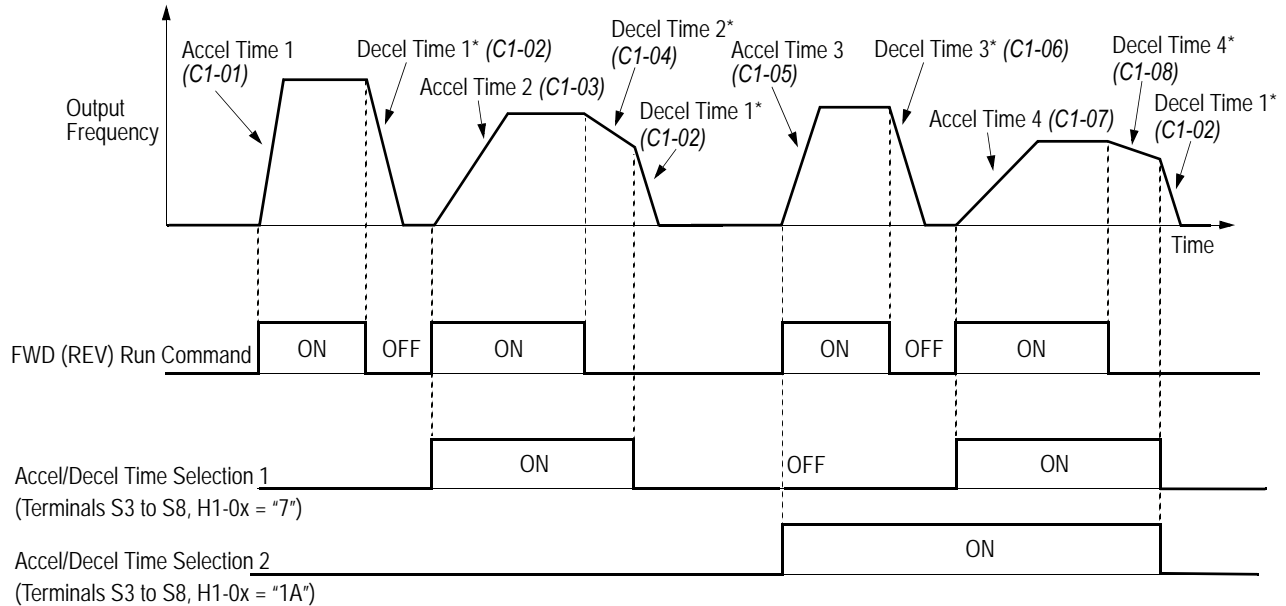
To change to the Jog frequency reference and provide a Run Command, with a single input, please refer to digital input settings “12” and “13”.

**Function: Multi-Acceleration/Deceleration 1**

**Setting: 7**

When any of the multi-function contact input selections (H1-01 to H1-06) are set to “7” and “1A”, up to four accel/decel times can then be selected by opening or closing the appropriate accel/decel time selection commands (terminals 3 to 8).

Accel/decel Time Selection 1 Multi-function Input Setting = "7"	Accel/decel Time Selection 2 Multi-function Input Setting = "1A"	Accel Time	Decel Time
Open or not set	Open or not set	C1-01	C1-02
Closed	Open or not set	C1-03	C1-04
Open or not set	Closed	C1-05	C1-06
Closed	Closed	C1-07	C1-08



\* When "deceleration to stop" is selected ( $B1-03 = "0"$ )

Fig. 45 Timing Diagram of Accel / Decel Time Change

**Function: External Baseblock N.O.**

**Setting: 8**

**Function: External Baseblock N.C.**

**Setting: 9**

When the Drive is commanded into baseblock, gating of the output transistor stops and output voltage/frequency drops to zero (motor coasts). The Drive can be forced into a baseblock state by either closing a digital input configured for Ext Baseblk N.O. ( $H1-0x = 8$ ) or opening a digital input configured for Ext Baseblk N.C. ( $H1-0x = 9$ ).

When the baseblock state is removed the speed search function is used to catch the coasting motor and ramp it back to the commanded speed.

The method of speed search, Current Detection or Speed Estimation, that is utilized when the baseblock input is removed depends on the setting of parameter b3-01:

If  $b3-01 = "0"$ : SpdsrchF Disable" or "1: SpdsrchF Enable"; Speed Estimation is used

If  $b3-01 = "2"$ : SpdsrchI Disable" or "3: SpdsrchF Enable"; Current Detection is used



**Function: V/f Control with PG Disabled****Setting: D**

PG feedback input can be disabled while the Drive is running when this function is selected. However, the speed control integral value (C5-05) is held until the run command is removed.

- Open: PG feedback control enabled (closed loop)
- Closed: PG feedback control disabled (open loop)

This function is available only during V/f control with PG feedback (A1-02 = 1).

**Function: Terminal Not Used****Setting: F**

Any digital input programmed as Term Not Used (H1-0x= F) will have no function assigned to it and it's OPEN/CLOSED state will not matter to the Drive's operation.

**Function: MOP Increase****Setting: 10****Function: MOP Decrease****Setting: 11**

Using two digital inputs, the Drive can operate with the same type of functionality as a motor operated potentiometer (MOP). One digital input can be programmed as an MOP Increase input (H1-0x= 10) and another digital input can be programmed as an MOP Decrease input (H1-0x= 11). This MOP functionality is also commonly referred to as Floating Point Control, Incremental Control or UP and DOWN Control since closing the MOP Increase input will cause the frequency reference to increase and closing the MOP Decrease input will cause the frequency reference to decrease.

If both the MOP Increase and the MOP Decrease are closed or open simultaneously, the speed will command will not change. The frequency reference will change at the active acceleration or deceleration rate.

MOP Increase cannot be programmed without also programming the MOP Decrease (or vice-versa) else an OPE03 fault will occur. Setting the MOP Increase/Decrease function while the Acc/Dec Ramp Hold function is programmed into other digital inputs will also cause an OPE03 fault.

Once the MOP function is programmed the preset speeds are disabled and the analog frequency reference input becomes a potential frequency reference lower limit. The lower limit of the MOP function is the greater of the analog frequency reference and the programmed frequency reference lower limit (d2-03). Once a Run command is issued the Drive will accelerate immediately to the lower limit. The upper limit will be the Frequency Reference Upper Limit (d2-01), if used, otherwise it will be the maximum output frequency (E1-04).

The status of the d4-01 parameter (MOP Reference Memory) will affect the performance of the Drive after power is cycled to the Drive and a fresh Run command is issued. If d4-01= "0: Disabled", the Run command will cause the Drive to ramp to the frequency reference lower limit. However, if d4-01= "1: Enabled", the Run command will cause the Drive to ramp to the last frequency referenced by the MOP function before the Run command was removed and the power cycled. Even if d4-01= "1: Enabled", the previous frequency reference can be reset to the frequency reference lower limit automatically by closing either the UP or Down input without having a Run command active.

**IMPORTANT**

Be sure to set b1-01= "1: Terminals", (frequency reference Source =Terminals) if the MOP function is to be used. If b1-01= "0: Operator", then the MOP is disabled even if it is programmed. The Jog inputs have priority over the MOP function.

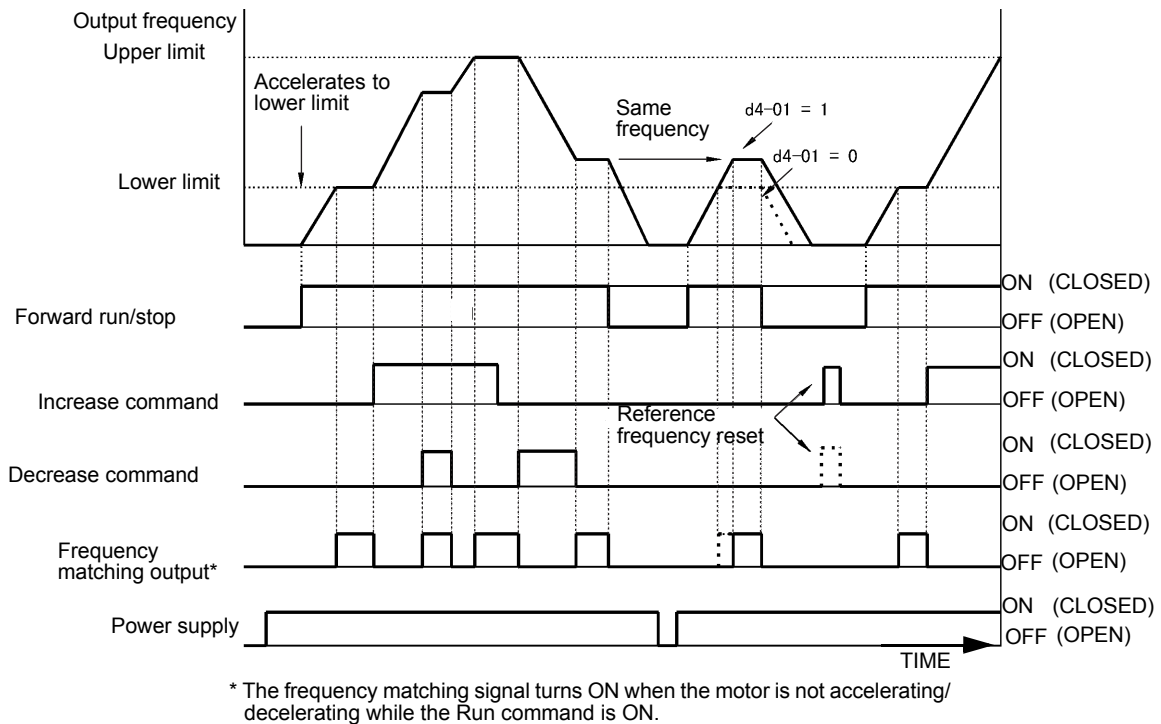


Fig. 48 Floating Point Control Time Chart

**Function: Forward Jog**

**Setting: 12**

**Function: Reverse Jog**

**Setting: 13**

Digital inputs programmed as Forward Jog (H1-0x= 12) and Reverse Jog (H1-0x= 13) will be Jog inputs that do not require a Run command. Closing the Forward Jog input will cause the Drive to ramp to the Jog Frequency Reference (d1-17) in the Fwd direction. The Reverse Jog will cause the same action in the Rev direction. The Forward Jog and Reverse Jog can be set independently.

The Forward and Reverse Jog inputs will have priority over other frequency references but the Reverse Jog input will not function if Reverse Operation is disabled (b1-04= "1: Reverse Disabled").

If both the Forward Jog and Reverse Jog are input simultaneously for 500 ms or more an external fault will occur and the Drive will stop, using the method set by b1-03.

**Function: Fault Reset**

**Setting: 14**

Whenever the Drive detects a fault condition, the fault output contact will close and the Drive's output will shut OFF causing the motor to coast (specific stopping methods can be selected for some faults such as L1-04 for motor overheat). Once the Run command is removed, the fault can be reset by either the RESET key on the digital operator or by closing a digital input configured as a Fault Reset (H1-0x= 14).

**Function: Fast Stop N.O.**

**Setting: 15**

The Fast Stop function operates much like an emergency stop input to the drive. While in the Run mode, if a Fast Stop is input to the Drive (CLOSED for H1-0x= 15 or OPEN for H1-0x= 17), the Drive will decelerate to a stop with the deceleration time determined by C1-09 (Fast Stop Time). The Run command can remain closed during the Fast Stop operation. The Drive will not run, from either the terminals or the digital operator, while the Fast Stop is being input to the Drive. To restart the Drive, the Fast Stop input must be removed and the Run command must be cycled.

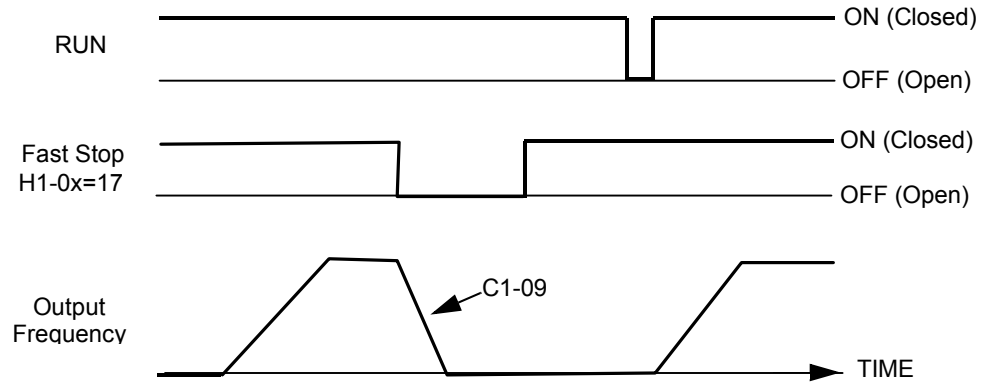


Fig. 49 Fast Stop Commands Time Chart

**IMPORTANT**

Be aware that during rapid deceleration the Drive may fault on an over voltage condition. When faulted, the Drive output shuts off allowing the motor to coast. The result is an uncontrolled motor state. Therefore, be sure to set an acceptable deceleration time in parameter C1-09 when using the fast stop feature.

**Function: Motor 2 Selection**

**Setting: 16**

The Drive has the capability to control 2 different motors independently. Motor 2 may be selected by closing the multi-function contact input programmed for motor 2 selection (H1-0x = 16). When motor 2 is selected E3 and E4 parameters set the V/f pattern, control method, and motor specifications.

**Function: Fast Stop N.C.**

**Setting: 17**

See setting 15 for details.

**Function: Timer Function**

**Setting: 18**

The Timer Function works independently from the Drive. For Timer operation a digital input must be configured for a Timer Function start (H1-0x= 18), a digital output must be configured as a Timer Function output (H2-0x= 12), and the Timer Function ON-Delay and OFF-Delay parameters (b4-01 and b4-02, respectively) must be programmed.

Once the applicable parameter are programmed the Timer Function start digital input must be closed at least as long as the setting of b4-01 before the Timer Function output will close. The Timer Function input must be open for at least as long as the setting of b4-02 before the Timer Function output will re-open.

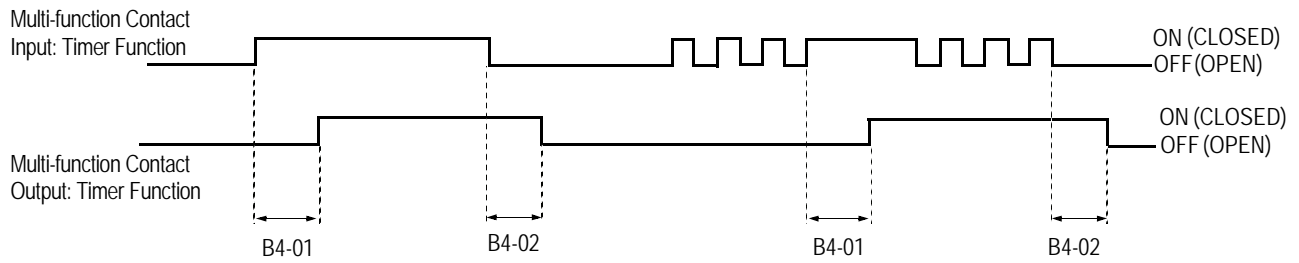


Fig. 50 Timer Function Time Chart

**Function: PID Disable**

**Setting: 19**

When the PID Function has been enabled by b5-01 (PID Mode Selection), it can be indefinitely disabled by closing a digital input configured as a PID Disable input (H1-0x= 19). When disabled, the Drive operates as a standard drive that does not have PID enabled

**Function: Multi-Acceleration/Deceleration 2**

**Setting: 1A**

See setting 7 for details.

**Function: Program Lockout**

**Setting: 1B**

A Program Lockout digital input will allow changing of parameter values when the input is closed but prevent changing of any Drive parameter value except the frequency reference when it is open. Parameter values can be viewed even when a Program Lockout is active.

**Function: Trim Control Increase**

**Setting: 1C**

**Function: Trim Control Decrease**

**Setting: 1D**

The Trim Control Increase and Trim Control Decrease must be used together and cannot be set independently. An OPE03 fault will occur if one is configured without the other. Once both are configured they can be used to trim the frequency reference by adding or subtracting a set frequency (d4-02) from the currently commanded speed. Once the input is cleared the frequency reference will return to the pre-Trim Control level. Refer to parameter d4-02.

The Trim Control Function is not effective when the frequency reference is coming from the digital operator.

**Function: Reference Sample Hold**

**Setting: 1E**

The Ref Sample Hold function will allow the user to sample an analog signal being input to A1, A2, or A3 and change the frequency reference to the sampled level. Once the digital input that is configured for the Ref Sample Hold function (H1-0x= 1E) is held for at least 100 ms, the Drive reads the analog input and changes the frequency reference to the newly sampled speed. If the digital input is not held for at least 100 ms, the analog input will not be sampled.

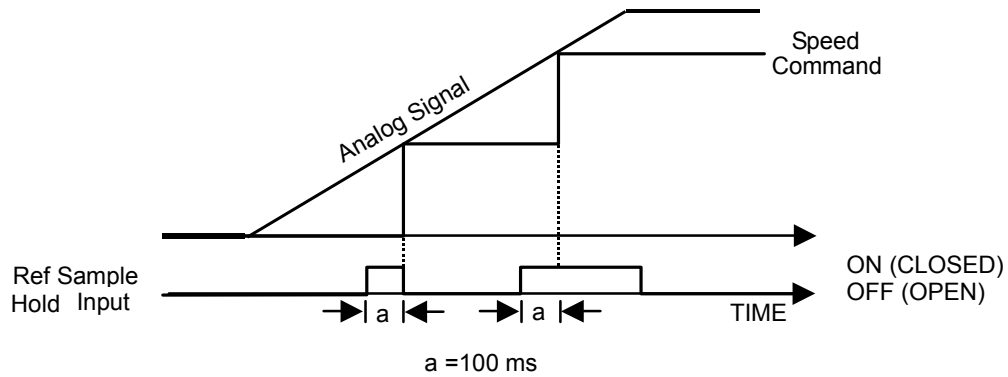


Fig. 51 Reference Sample Hold Time Chart

The Ref Sample Hold function cannot be programmed at the same time as the following digital input functions:

- Acc/Dec Ramp Hold
- MOP Increase/Decrease
- Trim Control Increase/Decrease

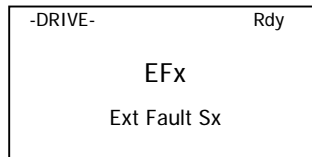
Doing so will cause an OPE03 fault to occur.

Cycling the input power will erase the sampled analog reference and the frequency reference will begin again from zero.

**Function: External Fault**

**Setting: 20 through 2F**

External Fault functionality can be programmed into the digital inputs of the Drive. The External Fault inputs can be used to signal to the Drive that other equipment related to the operation of the Drive has experienced problems. If the External Fault is input to the Drive the digital operator will display:



with the x in EFx and Sx represent the terminal number of the digital input that the fault was received on.

To program an External Fault the value input into the H1-0x parameter will be determined by:

- Contact type wired to the terminal (Normally Open or Normally Closed)
- Detection profile (Always Detected or Only Detected while Running)
- Drive operation after fault (stopping Method or Continue Operation)

The following table shows the programming choices.

Table 16 Programming Choices								
Set Value	Input Contact Type		Detection Mode		stopping Method			
	N.O. contact	N.C. contact	Always Detected	Detected while Running	Decel to stop (major fault)	Coast to stop (major fault)	Fast stop (major fault)	Continue operation (minor fault)
20	X		X		X			
21		X	X		X			
22	X			X	X			
23		X		X	X			
24	X		X			X		
25		X	X			X		
26	X			X		X		
27		X		X		X		
28	X		X				X	
29		X	X				X	
2A	X			X			X	
2B		X		X			X	
2C	X		X					X
2D		X	X					X
2E	X			X				X
2F		X		X				X

**Function: PID Integral Reset**

**Setting: 30**

By configuring one of the digital inputs as an Integral Reset Input, (H1-0x= 30), the value of the integral component of PID control can be reset to zero whenever the configured input is CLOSED. The integral component of PID control will be held at zero as long as the configured digital input is held CLOSED.

Resetting the Integral component of PID control can be useful in cases where an excessively large Integral value prevents the PID control from responding quickly to changes in the system being regulated by the Drive (e.g. duct pressure, water temperature).

**Function: PID Integral Hold**

**Setting: 31**

By configuring a digital input as an Integral Hold input (H1-0X= 31), the value of the Integral component of the PID control can be forced to clamp at the value it was at when the input is CLOSED. The Integral component of the PID control returns to accumulating the error when the digital input is OPEN again.

Holding the Integral Value can be useful during periods when the error can build up naturally, such as during long accelerations. Not allowing Integral wind-up produces a more stable PID control.

**Function: Multi-step Reference 4**

**Setting: 32**

See setting 3, 4, and 5 for description.

**Function: PID SFS Cancel**

**Setting: 34**

SFS means softstart, also referred to as accel/decel in this description.

By configuring a digital input as a PID SFS (softstart) Cancel input (H1-0x= 34), the operator will be able to use a contact closure to remove the acceleration and deceleration times that are applied to changes in the PID setpoint by the b5-17 parameter. If the digital input configured as PID SFS Cancel is closed, the PID setpoint Accel/Decel (Parameter b5-17) will be ignored. Immediate updating of any change to the setpoint will apply.

**Function: Input Level Selection**

**Setting: 35**

When using the PID Function built into the Drive, the chosen set point is compared with the measured feedback. The difference is called the Error. The proportional and integral function are applied to this error. For some applications it may be appropriate to invert the input to the PID block. This can be accomplished by setting one of the digital inputs up as an Input Level Sel (H1-0x=35). When an Input Level Sel digital input is closed the Error will be inverted before it is passed to the PID block.

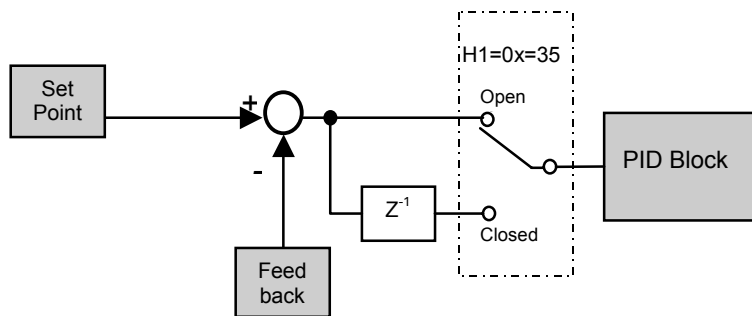


Fig. 52 PID Error signal Inversion Block Diagram

**Function: DC Injection Braking**

**Setting: 60**

When a DC injection braking command is input while the Drive is stopped, DC injection braking operation is activated. When a run command or a jog command is input, DC injection braking is released to start operation (jog operation has priority).

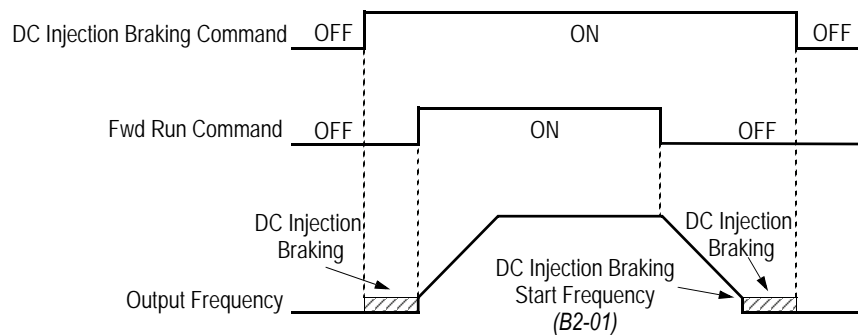


Fig. 53 DC Injection Braking Input Timing Diagram

**Function: Speed Search 1**

**Setting: 61**

**Function: Speed Search 2**

**Setting: 62**

Setting of b3-01	Speed Search Method Used for Multi-function inputs
0	Speed Estimation
1	
2	Current Detection
3	

The Speed Search function can be turned on for all starts with parameter b3-01. If, however, it is beneficial to only use Speed Search at certain starts, a digital input can be programmed to turn on Speed Search only when it is closed.

Speed Search 1 will start searching for the rotor speed from the maximum frequency (E1-04). Speed Search 2 will begin searching for the rotor speed from the existing frequency reference. Speed Search 3 will cause the motor to baseblock when the switch is open and then perform Speed Search when it closes.

In all cases the form of Speed Search, Speed Estimation or Current Detection, is determined by the setting of b3-01. If b3-01= "0: SpdsrchF Disable", then the Speed Estimation form of Speed Search is used. If b3-01= "2: SpdsrchI Disable", then the Current Detection form of Speed Search is used.

**Function: Field Weakening Command**

**Setting: 63**

When the Field Weakening Command is closed (H1-0x = 63) the Drive's output voltage level is reduced to the level set in parameter d6-01 at the output frequency set in d6-02. Field Weakening Command can only be in V/f control methods (A1-02 = 0 or 1).

**Function: Speed Search 3**

**Setting: 64**

See setting 61 and 62 for details.

**Function: KEB Ridethru N.C.**

**Setting: 65**

**Function: KEB Ridethru N.O.**

**Setting: 66**

The Kinetic Energy Braking (KEB) control circuit attempts to maintain the DC bus voltage at an optimum level [ $1.35 \times$  input voltage (E1-01)] during momentary power loss, by using load inertia to regenerate voltage back to the DC bus. The Drive decelerates at the fast-stop rate (C1-09), until power is restored, or until the time runs out and an undervoltage fault (UV) occurs. The larger the inertia, the longer the deceleration rate can be extended. If the inertia is small, then the Drive must decelerate quickly to regenerate voltage back to the DC bus, and thus the ride-through time is shorter.

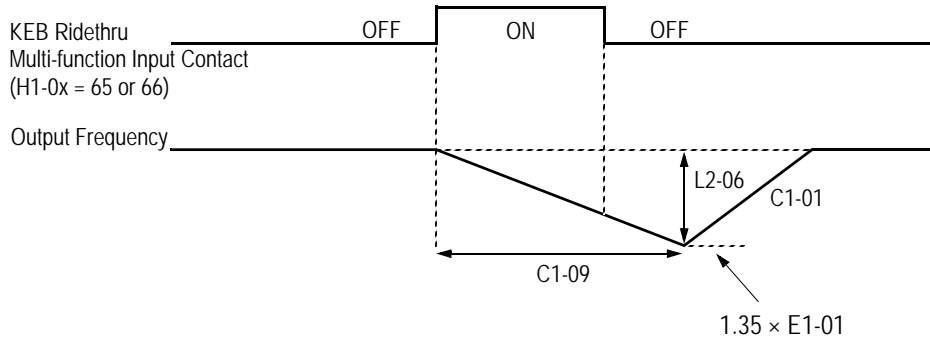


Fig. 54 KEB Ridethru Timing Diagram

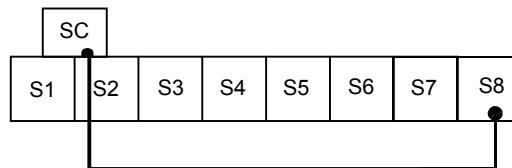
Note: Larger model inverters (F7U2022 and above, F7U4018 and above) require a separate uninterruptible power supply (UPS) for control power, in order for load inertia ridethru to be effective.

**Function: Communication Test Mode**  
**Setting: 67**

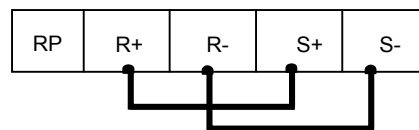
The Drive has a built-in function for self-diagnosing the serial communications operation. The test involves wiring the send and receive terminals of the RS-485/422 port together. The Drive transmits data and then confirms the communications are received normally.

In order to perform the serial communications self-diagnosis, terminal S7 must be programmed as the Comm Test Mode digital input (H1-05= "67: Com Test Mode") and then power removed from the Drive and the following steps performed:

1. Wire the S7 and SC terminals of the control circuit terminals together



2. Wire the R+ and S+ terminals of the RS-485/422 port together
3. Wire the R- and S- terminals of the RS-485/422 port together



4. Turn On the terminating resistance (Move Switch 1 of Dip Switch 1 to the ON position).

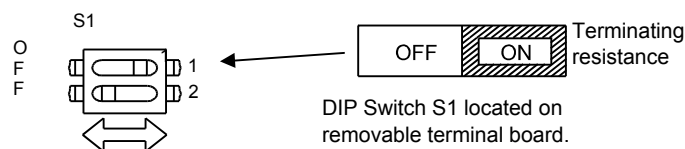


Fig. 55 DIP Switch Setting for Terminating Resistor  
 Programming 84

5. Turn on power to the Drive.

After step 5 above the Drive will either display “Pass” if everything is okay or a CE alarm will be displayed. If the CE alarm occurs, the fault output contact will energize.

**Function: High Slip Braking**

**Setting: 68**

A digital input can be configured as a High Slip Braking (HSB) command (H1-0x= 68). The HSB feature is intended to be used in applications where the load is high inertia and actual stopping time is not critical. The HSB feature does not “brake” the motor at a predetermined rate, but rather, creates a braking effect based on applied voltage and frequency to the motor. The result is reduced deceleration time as compared to a coasting load, yet the actual deceleration time is unknown (trial and error basis). The HSB feature does not require braking resistors. When the High Slip Braking input is closed during Run mode, the Drive will begin the High Slip Braking function. A braking time can be achieved that is approximately 50% of the time required to decelerate the load normally even without using braking resistors. The High Slip Braking function cannot be exited until the Drive is completely stopped.

The High Slip Braking function manipulates the output frequency while monitoring the output current and DC Bus to create a large slip condition. The regenerative energy caused by the shortened stopping is changed to heat by the motor windings. The increased motor heating limits the HSB duty cycle to 5% and stopping time should be limited to 90 seconds or less.

**Function: Jog 2**

**Setting: 69**

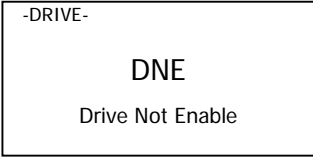
The Jog2 function applies to 3-Wire control only. If a digital input is configured as Jog2 (H1-0x= 69) when the drive is not in 3-Wire Control, an OPE03 fault will occur.

The Jog2 input will cause the Drive to ramp to the Jog Frequency Reference (d1-17) in the direction dictated by the Fwd/Rev input of the 3-Wire Control mode. Accelerating to and from the Jog Frequency Reference will be determined by the active Accel/Decel parameters.

**Function: Drive Enable**

**Setting: 6A**

A digital input configured as a Drive Enable input (H1-0x= 6A) will prevent the Drive from executing a Run command until it is closed. When the Drive Enable input is open the digital operator will display:



If a Run command is closed prior to the Drive Enable input being closed the Drive will not run until the Run command is cycled.

If the Drive Enable input is opened while the Drive is running, the Drive will stop, using the method set by parameter b1-03.

**Function: Speed / Torque Control Selection**

**Setting: 71**

This multi-function digital input is used to switch the Drive between speed control and torque control. The function is only available in flux vector control method (A2-01 = 3). Parameter D5-01 must be set to 0 and an analog input terminal (A2 or A3) must be programmed for function “13: torque reference”.

When the programmed terminal is open (off), the Drive will operate in speed control. The speed reference source is determined by parameter b1-01. The torque limit used is the smaller of the analog input limit (if an analog input is programmed for function 10, 11, 12, or 15), the torque limit parameter value (L7 group), or the absolute value of the analog input programmed for function “13: torque reference”, which acts as a 4-quadrant torque limit. There are multiple torque limits for each quadrant. If the run command is removed during speed control, the Drive will stay in speed control and stop according to parameter b1-03. For ramp to stop, the Drive will use the active torque limit as described above.

When the programmed terminal is closed (on), the Drive will operate in torque control. The torque reference will come from the analog input terminal (A2 or A3) programmed for function “13: torque reference”. The speed limit is determined by parameter d5-03. If d5-03 = 1, the speed limit used is the output of the soft starter as determined by b1-01, the analog input settings for A2 or A3, the active accel/decel time, and the s-curve settings. If d5-03 = 2, the speed limit is determined by parameter d5-04. If a stop command is received during torque control, the Drive will automatically switch to speed control and stop according to parameter b1-03. For ramp to stop, the Drive will use the active torque limit as described above.

**Function: Zero Servo Command**

**Setting: 72**

Zero-servo function provides position control capability at zero speed. When zero-servo is enabled by closing the programmed multi-function input, and the output frequency is less than the DC injection start frequency (b2-01), the shaft position is maintained by monitoring PG feedback pulses and correcting the position error. However, this function does not have the same capabilities of a position controller because there is no marker pulse feedback. Therefore, the motor will not stop in the same position every time the zero servo command is enabled.

**Function: ASR Gain Switch**

**Setting: 77**

This multi-function digital input is used to switch between ASR Gain 1 (C5-01) and ASR Gain 2 (C5-03). The function is only available in Flux Vector control method (A1-02 = 3). The ASR gain switch function has priority over the ASR switchover frequency parameter (C5-07). It will ramp from one gain to the other using the active ASR integral time. The use of the ASR gain switch allows for two different machine/motor responsiveness set-ups. This can be used for breaking loose a high friction load at start, acceleration versus constant speed, two different products running on the same machine, etc.

**Function: Polarity Reversing Command**

**Setting: 78**

This multi-function digital input is used to switch the polarity of the analog torque reference command (multi-function analog input function “13: Torque Reference / Limit”). The function is only available in Flux Vector control method (A1-02 = 3). The Drive must be in torque control by either setting D5-01 = 1 or setting D5-01 = 0 and closing the multi-function digital input function “71: Speed / Torque Changeover”. This function does not affect the signal when the Speed / Torque Changeover input is open (speed mode with the analog signal acting as a torque limit). This function is valid for either analog input terminal (A2 or A3) and any input signal level (4 to 20 mA, 0 to 10V, +/- 10V). When in torque control, the direction of the motor rotation is determined solely by the polarity of the torque reference command. This function provides for easy switching of the motor direction.

## ◆ H2 Digital Outputs

- H2-01 Terminal M1-M2 Function Selection
- H2-02 Terminal M3-M4 Function Selection
- H2-03 Terminal M5-M6 Function Selection

Setting Range: 0 to 38

Factory Default: H2-01 = “0: During Run 1”

H2-02 = “1: Zero Speed”

H2-03 = “2: Fref/Set Agree 1”

The Drive has two multi-function outputs. By programming parameters H2-01 and H2-02, the user can assign specific functions to each output. Below is a table with a complete list of all of the digital output functions. Following the table is a more detailed description of each of the functions.

Parameter Setting	Function	Control Method (A1-02)			
		V/f	V/f with PG	Open Loop Vector	Flux Vector
0	During Run 1 ( <i>factory default, H2-01</i> )	0	0	0	0
1	Zero Speed ( <i>factory default, H2-02</i> )	0	0	0	0
2	Fref/Fout Agree 1 ( <i>factory default, H2-03</i> )	0	0	0	0
3	Fref/Set Agree 1	0	0	0	0
4	Frequency Detection 1	0	0	0	0
5	Frequency Detection 2	0	0	0	0
6	Inverter Ready	0	0	0	0
7	DC Bus Undervoltage	0	0	0	0
8	Base Block 1 N.O.	0	0	0	0
9	Operator Reference	0	0	0	0
A	Local/Remote Operation	0	0	0	0
B	Torque Detection 1 N.O.	0	0	0	0
C	Loss of Reference	0	0	0	0
D	Braking Resistor Fault	0	0	0	0
E	Fault	0	0	0	0
F	Not Used	0	0	0	0
10	Alarm	0	0	0	0
11	Reset Command Active	0	0	0	0
12	Timer Output	0	0	0	0
13	Fref/Fout Agree 2	0	0	0	0
14	Fref/Set Agree 2	0	0	0	0
15	Frequency Detection 3	0	0	0	0
16	Frequency Detection 4	0	0	0	0
17	Torque Detection 1 N.C.	0	0	0	0
18	Torque Detection 2 N.O.	0	0	0	0
19	Torque Detection 2 N.C.	0	0	0	0
1A	Reverse Direction	0	0	0	0
1B	Baseblock 2 N.C.	0	0	0	0
1C	Motor 2 Selection	0	0	0	0

Table 18 Digital Output Functions (Continued)						
Parameter Setting	Function	Control Method (A1-02)				
		V/f	V/f with PG	Open Loop Vector	Flux Vector	
1D	Regenerating	X	X	X	O	
1E	Restart Enabled	O	O	O	O	
1F	Overload (OL1)	O	O	O	O	
20	OH Alarm	O	O	O	O	
30	During Torque Limit (when in speed control)	X	X	O	O	
31	During Speed Limit	X	X	X	O	
32	During Speed Limit (when in torque control)	X	X	X	O	
33	Zero Servo Complete	X	X	X	O	
37	During Run 2	O	O	O	O	
38	Drive Enable	O	O	O	O	

**Function: During Run 1**

**Setting: 0**

A During Run 1 output will close whenever the Run command is provided and the Drive is outputting voltage. This includes deceleration and DC Injection.

**Function: Zero Speed**

**Setting: 1**

The “Zero Speed” output will close whenever the output frequency falls below the Minimum Frequency (E1-09).

**Function: Fref/Fout Agree 1**

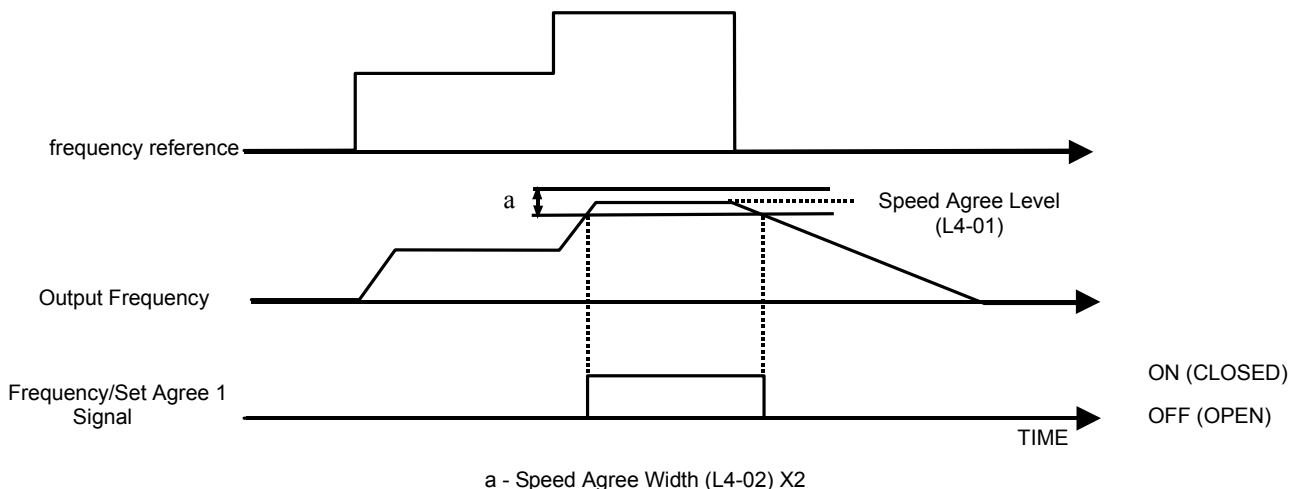
**Setting: 2**

The “Fref/Fout Agree 1” output will close whenever the actual output frequency is within the Speed Agree Width (L4-02) of the current frequency reference regardless of the direction.

**Function: Fref/Set Agree 1**

**Setting: 3**

The “Fref/Set Agree 1” output will close whenever the actual output frequency and the frequency reference are within the Speed Agree Width (L4-02) of the programmed Speed Agree Level (L4-01).



a - Speed Agree Width (L4-02) X2  
 Fig. 56 Fref/Set Agree 1 Timing Diagram  
 Programming 88

**Function: Frequency Detect 1**

**Setting: 4**

A “Freq Detect 1” output will be closed whenever the output frequency is equal to or below the value of the programmed Speed Agree Level (L4-01). The Speed Agree Width (L4-02) is the hysteresis to the Freq Detect 1 function. Whenever the output frequency approaches the Speed Agree Level while accelerating it will need to be equal to or exceed the Speed Agree Level (L4-01) plus the Speed Agree Width (L4-02) before the Freq Detect 1 output will energize.

As the output frequency approaches the Speed Agree Level while decelerating, the Freq Detect 1 output will de-energize exactly at the Speed Agree Level.

The Freq Detect 1 function is effective during both forward and reverse operation.

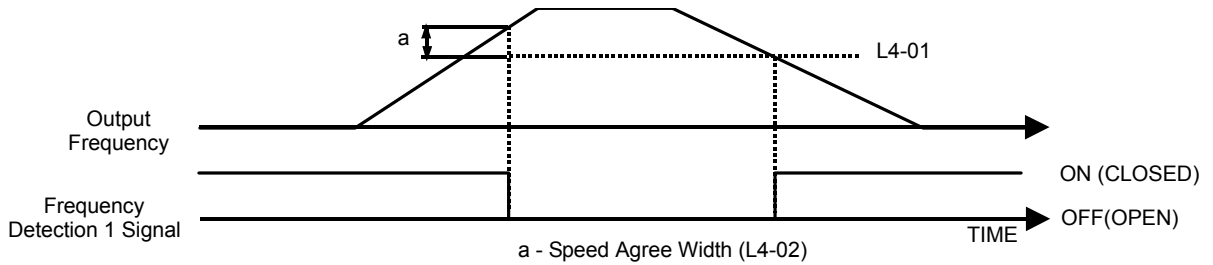


Fig. 57 Freq Detect 1 Timing Diagram

**Function: Frequency Detect 2**

**Setting: 5**

A Freq Detect 2 output will be closed whenever the output frequency is equal to or above the value of the programmed Speed Agree Level (L4-01). The Speed Agree Width (L4-02) is the hysteresis to the Freq Detect 2 function. Whenever the output frequency approaches the Speed Agree Level (L4-01) while accelerating it will de-energize exactly at the Speed Agree Level.

As the output frequency approaches the Speed Agree Level while decelerating, the Freq Detect 2 output will de-energize when the output frequency is equal to or below the Speed Agree Level (L4-01) minus the Speed Agree Width (L4-02).

The Freq Detect 2 function is effective during both forward and reverse operation.

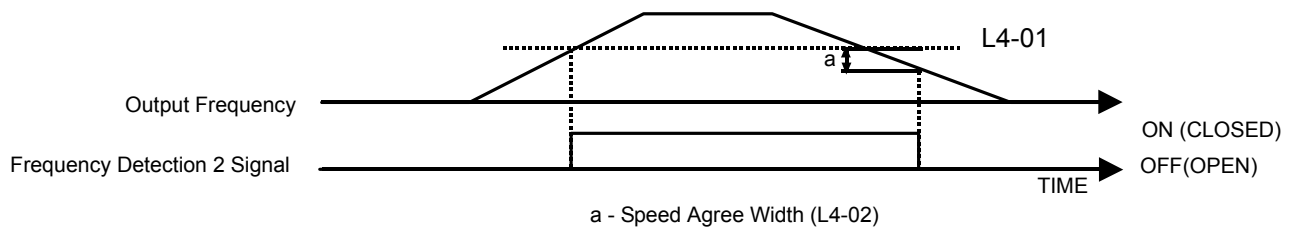


Fig. 58 Freq Detect 2 Timing Diagram

**Function: Inverter Ready**

**Setting: 6**

The Inverter Ready output will be closed whenever the Drive is not in a fault state and not being programmed. If b1-08 = “1: Enabled”, a Drive that is in an active Run state that is also being programmed will have the Inverter Ready output closed.

**Function: DC Bus Undervoltage**

**Setting: 7**

The DC Bus Undervoltage output will close whenever the main circuit DC Bus voltage or control circuit power supply drop below their respective trip level. The undervoltage trip level is determined by parameter L2-05. An open soft charge contactor answer back signal will also cause the DC Bus Undervoltage output to close.

**Function: Base Block 1 N.O.**

**Setting: 8**

A BaseBlk 1 programmed output will close to indicate that the Drive is in baseblocked state. While in a baseblock state the Drive’s output transistors are prevented from firing. A BaseBlk 1 output contact can also serve as notice that the Drive has a charged DC Bus, no fault and can start at any time.

**Function: Operator Reference**

**Setting: 9**

When an output is configured as an Operator Reference output, the output will close to show that the frequency reference is being sourced from the digital operator. If the Operator Reference output is open, it indicates the frequency reference is coming from the control circuit terminals or an optional communications card.

**Function: Local/Remote Operation**

**Setting: A**

When an output is configured as a Local/Remote Operation output, the output will close to show that the Run command is being sourced from the digital operator. If the Local/Remote Operation output is open, it indicates the Run command is coming from the control circuit terminals or an optional communications board.

**Function: Torque Detection 1 N.O.**

**Setting: B**

The Torque Detection 1 function ties a digital output to the overtorque/undertorque sensing capabilities of the Drive. If a digital output is configured as Torque Detection 1 N.O., whenever the output current differs from the level of L6-02 for at least the length of time set in L6-03, the digital output will close.

The torque detection function has a built-in hysteresis of 10% of the Drive rated output current.

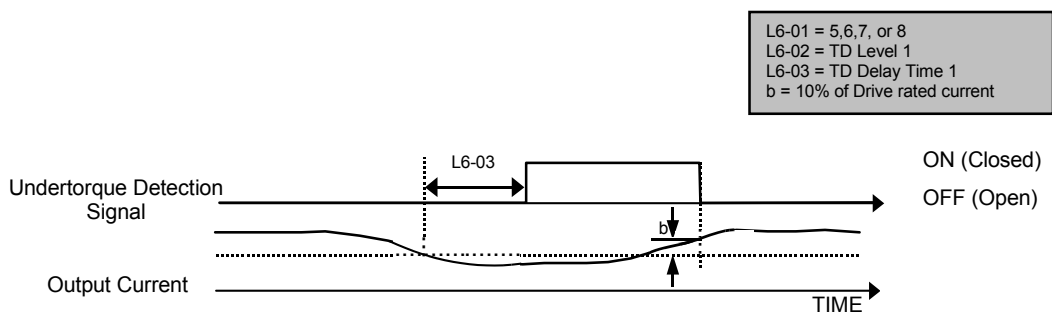


Fig. 59 Torque Detection 1 N.O. Timing Diagram

**Function: Loss of Reference**

**Setting: C**

The Loss of Reference configured digital output will close when the Drive has detected a loss of the analog frequency reference.















































































































































































































