

ACCel500
SPEED/TENSION APPLICATION SOFTWARE

Part Number 695107.V13

AVTRON INDUSTRIAL AUTOMATION, INC.
Cleveland, Ohio

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**AVTRON ACCEL500
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SECTION I

INTRODUCTION AND GENERAL INFORMATION

The ACCel500 Speed/Tension software is the standard application used by Avtron for most applications. It offers the most configuration options and adapts to almost any process. If a custom package is not requested, the drive will be shipped with this software loaded and ready to go.

Following is a list of the major software features.

Communications options:

- Ethernet (Modbus TCP, Ethernet IP, EGD)
- Devicenet
- Profibus DP
- Modbus
- System Bus (Fiber)

Reference location options:

- Fixed value
- Analog input
- Digital Increase/Decrease
- Communications
- Frequency

Speed reference features:

- Run, Thread, Jog Forward, Jog Reverse logic
- Reverse command
- Ramp with programmable rates and S-curves
- Ramp hold
- Master/Slave
- Ratio/Difference draw control
- Skip frequencies
- Speed step input

Speed loop:

- PI regulator
- Inertia compensation
- Current limit control
- Non-linear gains

Outer loop (Tension loop):

- Running/Stall tension ramping
- Bumpless transition in and out of control
- Tension loss and over tension protection
- Dancer slack control
- Output as speed trim, analog output or torque control

Spare operation blocks:

- Variety of logic blocks including , Ands, Ors, Inverts, and latches
- Comparitors
- Non-linear table functions
- Switches
- Gains

Firmware Options enabled

- Start Wizard
- Identification (Motor and torque loop tuning)
- Motor control
 - Volt/Hertz
 - Open loop vector
 - Closed loop vector
- Induction/Permanent magnet motors
- Extended speed range to 320 Hz
- Non-linear gains for extended speed range
- Fault FIFO
- Signal analyzer with trigger

SECTION II

SELECTING THE CONTROL MODE

The drive can be commanded to run from three distinct locations:

- Remote (from I/O or communications)
- Local drive keypad
- Computer diagnostic software

The drive out of the box is defaulted to the local mode. When the mode is changed, it is stored even through power failure (retentive).

The drive is set up so control location can not be switched while the drive is running (*MC Run* is TRUE).

2-1 REMOTE OPERATION

To transfer to remote operation, press the **loc/rem** button on the keypad while the drive is not running. The remote green LED should be on and the display should have the message “I/O term” displayed. If the **loc/rem** button is pressed while running in remote mode, the display will flash “Locked while RUNNING”.

Pressing the **start** button on the keypad will display a message “Keypad Control NOT ACTIVE”

Control Place = 0 in this mode.

For speed/tension software, the first digital input is defaulted for RUN command and *Run Stpt* is the speed reference.

2-2 LOCAL DRIVE KEYPAD

To transfer to local operation, press the **loc/rem** button on the keypad while the drive is not running. The local green LED should be on and the display should have the message “Keypad” displayed.

If the **loc/rem** button is pressed while running in local mode the display will flash “Locked while RUNNING”.

The **start/stop** buttons will now work and the drive will run at the entered keypad reference setpoint.

Set the keypad control parameters (Keypad Speed Direction, Keypad Speed Reference, Keypad Torque Direction, and Keypad Torque Reference) using menu M3 (Keypad Control).

If keypad communications goes down while in the local mode, the drive will fault (Keypad Comm).

Control Place = 1 in this mode.

2-3 PC CONTROL (COMPUTER DIAGNOSTIC SOFTWARE ADDaptACC)

The drive must be off before the PC Control check box from the diagnostic software is checked to go into computer control. If the box is checked while running, control will not be transferred until the run is removed and the box is re-checked.

While in computer control, both the local and remote LEDs will flash along with the two display messages.

If computer communications goes down while in PC control, the drive will fault (Keypad Comm). When the fault is reset, control will revert to the previous control mode (local or remote).

Once in computer control, the drive can be started/stopped by the control buttons.

Control Place = 2 in this mode.

SECTION III

KEYPAD AND PARAMETER DESCRIPTIONS

3-1 ACCel500 KEYPAD OPERATION

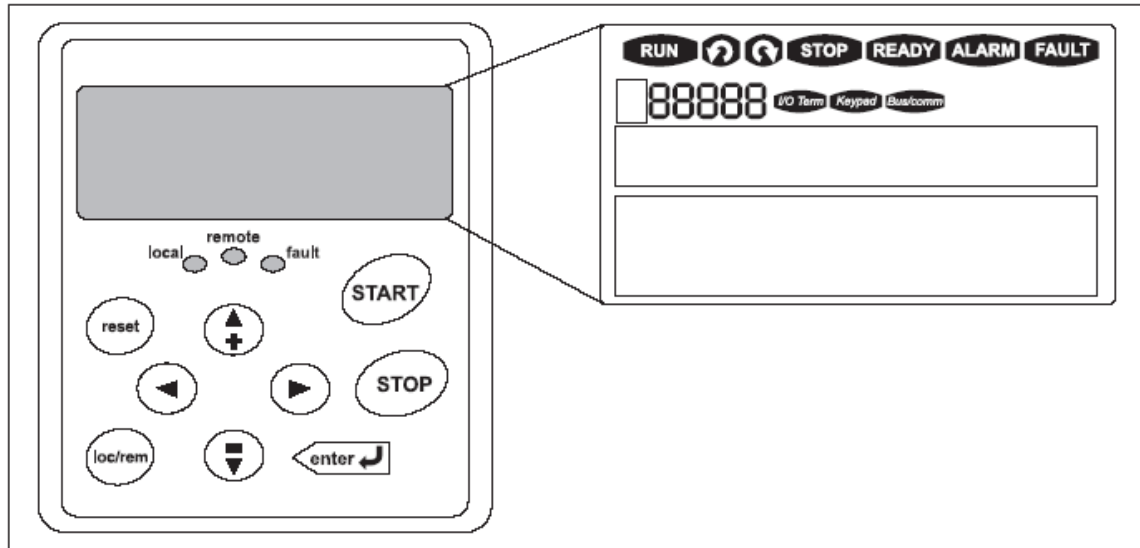


Figure 3-1. Keypad and Display

TABLE 3-1. NAVIGATION BUTTONS


















Button	Description
	<p>Start This button operates as the START button for normal operation when “local” is selected as the active control.</p>
	<p>Enter This button is used in the parameter edit mode to save the parameter setting and move to the next parameter ...</p> <ul style="list-style-type: none"> • to reset the Fault History if pressed while in the “Fault History” menu. • to confirm the acceptance of a change. • to change a virtual button status while in the “Button” menu. • to confirm the start-up list at the end of the Start-Up Wizard. • when the “Operate” menu is active, to exit the “Operate” submenu.
	<p>Stop This button has two integrated operations. The button operates as STOP button during normal (local) operation ...</p> <ul style="list-style-type: none"> • motor STOP from the keypad • used to reset the active faults. <p>Note that if the STOP button is depressed for 3 seconds, a Stop Fault will occur in any control mode.</p>
	<p>Reset Resets the active faults.</p>
	<p>Local/Remote Switches between LOCAL and REMOTE control for start, speed reference and reverse functions.</p>
	<p>Left Arrow</p> <ul style="list-style-type: none"> • navigation button, movement to left. • in parameter edit mode, exits mode, backs up one step. • cancels edited parameter (exit from a parameter edit mode). • When in “Operate” menu, will move backward through menu. • At end of “Start-Up Wizard”, repeats the “Start-Up Wizard” setup menu.
	<p>Right Arrow</p> <ul style="list-style-type: none"> • navigation button, movement to right. • enter parameter group mode. • enter parameter mode from group mode.
	<p>Up and Down Arrows</p> <ul style="list-style-type: none"> • move either up or down a menu list to select the desired menu item. • editing a parameter/password, while the active digit/character is scrolled. • increase/decrease the reference value of the selected parameter. • in the “Operate” menu, will cause the display of the current reference source and value and allow its change if the keypad is the active reference source. Used to set the password (if defined) when leaving the “Operate” menu. • scroll through the “Active Faults” menu when the ACCel500 is stopped.

TABLE 3-2. LCD STATUS INDICATORS

Indicator	Description
	Run Indicates that the ACCe500 is running and controlling the load. Blinks when a stop command has been given but the ACCe500 is still ramping down.
	Counterclockwise Operation The output phase rotation is BAC, corresponding to counterclockwise rotation of most motors.
	Clockwise Operation The output phase rotation is ABC, corresponding to clockwise rotation of most motors.
	Stop Indicates that the ACCe500 is stopped and not controlling the load.
	Ready Indicates that the ACCe500 is ready to be started.
	Alarm Indicates that there is one or more active drive alarm(s).
	Fault Indicates that there is one or more active drive fault(s).
	I/O Terminal* Indicates that the I/O terminals have been chosen for control (remote).
	Keypad* Indicates that the keypad has been chosen for control (local).

*Both "I/O Terminal" and "Keypad" will be on and flashing when ADDaptACC is chosen for control.

TABLE 3-3. LED STATUS INDICATORS

Indicator	Description
local	Local* Indicates that the ACCe500 is ready to be started and operated from the Local mode.
remote	Remote* Indicates that the ACCe500 is operating and controlling the load remotely.
fault	Fault Indicates that there are one or more active drive fault(s).

*Both "local" and "remote" will be flashing when ADDaptACC is chosen for control.

3-2 MENU NAVIGATION

3-2.1 NAVIGATION TIPS

- To navigate within one level of a menu, use the up and down arrows.
- To move deeper into the menu structure and back out, use the right and left arrows.
- To edit a parameter, navigate to show that parameter's value, and press the right arrow button to enter the edit mode. When in edit mode, the parameter value will flash.

- When in edit mode, the parameter value can be changed by pressing the up or down arrow keys.
- When in edit mode, pressing the right arrow a second time will allow you to edit the parameter value digit by digit.
- To confirm the parameter change, you must press the **enter** button. The value will not change unless the **enter** button is pushed.
- Some parameters can not be changed while the ACCe1500 drive is running. The screen will display LOCKED if you attempt to edit these parameters while the drive is running. Stop the drive to edit these parameters.
- Appendix B lists all parameters for the application in menu order.

3-2.2 MAIN MENU

The data on the control keypad are arranged in menus and submenus. The first menu level consists of M1 to M8 and is called the Main Menu. The structure of these menus and their submenus is illustrated in Figure 3-2.

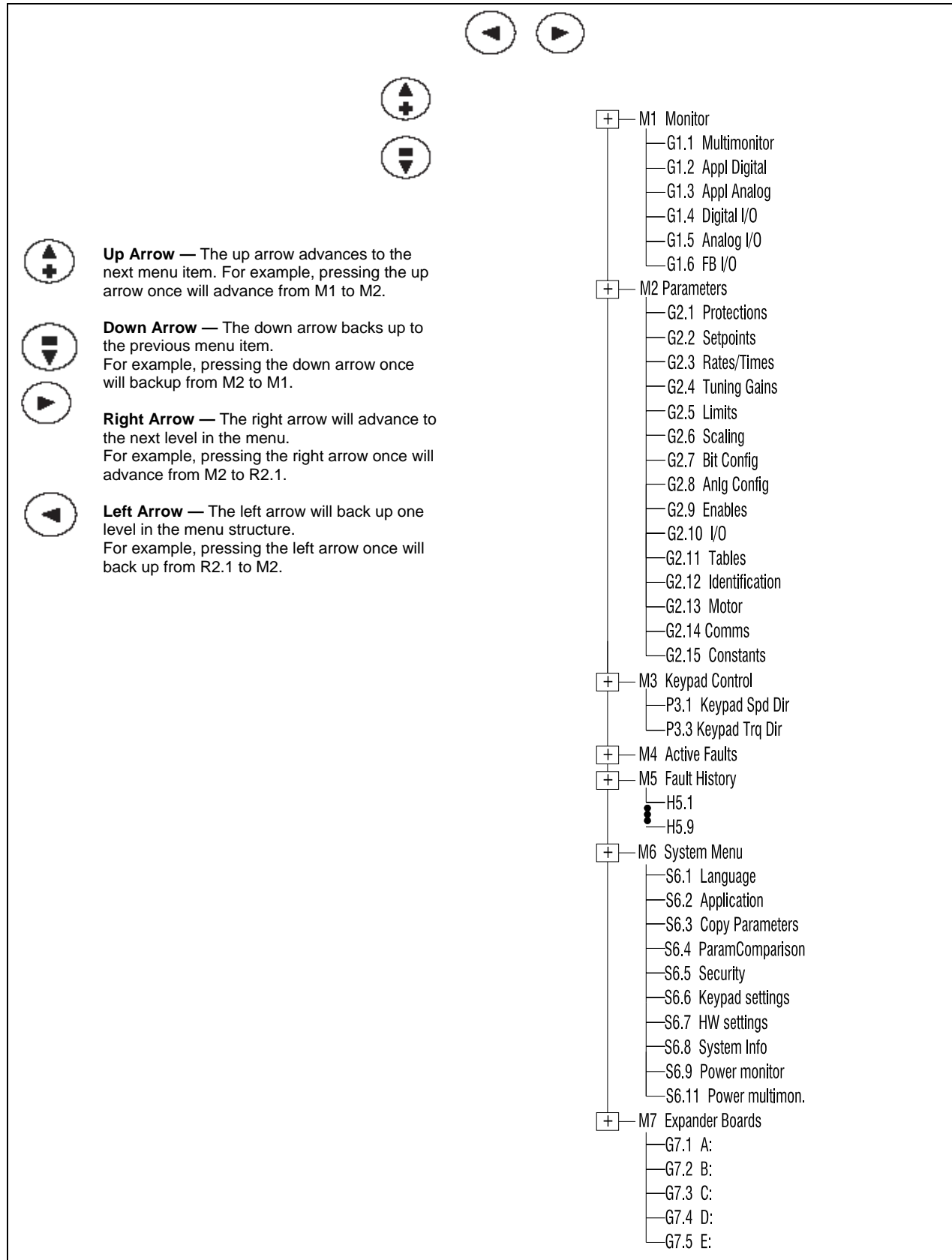


Figure 3-2. Main Menu Navigation

3-2.3 MONITOR MENU (M1)

The Monitoring Menu items are meant for viewing parameter values during operation. Monitored values are updated every 0.3 sec. Monitored items are identified by item numbers V1.1 to V1.xx, where “xx” varies by application.

Monitored parameters are not editable from this menu (See Parameter Menu [M2] to change parameter values).

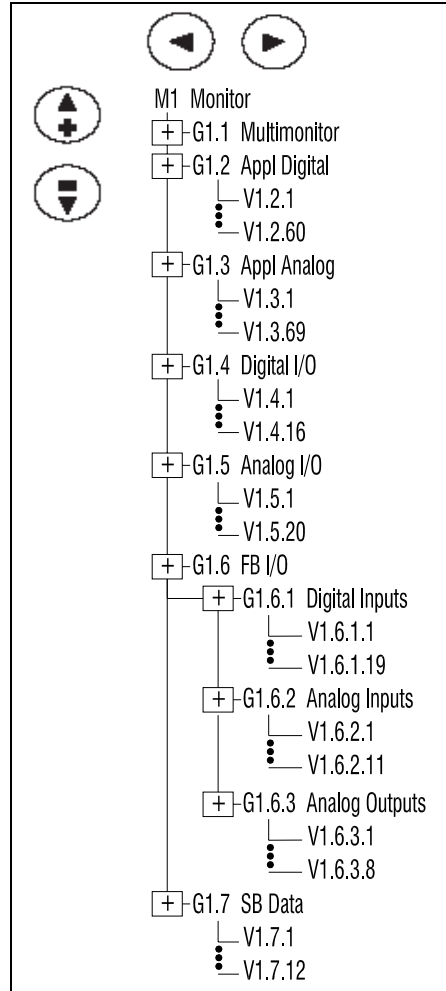


Figure 3-3. Monitor Menu Structure Example

Multimonitor (G1.1)

This parameter allows the viewing and selection (if allowed by System menu item, S6.11) of three simultaneously monitored items from the Monitored Menu Items. Use the right arrow key to select the item to be modified and then the up or down arrow keys to select the new item. Press the **enter** key to accept the change.

3-2.4 PARAMETER MENU (M2)

The Parameter Menu is a single or multi-level menu dependent upon the application in use, arranged by the parameter group items. See Figure 3-4. Parameters and parameter groups are explained in further detail in the ACCel500 Application Manual.

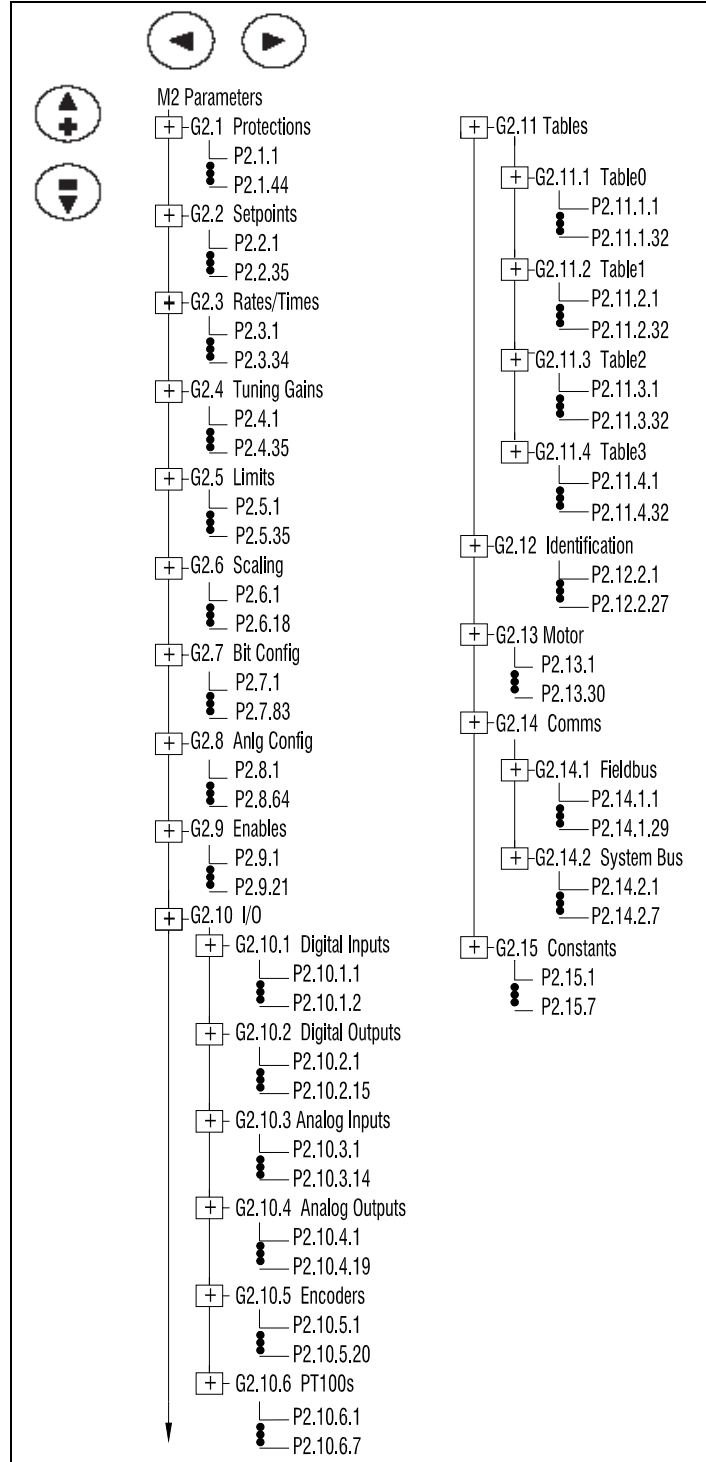


Figure 3-4. Parameter Menu

3-2.5 KEYPAD CONTROL MENU (M3)

In the Keypad Control Menu, you can set the frequency reference, choose the motor direction for keypad operation when “local” mode is in operation. See Figure 3-5.

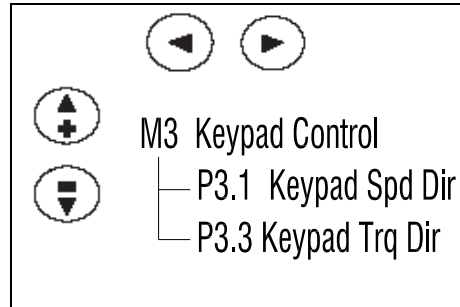


Figure 3-5. Keypad Control Menu

P3.1 Range: Forward, Reverse
Keypad Spd Dir

This allows the operator to change the rotation direction of the motor. This setting will not influence the rotation direction of the motor unless the keypad has been selected as the active control place.

P3.3 Range: Forward, Reverse
Keypad Trq Dir

3-2.6 ACTIVE FAULTS MENU (M4)

When a fault occurs, the ACCel500 drive stops. The sequence indication F1, the fault code, a short description of the fault and the fault type symbol will appear on the display. In addition, the indication FAULT or ALARM is displayed and, in case of a FAULT, the red LED on the keypad starts to blink. If several faults occur simultaneously, the sequence of active faults can be browsed with the Browser buttons. See Figure 3-6.

The active faults memory can store the maximum of 10 faults in the sequential order of appearance. The fault remains active until it is cleared with either the STOP or reset buttons or with a reset signal from the I/O terminal. Upon fault reset the display will be cleared and will return to the same state it was before the fault trip.

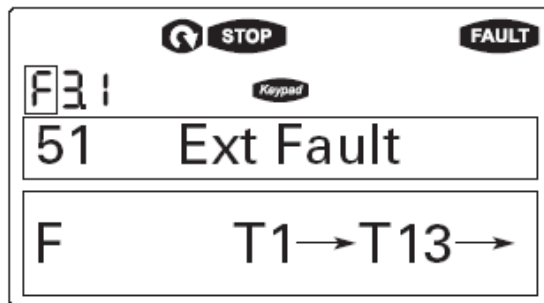


Figure 3-6. Active Fault Display Example

WARNING

Remove any External Start signals or permissives before resetting the fault to prevent an unintentional restart of the ACCel500, which could result in personal injury or equipment damage.

Fault Type Range: A, F, AR, FT
There are four different types of faults. See Table 3-4.

TABLE 3-4. FAULT TYPES

Fault Type	Fault Name	Description
A	Alarm	This type of fault is a sign of an unusual operating condition. It does not cause the drive to stop, nor does it require any special actions. The “A fault” remains in the display for about 30 seconds.
F	Fault	An “F fault” is a kind of fault that makes the drive stop. Actions need to be taken in order to restart the drive.
AR	Auto-Restart Fault	If an “AR fault” occurs the drive will also stop immediately. The fault is reset automatically and the drive tries to restart the motor. If the restart is not successful, a fault trip (FT) occurs.
FT	Fault Trip	If the drive is unable to restart the motor after an AR fault, an FT fault occurs. The effect of the “FT fault” is the same as that of the F fault — the drive is stopped.

Fault Code Range: 1 – 54
Fault codes indicate the cause of the fault. A list of fault codes, their descriptions, and possible solutions can be found in Appendix E — Application-Specific Faults.

Fault Time Range: T.1 – T.13
Data Record In this menu, important data recorded at the time the fault is available. This feature is intended to help the user or the service person to determine the cause of fault. Table 3-5 indicates the information that is recorded.

TABLE 3-5. FAULT TIME DATA

Data	Units	Description
T.1 ¹	D	Counted operation days (Fault 43: Additional code)
T.2 ¹	hh:mm:ss (d)	Counted operation hours (Fault 43: Counted operation days)
T.3	Hz hh:mm:ss	Output frequency (Fault 43: Counted operation hours)
T.4	A	Motor current
T.5	V	Motor voltage
T.6	%	Motor power
T.7	%	Motor torque
T.8	V	DC bus voltage
T.9	°C	Unit temperature
T.10	—	Run status
T.11	—	Direction
T.12	—	Warnings
T.13	—	Zero speed

¹Real time record.

3-2.7 FAULT HISTORY MENU (M5)

All faults are stored in the Fault History Menu, which can be viewed by using the Browser buttons. Additionally, the Fault time data record pages are accessible for each fault as in the Active Faults Menu described above. See Figure 3-7.

The ACCel500 drive's memory can store a maximum of 30 faults, in the order of appearance. If there are 30 uncleared faults in the memory, the next occurring fault will erase the oldest fault from the memory.

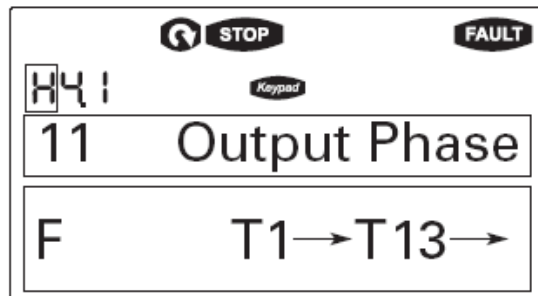


Figure 3-7. Sample Fault History Display

3-2.8 SYSTEM MENU (M6)

The controls associated with the general use of the drive, such as application selection, customized parameter sets or information about the hardware and software are located in the System Menu. Password protection can be activated by parameter P6.5.1.

Descriptions of the system menu parameters are illustrated in Figure 3-8.

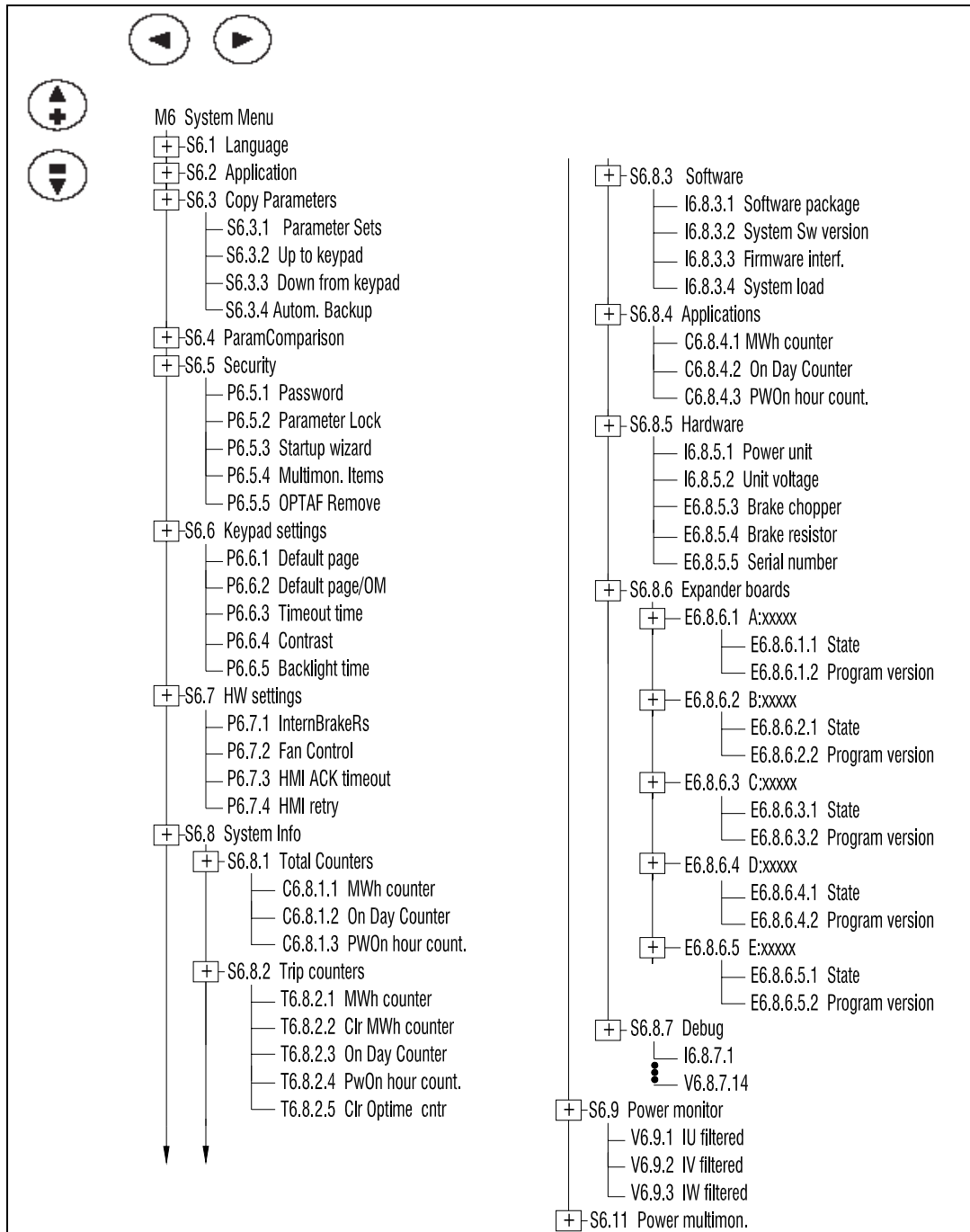


Figure 3-8. System Menu Structure

System Menu Parameters

S6.1 Range: English Default: English
Language Selection This parameter offers the ability to control the ACCE500 through the keypad in the language of your choice.

S6.2 Range: Spd /Ten
Application This parameter sets the active application. When changing applications, you will be asked if you want the parameters of the new application to be uploaded to the keypad. If you wish to load the new application parameters, push the **enter** button. Pushing any other button saves the parameters of the previously used application in the keypad.

Parameter Comparison Options (S6.4)

S6.4
Parameter Comparison With the Parameter Comparison function, you can compare the actual parameter values to the values of your customized parameter sets and those loaded to the control keypad.

The actual parameter values are first compared to those of the customized parameter Set1. If no differences are detected, a “0” is displayed on the lowermost line of the keypad.

If any of the parameter values differ from those of the Set1 parameters, the number of the deviations is displayed together with symbol P (e.g. P1 →P5 = five deviating values).

By pressing the right arrow button once again, you will see both the actual value and the value it was compared to. In this display, the value on the Description line (in the middle) is the default value, and the one on the value line (lowermost line) is the edited value. You can also edit the actual value by pushing the right arrow button.

Actual values can also be compared to Set2, Factory Settings and the Keypad Set values.

Security Parameter Options (S6.5)

The Security submenu is protected with a password. Store the password in a safe place.

S6.5.1 Range: 0 – 65535 Default: 0
Password The application selection can be protected against unauthorized changes with the Password function. When the password function is enabled, the user will be prompted to enter a password before application changes, parameter value changes, or password changes.

By default, the password function is not in use. If you want to activate the password, change the value of this parameter to any number between 1 and 65535. The password will be activated after the Timeout time (Timeout Time) has expired.

To deactivate the password, reset the parameter value to 0.

- P6.5.2** Range: ChangeEnable, ChangeDisabl Default: ChangeDisabl
Parameter Lock This function allows the user to prohibit changes to the parameters. If the parameter lock is activated, the text *locked* will appear on the display if you try to edit a parameter value.
 This function does not prevent unauthorized editing of parameter values.
- P6.5.3** Range: Yes, No Default: No
Start-up Wizard The Start-Up Wizard facilitates commissioning the ACCel500. If selected active, the Start-Up Wizard prompts the operator for the language and application desired and then advances through the start-up parameter list. After completion, it allows the user to repeat the Start-Up Wizard or return to the default page, the Operate Menu. The Start-Up Wizard is always active for the initial power up of the ACCel500.
- P6.5.4** Range: ChangeEnable, ChangeDisabl Default: ChangeEnable
Multimon. Items The keypad display can display three actual monitored values at the same time. This parameter determines if the operator is allowed to replace the values being monitored with other values.

Keypad Settings (S6.6)

There are five parameters (Default Page to Backlight Time) associated with the keypad operation:

- P5.6.1** Default: 0
Default page This parameter sets the view to which the display automatically moves as the Timeout Time expires or when the keypad power is switched on. If the Default Page value is 0, this function is not activated, i.e., the last displayed page remains on the keypad display.
- P5.6.2**
Default page/OM Here you can set the location in the Operating menu to which the display automatically moves as the set Timeout Time expires, or when the keypad power is switched on. See setting of Default Page parameter above.
- P5.6.3** Range: 0 – 65535 Default: 30
Timeout time Units: Seconds
 The Timeout Time setting defines the time after which the keypad display returns to the Default Page. If the Default Page value is 0, the Timeout Time setting has no effect.
- P5.6.4**
Contrast If the display is not clear, you can adjust the keypad contrast with this parameter.
- P5.6.5** Range: 1 – 65535 or Forever Default: 10
Backlight time Units: Minutes
 This parameter determines how long the backlight stays on before going out. You can select any time between 1 and 65535 minutes or “Forever”.

Hardware Settings (S6.7)

The Hardware Settings submenu (S6.7) provides parameters for setting information on Internal brake resistor connection, Fan control, Keypad acknowledge timeout and Keypad retries.

P6.7.1 InternBrakeRs Range: Connected – Not Connected Default: Connected
With this function you tell the ACCel500 whether the internal brake resistor is connected or not.

If your drive has an internal brake resistor, the default value of this parameter is “Connected”. However, if it is necessary to increase braking capacity by installing an external brake resistor, or if the internal brake resistor is disconnected, it is advisable to change the value of this function to “Not Connected” in order to avoid unnecessary fault trips.

The brake resistor is available as an option for all drives. It can be installed internally in frame sizes FR4 to FR6.

P6.7.2 Fan Control Range: Continuous, Temperature Default: Continuous
This function sets the control method of the ACCel500 drive’s cooling fan. You can set the fan to run continuously when the power is switched on or to run based on the temperature of the unit. If the latter function has been selected, the fan is switched on automatically when the heatsink temperature reaches 60°C. The fan receives a stop command when the heatsink temperature falls to 55°C. The fan runs for about a minute after receiving the stop command or switching on the power, as well as after changing the value from “Continuous” to “Temperature”.

The fan runs continuously, regardless of this setting, when the ACCel500 drive is in RUN state.

P6.7.3 HMI ACK timeout Range: 200 – 5,000 Default: 200
Keypad Units: ms
This function allows the user to change the timeout of the Keypad acknowledgement time.

If the ACCel500 drive has been connected to a PC with a serial cable, the default values of Keypad Acknowledge Timeout and Number of Retries to Receive Keypad Acknowledgement must not be changed.

If the ACCel500 drive has been connected to a PC via a modem and there is delay in transferring messages, the value of Keypad Acknowledge Timeout must be set according to the delay as follows:

Example:

- Transfer delay between the ACCel500 drive and the PC is found to be = 600 ms
- The value of Keypad Acknowledge Timeout is set to 1200 ms (2 x 600, sending delay + receiving delay)
- The corresponding setting is then entered in the [Misc] section of the file ACCELDRIVE.INI:
Retries = 5
AckTimeOut = 1200
TimeOut = 5000

It must also be considered that intervals shorter than the Keypad Acknowledge Timeout time cannot be used in ACCel500 drive monitoring.

- P6.7.4** Range: 1 – 10 Default: 5
HMI retry With this parameter, you can set the number of times the drive will try to receive an acknowledgement when it has not been received within the acknowledgement time (Keypad Acknowledge Timeout) or if the received acknowledgement is faulty.

System Information (S6.8)

This section contains hardware and software information as well as operation information.

S6.8.1

Total Counters In the Total Counters page you will find information related to the ACCel500 operating times, i.e., the total numbers of MWh, operating days, and operating hours. See Table 3-6.

Unlike the counters for the Trip Counters, these counters cannot be reset.

The Power On time counters, days and hours, operate whenever power is applied to the ACCel500 drive.

TABLE 3-6. TOTAL COUNTERS

Number	Name	Description
C6.8.1.1	MWh counter	Megawatt hours total operation time counter
C6.8.1.2	On Day counter	Number of days the ACCel500 drive has been supplied with power
C6.8.1.3	PWOn hour count.	Number of hours the ACCel500 drive has been supplied with power

S6.8.2

Trip counters The Trip Counters are counters whose values can be reset to zero. The resettable counters are shown in Table 3-7.

TABLE 3-7. TRIP COUNTERS

Number	Name	Description
T5.8.2.1	MWh counter	Megawatts hours since last reset
P5.8.2.2	Clear MWh counter	Resets megawatts hours counter
T5.8.2.3	Power On day counter	Number of days the ACCel500 drive has been run since the last reset
T5.8.2.4	Power On hour counter	Number of hours the ACCel500 drive has been run since the last reset
P5.8.2.5	Clr Optime cntr	Resets the operating day and hour counters

Note: The Trip Counters operate only when the motor is running.

S6.8.3

Software The Software information page includes information on the following software related topics:

TABLE 3-8. SOFTWARE INFORMATION

Number	Name	Description
I6.8.3.1	Software package	ACC00031V003
I6.8.3.2	System Sw version	11.53.6536
I6.8.3.3	Firmware interf.	4.37
I6.8.3.4	System load	G9.1

S6.8.4 Applications The Application information page includes information on not only the application currently in use but also all other applications loaded into the ACCel500. The information available is shown in Table 3-9. Note that the “x” in the table refers to the sequential number of the application in the list.

TABLE 3-9. APPLICATIONS INFORMATION

Number	Content
A6.8.4.x	Application name
D6.8.4.x.1	Application ID
D6.8.4.x.2	Version
D6.8.4.x.3	Firmware interface

S6.8.5 Hardware The Hardware information page provides information on the following hardware-related topics.

TABLE 3-10. HARDWARE INFORMATION

Number	Content
I6.8.5.1	Number of the power unit
I6.8.5.2	Nominal voltage of the unit
I6.8.5.3	Brake chopper
I6.8.5.4	Brake resistor
I6.8.5.5	Serial Number

S6.8.6 Expander boards This parameter and its sub-items provide information about the basic and option boards plugged into the control board as shown in Table 3-11. Note that the “x” in the table refers to the sequential number of the slot, with slot A being “1” and slot E being “5”.

TABLE 3-11. EXPANDER BOARD INFORMATION

Number	Content
E6.8.6.x	Slot “x” board identification
E6.8.6.x.1	Operating state
E6.8.6.x.2	Software version

S6.8.7 Debug Menu

This menu is meant for advanced users and application designers. Contact the factory for any assistance needed.

Power Monitor (S6.9)

This menu shows the actual filtered current in amps.

TABLE 3-12. POWER MONITOR INFORMATION

Number	Content
C6.9.1	IU filtered
C6.9.2	IV filtered
C6.9.3	IW filtered

3-2.9 EXPANDER BOARD MENU (M7)

The Expander Board Menu makes it possible for the user:

- to see what expander boards are connected to the control board and
- to access and edit the parameters associated with the expander board.
- to monitor option board values.

Each option board has its own set of parameters.

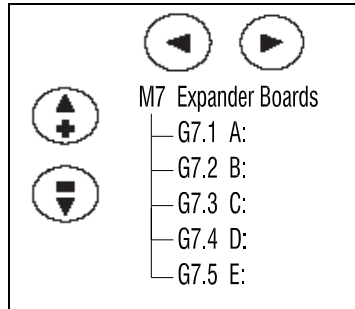


Figure 3-9. Expander Board Menu Structure

Example of Expander Board Parameters for Option Board A9

- | | |
|--|-------------------|
| <p>P7.1.1.1 Range: 1 – 5</p> <p>AI1 Mode Analog Input 1 input options:</p> <p>1 0 to 20 mA</p> <p>2 4 to 20 mA</p> <p>3 0 to 10V</p> <p>4 2 to 10V</p> <p>5 -10 to +10VP</p> | <p>Default: 3</p> |
| <p>P7.1.1.2 Range: 1 – 5</p> <p>AI2 Mode Analog Input 2 input options:</p> <p>1 0 to 20 mA</p> <p>2 4 to 20 mA</p> <p>3 0 to 10V</p> <p>4 2 to 10V</p> <p>5 -10 to +10VP</p> | <p>Default: 1</p> |
| <p>P7.1.1.3 Range: 1 – 4</p> <p>AO1 Mode Analog Output 1 output options:</p> <p>1 0 to 20 mA</p> <p>2 4 to 20 mA</p> <p>3 0 to 10V</p> <p>4 2 to 10V</p> | <p>Default: 1</p> |

3-2.10 EDITING A NUMERIC VALUE

Use the following procedure to edit numeric parameter values.

1. To edit a parameter, navigate to show that parameter and its value.
2. Press the right arrow button to enter the edit mode. In edit mode, the parameter value will flash.
3. Pressing the up or down arrow keys to change the parameter value.

If you press the right arrow a second time, the leftmost digit of the parameter value will flash. You can then use the up or down arrow keys to change the value of the flashing digit.

Press the right arrow again to select the next digit, and repeat the process to change the rest of the digits in the parameter value.

4. When you are finished, you must press the **enter** button to confirm the parameter change. **The new value will not be saved unless the enter button is pushed.**

3-2.11 EDITING A CONFIGURATION VALUE

A configuration parameter gets its data from the parameter whose ID number you enter here. Parameter ID numbers are listed in Appendix D.

Configuration parameters can have values ranging from 1 to 2000. Values 1 to 1000 indicate firmware values; values 1001 to 2000 indicate application values.

Use the following procedure to edit configuration parameter values.

1. To edit a parameter, navigate to show that parameter and its value.
2. Press the right arrow button to enter the edit mode. In edit mode, the parameter value will flash.
3. Pressing the up or down arrow keys to change the parameter value.

If you press the right arrow a second time, the rightmost digit of the parameter value will flash. You can then use the up or down arrow keys to change the value of the flashing digit.

Press the left arrow to select the next digit, and repeat the process to change the rest of the digits in the parameter value.

4. When you are finished, you must press the **enter** button to confirm the parameter change. **The new value will not be saved unless the enter button is pushed.**

3-2.12 EDITING A SELECTION VALUE

Some parameter values are displayed as text. For example, parameter S6.1 (Language) can be set to four values: English, Español (Spanish), Français (French), or Português (Portuguese). Use the following procedure to edit a parameter selection value.

1. To edit a parameter, navigate to show that parameter and its value.
2. Press the right arrow button to enter the edit mode. In edit mode, the parameter value will flash.
3. Pressing the up or down arrow keys to change the parameter value.
4. When you are finished, you must press the **enter** button to confirm the parameter change. **The new value will not be saved unless the enter button is pushed.**

3-2.13 KEYPAD REMOVAL WHILE DRIVE IS RUNNING

If the keypad is removed while the drive is running, a Keypad Comm fault (52) will result. The drive will also be placed in remote control mode. Clear the Keypad Comm fault by pressing the **reset** button. To restore local keypad control, press the **loc/rem** button.

3-2.14 STOP FAULT

The Keypad **stop** button will fault the drive and operate as a coast stop if held for three seconds, regardless which mode is active.

3-2.15 REMOTE KEYPAD

The Control Keypad is removable. It can be mounted externally and connected with the appropriate cable.

SECTION IV

I/O PARAMETER DESCRIPTIONS

4-1 ANALOG INPUTS

Parameters	Type	Default
<i>AIN3 Slot ID to AIN4 Slot ID</i>	ACFG	0
<i>AIN1 Gain to AIN4 Gain</i>	CAL	1.00
<i>AIN1 Off to AIN4 Off</i>	CAL	0.0
<i>AIN1 Tc to AIN4 Tc</i>	CAL	0.1 seconds
<i>AI1 Type to AI4 Type</i>	APB	
<i>AIN1 to AIN4</i>	APB	
<i>AIN1 Fault to AIN4 Fault</i>	DPB	

Description

Four analog inputs are available in this software. Two of the analog inputs are available with the standard board in slot A. The other two require additional I/O boards to take advantage of them.

The slot ID configures the location of the analog input. The first digit of the ID is the slot location: Slot A-E = 1-5. The second digit is the order of the input on the board. 0 = first analog input. The first two analog inputs are hard set Slot A input 0 and 1.

Before scaling, the value of the analog inputs are scaled 0-10,000; +/-10,000 for +/-10 volt boards.

The Type of board is read from the I/O slot and can be viewed as *AI1 Type* - *AI4 Type* as follows:

Mode

- 0 = Unknown
- 1 = 0-20 ma
- 2 = 4-20 ma
- 3 = 0-10 V
- 4 = 2-10 V
- 5 = +/-10 V

Scaling for the first analog input is done as follows:

$$\text{Value 1} = (AI1 \times AIN1 \text{ Gain} / 100) + AIN1 \text{ Off}$$

AIN1 Tc is a low pass filter on the input, entered in seconds.

AIN1 is the value after scaling and filtering.

AIN1 Fault bit will go high only in modes 2 or 4.

Mode 2 will fault when the input current is less than 4 mA.

Mode 4 will fault when the input voltage is less than 2 V.

4-2 ANALOG OUTPUTS

Parameters	Type	Default
<i>AOUT1 ID</i> to <i>AOUT4 ID</i>	ACFG	3 = <i>Motor Current</i> 2 = <i>Motor Speed</i> 1200, 1200 = <i>Zero-Analog</i>
<i>AOUT1 Zero</i> to <i>AOUT4 Zero</i>	CAL	0.0
<i>AOUT1 Cal</i> to <i>AOUT4 Cal</i>	CAL	1.00
<i>AOUT1 TC</i> to <i>AOUT4 TC</i>	CAL	0.10 seconds
<i>AOUT2 Slot ID</i> to <i>AOUT4 Slot ID</i>	ACFG	0
<i>AOUT1 Val</i> to <i>AOUT4 Val</i>	APB	

Description

Four analog outputs are available in this software. One analog output is available with the standard board in slot A. The other three require additional I/O boards to take advantage of them.

The ID configures which parameter value to map to the analog output.

The slot ID configures the location of the analog output. First digit of the ID is the slot location: Slot A-E = 1-5. Second digit is the order of the output on the board; 0 = first analog output. The first analog output is hard set to Slot A first output.

After scaling, the value can be viewed as *AOUTx Val* with a range of 0-10,000; +/-10,000 for ±10 volt boards.

The Type of board must be known for the scaling factor:

- 0 = Unknown
- 1 = 0-20 mA = 0-10,000 value
- 2 = 4-20 mA = 0-10,000 value
- 3 = 0-10 V = 0-10,000 value
- 4 = 2-10 V = 0-10,000 value
- 5 = +/-10 V = 0-10,000 value

Scaling for the first analog output is done as follows:

$$\text{Value 1} = (\text{AOUT1 ID value} + \text{AOUT1 Zero}) \times \text{AOUT1 Cal} / 100$$

Note: 10,000 is the board's full output.

$AOUT_x T_c$ is a low-pass filter on the output entered in seconds.

4-3 DIGITAL INPUTS

Parameters	Type	Default
<i>DIN7 Slot ID to DIN8 Slot ID</i>	ACFG	0
<i>DIN 1 to DIN 8</i>	DPB	
<i>Not DIN 1 to Not DIN 8</i>	DPB	

Description

Eight digital inputs are available in this software. Six digital inputs are available with the standard board in slot A. The other two require additional I/O boards to take advantage of them.

The slot ID configures the location of the digital input. The first digit of the ID is the slot location: Slot A-E = 1-5. The second digit is the order of the input on the board; 0 = first digital input. The first eight digital inputs are hard set to Slot A digital inputs.

The digital inputs and their invert can be viewed as *DIN x* and *Not DIN x*.

4-4 DIGITAL OUTPUTS

Parameters	Type	Default
<i>DOUT1 ID to DOUT6 ID</i>	BCFG	111 6 = <i>MC_Fault</i> = Drive fault 1098 = <i>MC_Run</i> = Drive running 1118 = <i>MC_AtSpeed</i> = Not ramping 1002, 1002, 1002 = <i>Zero Bit</i>
<i>DOUT1 Inv to DOUT6 Inv</i>	En	0
<i>DOUT4 Slot ID to DOUT6 Slot ID</i>	ACFG	0

Description

Six digital outputs are set up in the software. Three digital outputs are available with the standard board in slot A or B. The other three require additional I/O boards to take advantage of them.

The ID configures which parameter to map to the digital output.

The slot ID configures the location of the digital output. The first digit of the ID is the slot location: Slot A-E = 1-5. The second digit is the order of the output on the board; 0 = first digital output. The first three digital outputs are hard set to the default boards (One output in slot A and two in slot B).

The value bit can be inverted before being sent out by *DOUTx_Inv* parameters.

4-5 ENCODER COUNTER OUTPUTS

Parameters	Type	Default
<i>Enc1 Slot ID, Enc2 Slot ID</i>	ACFG	0
<i>Enc1 Mlt, Enc2 Mlt</i>	CAL	1000
<i>Enc1 Div, Enc2 Div</i>	CAL	1000
<i>C_Enc2_Add</i>	CAL	0
<i>Enc1 Tc, Enc2 Tc</i>	CAL	1 ms
<i>Counter1 Dec, Counter2 Dec</i>	CAL	0
<i>Counter1 Mult, Counter2 Mult</i>	CAL	1
<i>Counter1 Hld, Counter2 Hld</i>	BCFG	1
<i>Counter1 Res, Counter2 Res</i>	BCFG	1002 (Zero Bit)
<i>Counter1, Counter2</i>	En	0 (Disabled)
<i>Encoder1FiltTime</i>	Cal	1 ms
<i>Enc1_Out, Enc2_Out</i>	APB	
<i>Counter1, Counter2</i>	APB	

Frequency Description:

Two encoder inputs are available in this software, but require additional option boards to enable.

When closed loop speed control is requested, the first encoder feedback is always selected for speed feedback. This is taken from the board, and is not affected by the parameter scalings.

The slot ID configures the location of the encoder input. First digit of the ID is the slot location: Slot A – E = 1 – 5. Second digit is the order of the output on the board. 0 = first encoder input. On option board A7, the second frequency input is input 3 of the board.

The frequency feedback is scaled by the option board by entering the proper PPR in the option board parameters. It is assumed that the encoder is mounted directly to the motor with no gear ratio and value read from the board is in motor rotation in hertz for speed feedback.

$$\text{Value from board} = \frac{(\text{Frequency Hz}) \times (60 \text{ s/m}) \times (\text{Nominal motor frequency Hz})}{(\text{PPR}) \times (\text{Nominal motor speed RPM})}$$

Both frequency feedbacks can be scaled and filtered and used for other functions such as speed reference.

Enc1_Out = first encoder input scaled by (motor Hz x *Enc1 Mult* / *Enc1 Div*) with a low pass filter of time constant *Enc1 Tc*.

Enc2_Out = second encoder input scaled by ((motor Hz + *Enc2 ADD*) x *Enc2 Mult* / *Enc2 Div*) with a low pass filter of time constant *Enc2 Tc*.

Counter Description:

Both encoder inputs have pulse counters associated with them. These are bi-directional counters with hold and reset bits. The values of the counters will be stored and recalled through drive power loss (retentive).

Three words read from the encoder board contain the raw motor rotations. The first two offer complete revolution counter and the third is the fraction of rotation.

$Counter1 = \text{Motor rotations} \times Counter1 \text{ Mult} / Counter1 \text{ Dec}$

$Counter2 = \text{Motor rotations} \times Counter2 \text{ Mult} / Counter2 \text{ Dec}$

Counter1 Hld, *Counter2 Hld* will hold their respective counters at their current count when high.

Counter1 Res, *Counter2 Res* will reset their respective counters to zero when high.

4-6 DRIVE HARDWARE INPUTS

Parameters	Type	Description
<i>Motor Torque</i>	APB	Percent of motor
<i>Motor Voltage</i>	APB	Volts
<i>Motor Power</i>	APB	Percent of motor
<i>Motor Current</i>	APB	Amps
<i>Unit Temperature</i>	APB	C.

SECTION V

LOGIC SEQUENCE

5-1 MISCELLANEOUS LOGIC

Zero Bit - Set to FALSE. ID number for this bit is 1002.

One Bit - Set to TRUE. ID number for this bit is 1001.

Zero Analog = 0

One Analog = 1

Int Ten = 10

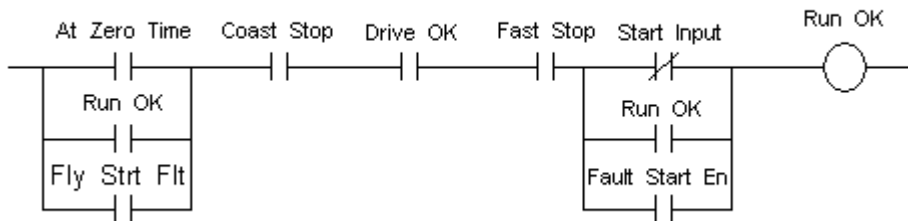
Int Hundred = 100

Int Thousand = 1000

5-2 REMOTE OPERATION (See Appendix A-5)

There are four basic run commands for the ACCel500 drive. Run and thread are maintained. Jog forward and Jog reverse are momentary.

5-2.1 Run OK



The *Run OK* bit is used to stop the drive in any control mode.

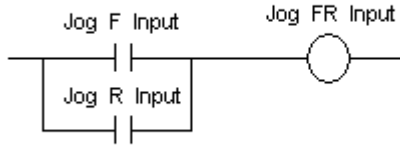
If the *Fly Start Flt* bit is enabled, then the drive can be restarted after a fault without first going to zero speed. This may be helpful for sections such as dryer helpers that get dragged along with the machine.

The *Fault Start En* bit allows the drive to start running as soon as the fault is cleared. If it is disabled, the Runs must first be removed before they can be energized again. This bit should be disabled when the runs come from a communication port rather than direct I/O. This will force the communications to come up and remove the runs before you can safely run.

The internal *MC Ready* is tied to the firmware *Drive OK* variable.

Coast Stop and *Fast Stop* are defaulted to *One Bit*.

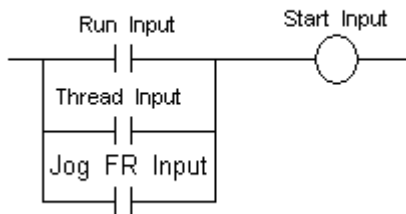
5-2.2 Jog FR Input



The *Jog FR Input* is active when either of the Jog inputs are a TRUE.

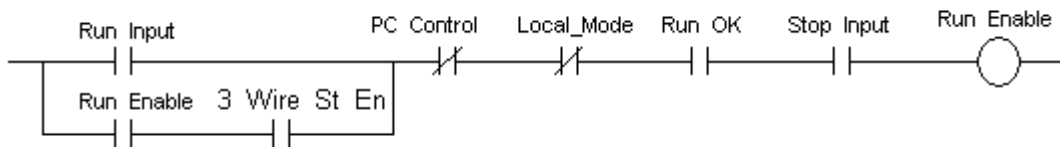
Jog F Input is defaulted to the second digital input. *Jog R Input* is defaulted to *Zero Bit*.

5-2.3 Start Input



Start Input is TRUE when any of the drive run inputs are active.

5-2.4 Run Enable

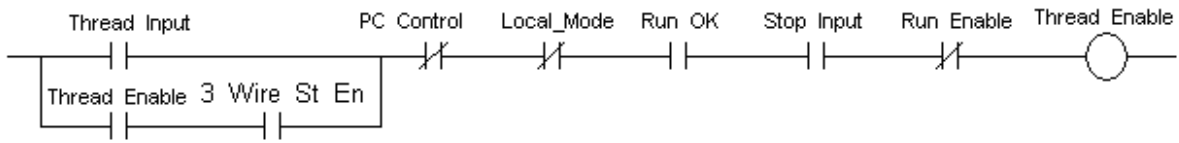


The *Run Input* will energize the *Run Enable* if all interlocks are met.

The *Stop Input* defaults to TRUE. This can be set to a normally closed stop input along with enabling the *3 Wire St En* to implement a three wire start/stop circuit.

Run Input is defaulted to the first digital input.

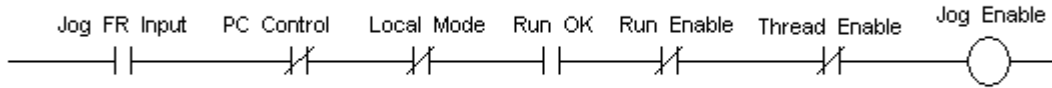
5-2.5 Thread Enable



Thread Enable is setup similar to the *RunEnable*. *Run_Enable* takes priority. If in Thread and the *Run_Input* goes high the control will transfer to the Run mode.

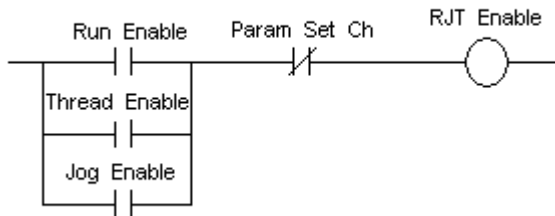
Thread Input is defaulted to *Zero Bit* which disables this function.

5-2.6 Jog Enable



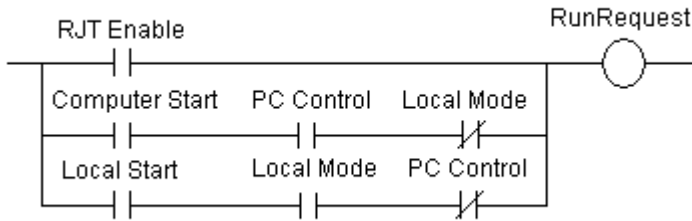
The *Jog Enable* is not maintained. Removing the input turns off the enable. Also, Thread and Run Enables have a higher priority.

5-2.7 RJT Enable



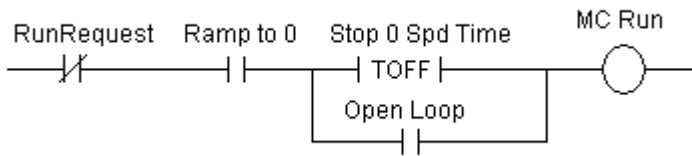
RJT Enable is high if any of the modes are enabled and the drive is done with a parameter change. This makes sure all proper values are in place before proceeding.

5-2.8 RunRequest



RunRequest is high if *RJT Enable* is High or if the drive is commanded to run from either the local mode or computer ADDaptACC mode.

5-2.9 MC Run



RunRequest sets *MC Run* which is sealed in until the drive ramps to zero speed. Also in closed loop mode *MC Run* can be set to stay enabled keeping the drive running at zero speed for *Stop 0 Spd Time* in seconds.

5-2.10 Cntrl Inhib

Cntrl Inhib is the invert of *MC Run*.

5-2.11 Fast Stop

When *Fast stop* input goes low, the drive will stop at its fast ramp rate. This is defaulted to *One Bit*.

5-2.12 Coast Stop

The drive will coast stop under the following conditions:

- Not in *PC Control* and *Coast Stop* goes low.
- In *PC Control* and the user presses the coast stop button in ADDaptACC.
- Drive faults out and the response is setup for coast stop.
- Removal of the run if the *Stop Funct* parameter is set to Coast.

5-2.13 Cntrl Mode

Cntrl Mode is an integer based on the following:

- 0 = Not enabled
- 1 = *Run Enable*
- 2 = *Thread Enable*
- 3 = *Jog F En*
- 4 = *Jog R En*

This is used for the reference select blocks.

5-2.14 Ramp Delays

Two delays are available when operating in the closed loop mode.

- *Strt 0 Spd Time* will hold the speed ramp at zero until it times out on a start command. This value is in ms. This is used to allow contactors and brakes to energize before ramping up the speed. This operates in close loop mode only.
- *Stop 0 Spd Time* keeps the drive running at zero speed until it times out after runs are removed. This value is also in ms. This is used to hold at zero speed until brakes are removed.

5-2.15 Motor Control Mode

Mtr Ctlr Sw toggles between two motor control modes, *Motor Ctrl Mode* and *Motor Ctrl Mode2*.

The motor control mode options are:

- Freq Control – Open loop volts per hertz operation
- OL SpeedCont – Open loop speed control
- OL TorqCtrl – Open loop torque control (No encoder)
- CL SpeedCtrl – Close loop control mode
- CL TorqCtrl – Close loop torque control (With encoder)

5-3 LOCAL DRIVE KEYPAD

5-3.1 LOCAL RUN MODE

The drive can be put into the local mode by pressing the local/remote button on the keyboard. This will transfer control as long as the drive is not in PC control or running at the time.

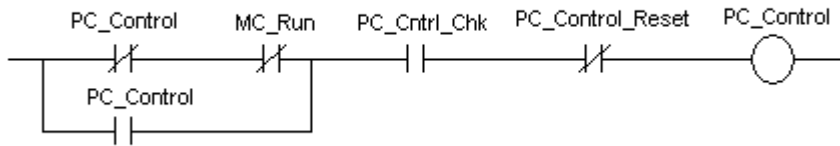
Pressing the Start button on the keypad when in the local mode will initiate a drive Run as long as *MC Ready* is high and the drive is not faulted (*MC Fault* is low)

Pressing the Stop Button on the keypad will initiate a local stop. This does not stop the drive in remote or PC control. See button Stop fault in next section.

5-3.2 BUTTON STOP FAULT

In any mode, if the Stop button is pressed for 4 seconds a button stop fault will occur.

5-4 ADDaptACC SOFTWARE CONTROL

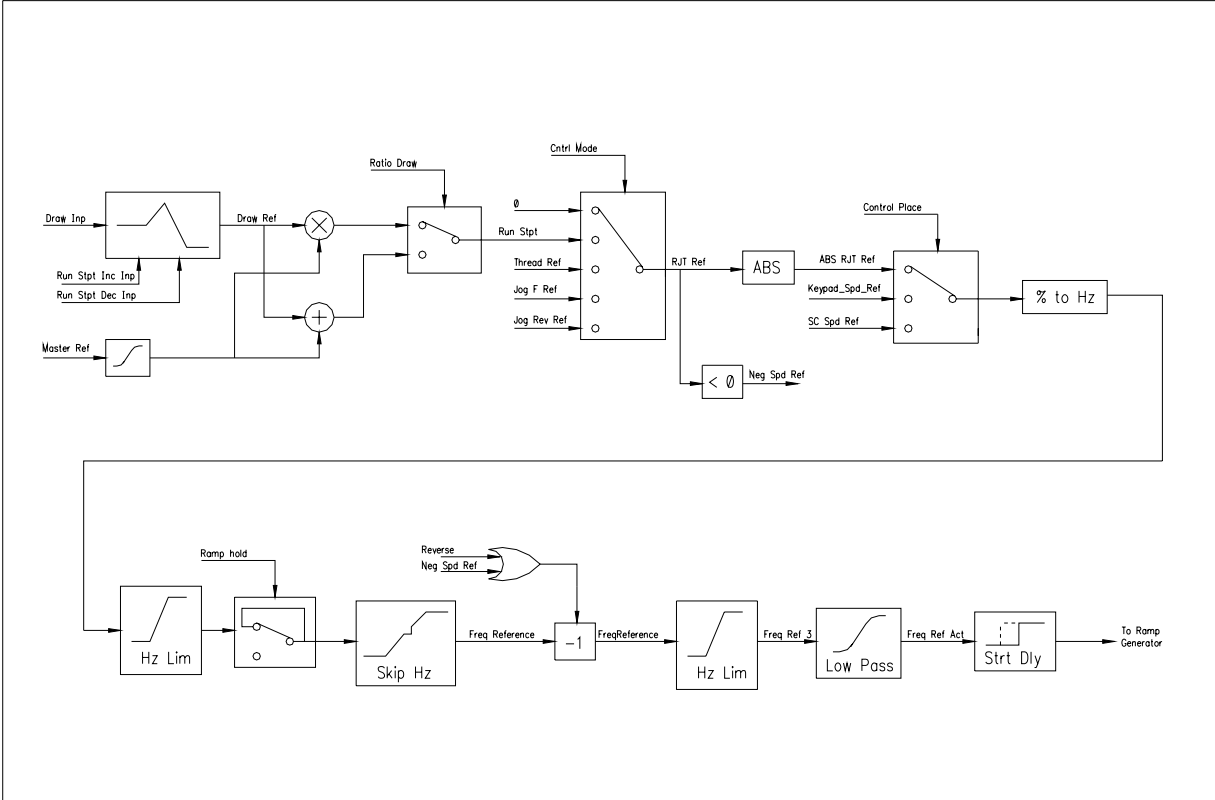


PC Control is enabled by the ADDaptACC diagnostic software package. It will transfer into this mode only if the drive is not running. The drive will transfer out of *PC Control* if communications are lost to the computer.

SECTION VI

REFERENCING AND OUTER CONTROL LOOP

6-1 SPEED RAMP REFERENCE (See Appendix A-1)



6-1.1 RUN REFERENCES

Parameters	Type	Default
<i>Draw Inp</i>	Acfg	<i>Draw Stpt</i> = 1.00
<i>Master Ref</i>	Acfg	<i>Run Speed</i> = 20.00%

Description:

Two inputs are available to set the drives speed while in Run mode. *Master Ref* is the normal speed input and it is defaulted to the calibration value *Run Speed*. *Draw Inp* is the other input and this is defaulted to be a ratio draw input defaulted to a calibration value *Draw Stpt*. Several options are available to manipulate these two inputs including digital increase/decrease, ramping and changing to difference draw as described in the next three sections.

6-1.2 INCREASE / DECREASE COMMANDS

Parameters	Type	Default
<i>Run Stpt Up</i>	E/D	Disabled
<i>Draw Inp</i>	Acfg	<i>Draw Stpt</i> = 1.00
<i>Run Inc Rate</i>	Cal	5.00 Draw/S
<i>Run Dec Rate</i>	Cal	5.00 Draw/S
<i>Run Stpt Res</i>	Bcfg	<i>Cntrl Inhib</i>
<i>Max Run Stpt</i>	Cal	60.00 draw
<i>Min Run Stpt</i>	Cal	- 60.00 draw
<i>Run Stpt Inc Inp</i>	Bcfg	Zero Bit
<i>Run Stpt Dec Inp</i>	Bcfg	Zero Bit
<i>Run Stpt Dif</i>	Apb	
<i>Draw Ref</i>	Apb	
<i>Run In Max</i>	Dpb	
<i>Run In Min</i>	Dpb	

Description:

Draw Ref is the value of *Draw Inp* after modifications by increase or decrease commands. The drive is defaulted so the commands are not active. To activate the commands see the following:

- Set *Run Stpt Inc Inp* to the digital increase command input.
- Set *Run Stpt Dec Inp* to the digital decrease command input.
- Set the rates to ramp the draw by *Run Inc Rate* and *Run Dec Rate*.
- Set *Max Run Stpt* and *Min Run Stpt* as output limits for *Draw Ref*.
- The increase /decrease setting is defaulted to reset on removal of the drive run. Changing *Run Stpt Res* to desired function to reset. Set to *Zero Bit* to disable reset of the draw.
- *Run Stpt Up* is used if a draw is set by both an operator display and increase / decrease commands. If this bit is enabled then the increase / decrease value will be reset upon changes in *Draw Inp*.

6-1.3 RATIO / DIFFERENCE DRAW

Parameters	Type	Default
<i>Draw Ref</i>	Apb	
<i>Slv No Rmp</i>	Bcfg	<i>One Bit</i>
<i>Master Ref</i>	Acfg	<i>Run_Speed</i> = 20.00 %
<i>Slv Rate Lim</i>	Cal	10 % / Sec
<i>Ratio Draw En</i>	E/D	Enabled
<i>Ratio Div</i>	CAL	100
<i>Run Stpt</i>	Apb	

Description:

Master Ref is the speed reference input for most applications. *Slv Rate Lim* is provided to allow for a slower ramp rate other than the internally ramp block. Note that if *Slv No Rmp* is enabled (Set low) and *Slv Rate Lim* is set to zero the output will not update.

If *Ratio Draw En* is disabled *Master Ref* is added to the output of the inc/dec block to become *Run Stpt*.

If *Ratio Draw En* is enabled *Master Ref* is multiplied with the output of the inc/dec block divided by *Ratio Div* to become *Run Stpt*. Default has the output of the inc/dec = 1.00 and Ratio Div as 1.00 so $RunStpt = Master Ref$.

6-1.4 SPEED REFERENCE SELECTION

Parameters	Type	Default
<i>Run Stpt</i>	APB	
<i>Cntrl Mode</i>	APB	
<i>Thread Ref</i>	Acfg	<i>Thread Speed</i> = 10.00 %
<i>Jog F Ref</i>	Acfg	<i>Jog F Speed</i> = 5.00 %
<i>Jog R Ref</i>	Acfg	<i>Jog R Speed</i> = -5.00 %
<i>RJT Ref</i>	APB	
<i>ABS RJT Ref</i>	APB	
<i>Neg Spd Ref</i>	DPB	

Description:

Cntrl Mode from the Run logic determines the value of *RJT Ref* as follows:

- 0 = 0.00%
- 1 = *Run Stpt*
- 2 = *Thread Ref*
- 3 = *Jog F Ref*
- 4 = *Jog R Ref*

The drive is defaulted so the first digital input enables the run and the second digital input enables the jog forward.

ABS_RJT_Ref then becomes the absolute value of *RJT Ref*.
Neg Spd Ref goes high if *RJT Ref* is negative.

6-1.5 REVERSE

Parameters	Type	Default
<i>Reverse Inp</i>	BCFG	<i>Zero Bit</i>
<i>Jog enable</i>	DPB	
<i>Control Place</i>	APB	
<i>Keypad Spd Dir</i>	DPB	
<i>Reverse</i>	DPB	

Description:

Reverse command is dependent on *Control Place* as follows:

- *Control Place* = 0 = Remote Control - Reverse comes from *Reverse Inp* (the reverse input configuration point). This is not used when jogging since there is a separate jog forward and jog reverse. Reverse can also be commanded by having a negative speed reference.
- *Control Place* = 1 = Panel Control – *Keypad Spd Dir* command. This is changed via the keypad.
- *Control Place* = 2 = Computer Control - Reverse comes from a check box on the control pad screen from ADDaptACC

6-1.6 REFERENCE SELECTION AND RAMP HOLD

Parameters	Type	Default
<i>Control Place</i>	APB	
<i>ABS RJT Ref</i>	APB	
<i>LS to Freq</i>	CAL	.600
<i>LS Scl Div</i>	CAL	1000
<i>Min Frequency</i>	CAL	0.00 Hz
<i>Freq Max</i>	CAL	60.00 Hz
<i>Ramp Hold</i>	BCfg	Zero Bit
<i>Freq Ramp Out</i>	APB	

Description:

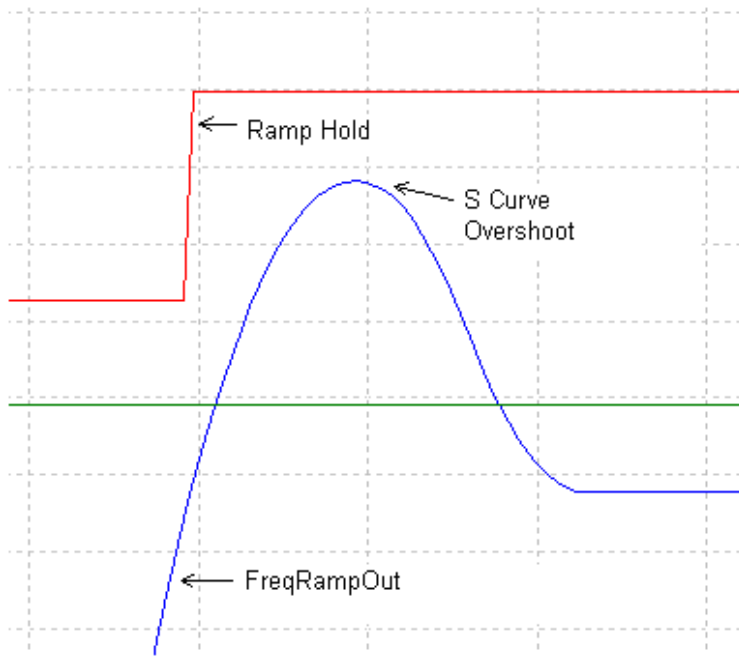
The Speed reference is dependent on *Control Place* as follows:

- *Control Place* = 0 = Remote control - Derived from the Run, Jog, Thread reference *ABS RJT Ref*.
- *Control Place* = 1 = Panel control - Set from the keypad Keypad Spd ref.
- *Control Place* = 2 = Computer control - Set from the computer control slider bar from ADDaptACC.

The Speed reference is then scaled from percent line speed to motor hertz. The default scaling is 100.00% speed = 60.00 Hz. *LS_to_Freq* and *LS_to_Freq* are used for this scaling.

The reference can be held at any time by enabling *Ramp Hold*. This takes the output of the ramped speed reference *Freq Ramp Out* and makes this the reference value. Note: this will hold the reference in all modes except when the run is removed. If you only want this to be active in the run mode, you must use spare logic blocks.

Also note that if S-curve ramping is enabled, the speed will overshoot by the S-curve value, then it will ramp back to the correct value. See the example below:



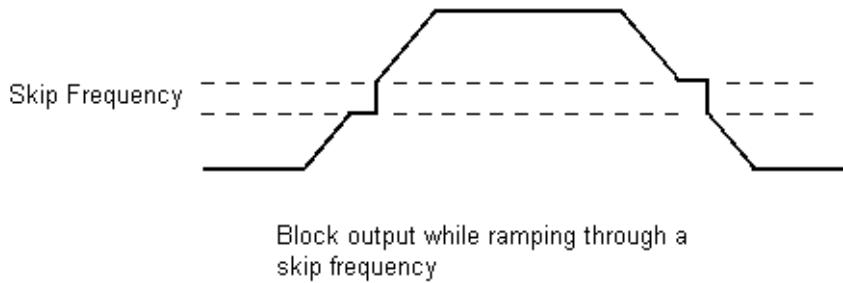
6-1.7 SKIP FREQUENCY AND REFERENCE POLARITY

Parameters	Type	Default
<i>Skip Freq H1</i>	CAL	0
<i>Skip Freq L1</i>	CAL	0
<i>Skip Freq H2</i>	CAL	0
<i>Skip Freq L2</i>	CAL	0
<i>Freq Reference</i>	APB	
<i>Reverse</i>	DPB	
<i>Neg Spd Ref</i>	DPB	
<i>FreqReference</i>	APB	

Description:

The speed reference after the ramp hold logic gets checked for skip frequencies. Two separate skip frequencies can be selected to keep from running the drive within the range. The skip frequencies are entered in motor Hertz.

See the example below:



Freq Reference is the speed reference after the skip frequency logic in motor Hertz.

Freq Reference is then checked for polarity as described in section 6-3 and becomes *FreqReference*. Either *Reverse* or *Neg Spd Ref* will invert the reference.

6-1.8 LOW PASS AND DELAY

Parameters	Type	Default
<i>FreqReference</i>	APB	
<i>Strt 0 Spd Time</i>	CAL	0 ms
<i>RunRequest</i>	DPB	
<i>Freq Ref LP TC</i>	CAL	0 ms

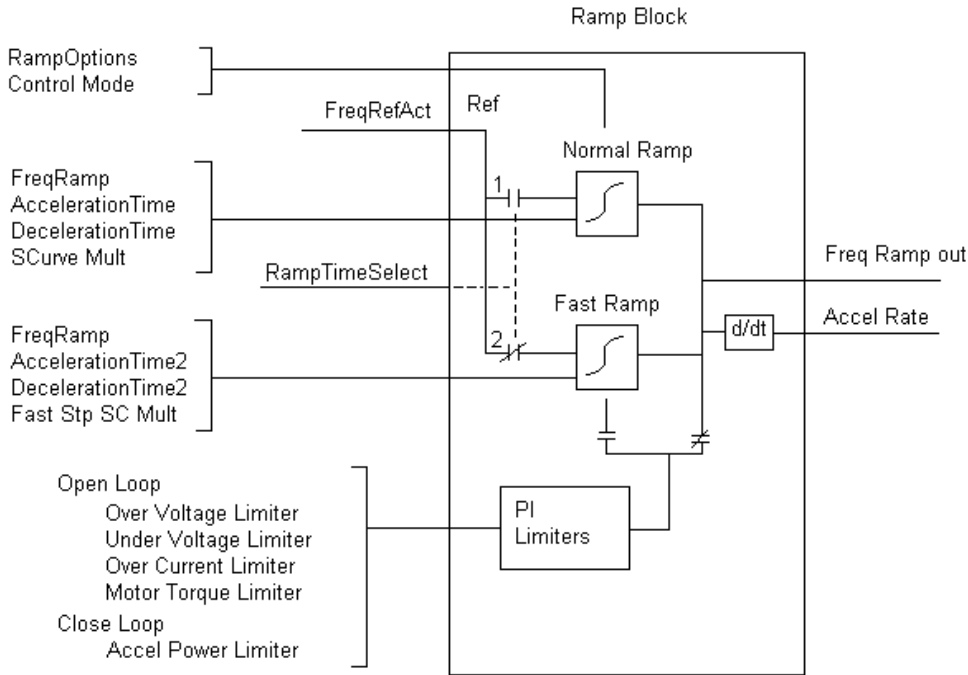
Description:

A second order low pass filter with a time constant of *Freq Ref LP TC* is available to smooth the reference (*FreqReference*), if required.

If the drive is in the closed loop mode of operation, a time delay *Strt 0 Spd Time* can be set to delay the ramping of the reference after *RunRequest*. This can be used to delay for contactor or brake operations.

The output of this section then goes to the ramp generator blocks.

6-1.9 RAMPING



Parameters	Type	Default
<i>Accel Inp</i>	ACFG	<i>Accel Time 1</i> = 10 seconds
<i>Decel Time</i>	ACFG	<i>Decel Time 1</i> = 10 seconds
<i>Skip Freq Mlt</i>	CAL	0.5 ratio
<i>In Skip Freq</i>	DPB	
<i>Acceleration Tim</i>	APB	
<i>Deceleration Time</i>	APB	
<i>Fast Stop Tim</i>	CAL	0.1 seconds
<i>Fast Stop</i>	BCFG	<i>One Bit</i>
<i>Smooth Ratio</i>	CAL	1
<i>Smooth Ratio 2</i>	CAL	0
<i>MC AtSpeed</i>	DPB	
<i>MC Reverse</i>	DPB	

Description:

The ramp rates are entered in seconds, from zero speed to *Freq Max*. A default of ten seconds with *Freq Max* of 60 Hz gives a ramp rate of 6 Hz/s. Forward and reverse acceleration input is *Accel Inp*. Forward and reverse deceleration input is *Decel Time*.

While in any of the three user-defined skip frequencies (*In Skip Freq* is high), the ramp rate can be modified to get through them quicker. The default multiplier is 0.5. This would reduce the 10 second ramp time to 5 seconds, which increases the ramp rate from 6 Hz/s to 12 Hz/s. The ramp times for the skip frequencies can be viewed at *Acc Skip Tim* and *Dec Skip Tim*.

Acceleration Tim and *Deceleration Time* are the ramp time value depending if the section is in a skip frequency or not.

When *Fast Stop* input is goes low the drive stops at *Fast Stop Tim* ramp time. This allows for a very fast current limit deceleration during emergencies.

Smooth Ratio is used to create a rounding to the ramp rate. The units are in seconds to get to from zero to the ramp rate. Note that if *Smooth Ratio* = 2, then it will take 2 seconds to get to the ramp rate. It does not matter if the rate is 1 Hz/s or 10 Hz/s.

Smooth Ratio 2 is used during the fast stop condition and should be left at zero unless the machine can not handle the stress.

Once the ramping is complete *MC AtSpeed* goes high.

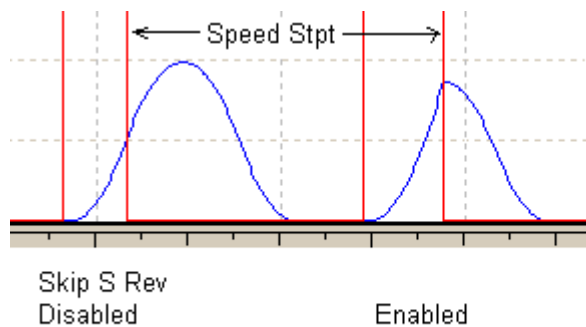
When the drive has ramped through zero and is negative *MC Reverse* goes high.

6-1.10 RAMP OPTIONS

Parameters	Type	Default
<i>Skip S Rev</i>	E/D	Disable
<i>Disable Ramp</i>	BCFG	Zero Bit
<i>Rmp Act Lim</i>	E/D	

Description:

Skip S Rev disables the continuation of an S-Curve when a reference change has been made. For example, if the drive is accelerating and the run is removed, the drive would continue to increase in speed until the S-Curve is complete before starting to decelerate. When *Skip S Rev* is enabled, the drive would not continue to accelerate at the time of the Run off, but start to decelerate right away. See the examples below.



Disable Ramp removes both the linear ramp and S-Curve. This should be used only when the drive is a slave section directly coupled and set as a current follower. This works only in the closed loop mode of operation.

There are four override speed limiters available. These modify the speed reference to keep the drive from faulting out. *Rmp Act Lim* enables these limiters to be ramped instead of being step changes to the speed loop.

6-1.11 RAMP OUTPUTS

Parameters	Type	Default
<i>Freq Ramp Out</i>	APB	
<i>Freq Delta</i>	APB	
<i>Final Freq Ref</i>	APB	

Description:

Freq Ramp Out is the final speed reference after ramping and limiting functions. The value is in Hz. *Freq Delta* is the derivative of the reference. The units are in Hz/s. See the appropriate sections for the other inputs to the blocks.

Freq Ramp Out is checked again to be within the min and max limits and becomes *Final Freq Ref*.

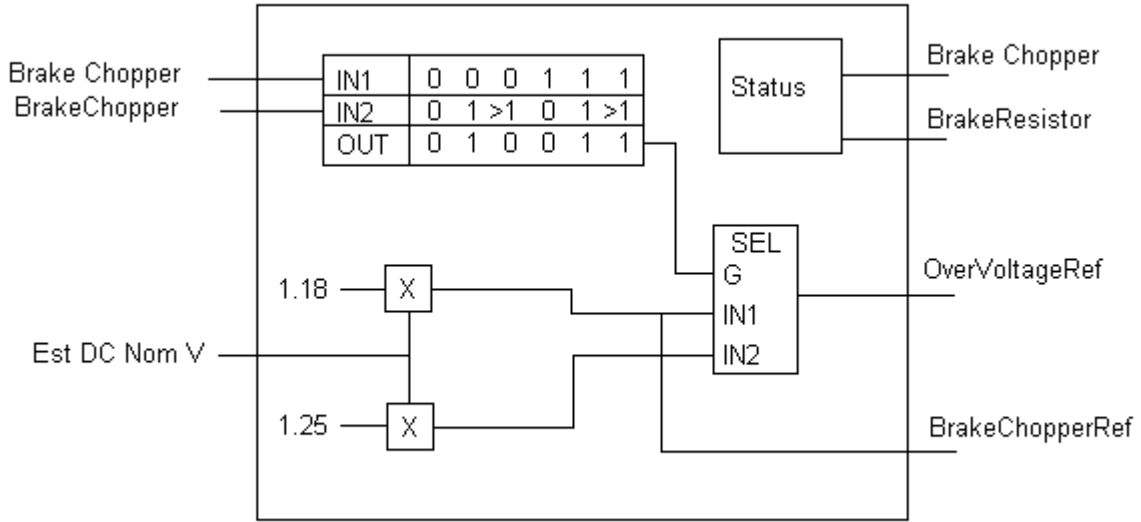
6-2 PI LIMITERS (See Appendix A-1)

There are four open loop PI limiters and two closed loop limiters. When enabled the limiters modify the speed reference to avoid the drive from tripping out. The output of these limiters can go before or after the ramp block depending if *Rmp Act Lim* is enabled.

MtrRegStatus gives the status if a limiter is active as follows:

- 0 = None Active
- Bit 0 = Motoring current
- Bit 1 = Generating current
- Bit 2 = Motoring torque
- Bit 3 = Generating torque
- Bit 4 = Over voltage
- Bit 5 = Under voltage

6-2.1 OPEN LOOP OVERVOLTAGE LIMITER



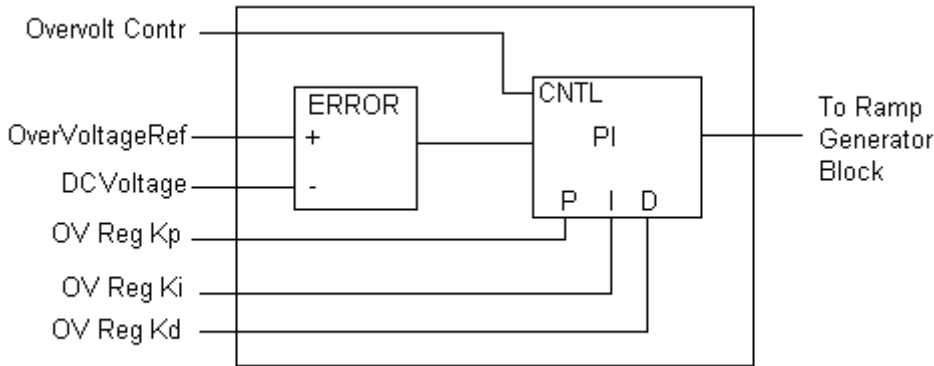
Parameters	Type	Default
<i>Brake Chopper</i>	APB	
<i>BrakeChopper</i>	CAL	0
<i>BrakeResistor</i>	APB	

Description:

The Overvoltage reference is either set to 1.18 or 1.25 times the estimated DC voltage, depending on whether there is a DC chopper and if there is a resistor present.

Brake Chopper is set to 0 if the drive is not equipped with an internal brake Chopper. Otherwise, it is set equal to 1.

BrakeResistor is set to 0 if no resistor is detected when tested. Otherwise, it is set equal to 1.



Parameters	Type	Default
<i>Overvolt Contrl</i>	CAL	0
<i>DCVoltage</i>	APB	

<i>OV Reg Kp</i>	CAL	By frame size
<i>OV Reg Kd</i>	CAL	By frame size
<i>OV Reg Ki</i>	CAL	By frame size
<i>Field WeakngPnt</i>	CAL	60 Hz

Description:

The Overvoltage limiter can be used to avoid the DC Bus from tripping out. This modifies the speed reference to try and keep the Bus voltage down.

Overvolt Contrl can be set to disabled, no ramp (resets the integrator), or ramping. Default is disabled.

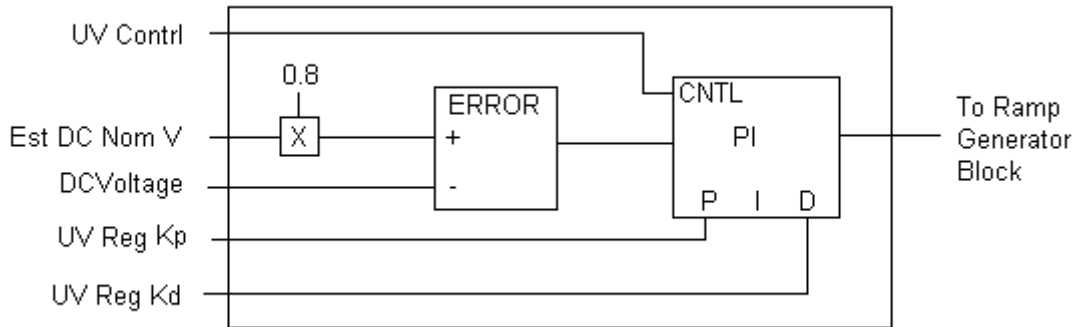
The over voltage reference is either 1.18 or 1.25 times the nominal bus voltage, depending on if there is a brake chopper circuit and resistor present.

The four gains *OV Reg Kp*, *OV Ref Kp Add*, *OV Reg Ki*, and *OV Reg Kd* all have different default values based on frame size. These should not need to be tuned except for extreme situations.

OV Ref Kp Add is an additional P gain for low speeds. It will decay to zero when the drive gets to the *Field WeakngPnt* (default 60 Hz). This feature is not changeable in our standard speed/tension software.

The output of the regulator, when enabled, will add or subtract to the speed reference in the Ramp Generator block and become part of *Freq Ramp Out*.

6-2.2 OPEN LOOP UNDERVOLTAGE LIMITER



Parameters	Type	Default
<i>UV Contrl</i>	CAL	disable
<i>DCVoltage</i>	APB	
<i>UV Reg Kp</i>	CAL	By frame size
<i>UV Reg Kd</i>	CAL	By frame size
<i>Field WeakngPnt</i>	CAL	60 Hz

Description:

The Undervoltage limiter can be used to avoid the DC Bus from tripping out. This modifies the speed reference to try and keep the Bus voltage up.

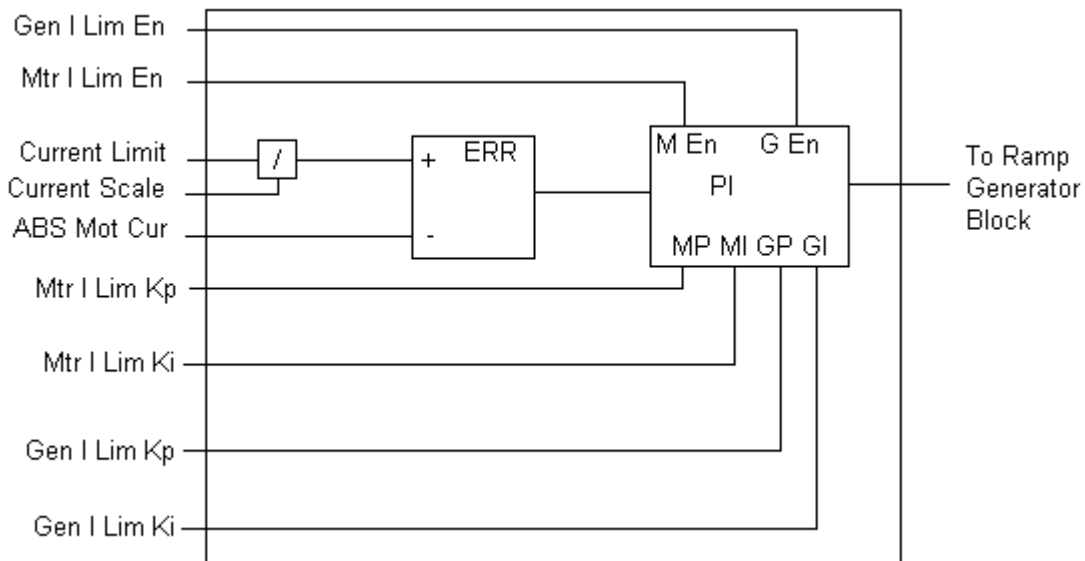
UV Contrl can be used to enable or disable this function. It is defaulted to disable.

The setpoint is 0.8 x DC voltage.

The *UV Reg Kp* and *UV Reg Kd* have different default values based on frame size. These should not need to be tuned except for extreme situations.

The output of the regulator, when enabled, will add or subtract to the speed reference in the Ramp Generator block and become part of *FreqRampOut*.

6-2.3 OPEN LOOP CURRENT LIMITER



Parameters	Type	Default
<i>Gen I Lim En</i>	EN	1 – Disable
<i>Mtr I Lim En</i>	EN	1 – Disable
<i>Mtr I Lim Kp</i>	CAL	By frame size
<i>Mtr I Lim Ki</i>	CAL	By frame size
<i>Gen I Lim Kp</i>	CAL	By frame size
<i>Gen I Lim Ki</i>	CAL	By frame size

Description:

The overcurrent limiter can be used to avoid the drive from tripping out. This modifies the speed reference to try and keep the current within tolerance.

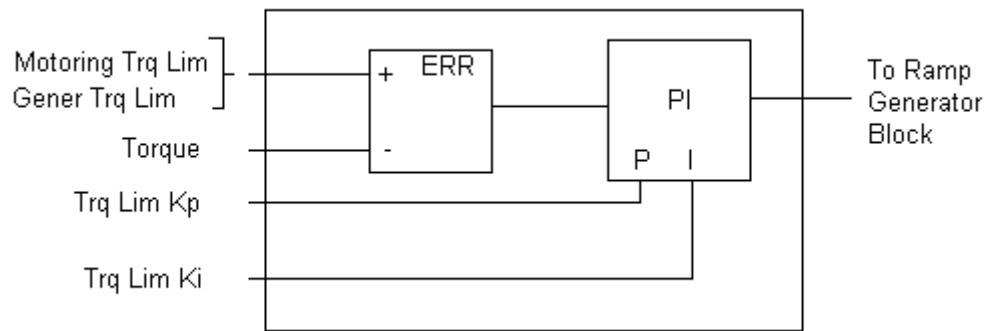
There are two regulators based on whether the drive is motoring or regenerating. *Gen I Lim En* enables the regeneration regulator, while *Mtr I Lim En* enables the motoring regulator. Both are defaulted to disable.

The entered current limit is the setpoint. This gets subtracted to the absolute value of the motor current to create the regulator error.

The four gains *Mtr I Lim Kp*, *Mtr I Lim Ki*, *Gen I Lim Kp* and *Gen I Lim Ki* have different default values based on frame size. These should not need to be tuned except for extreme situations.

The output of the regulator, when enabled, will add or subtract to the speed reference in the Ramp Generator block and become part of *FreqRampOut*.

6-2.4 OPEN LOOP TORQUE LIMITER



Parameters	Type	Default
<i>Motoring Trq Lim</i>	CAL	300%
<i>Gener Trq Lim</i>	CAL	300%
<i>Motor Torque</i>	APB	
<i>Trq Lim Kp</i>	CAL	3000
<i>Trq Lim Ki</i>	CAL	200

Description:

The over torque limiter can be used to avoid the drive from tripping out. This modifies the speed reference to try and keep the current within tolerance.

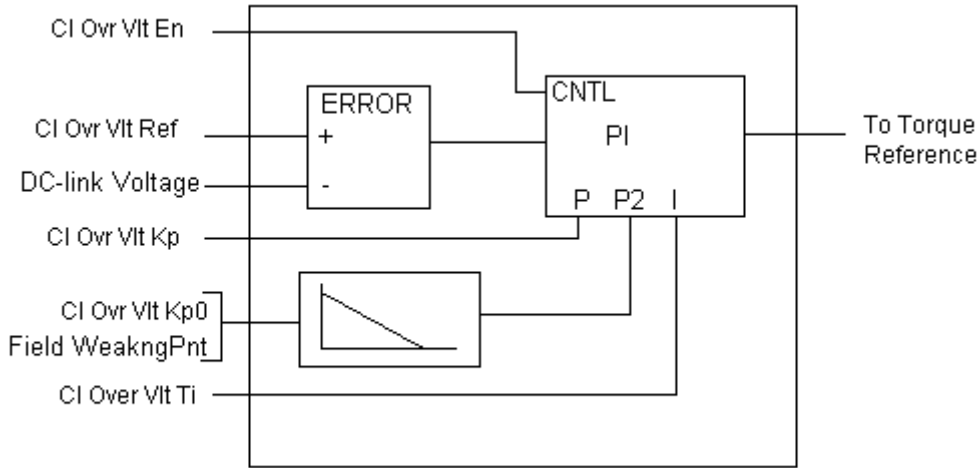
There are two regulators based on whether the drive is motoring or regenerating. Unlike the other regulators, there is no enable or disable for this limiter. The limits can be set above 300% to cause the drive to trip prior to the regulator turning on.

Motoring Trq Lim and *Gener Trq Lim* are the torque limits to start regulating the speed reference down. These are in percent motor torque. The feedback is unfiltered, calculated motor torque.

Trq Lim Kp and *Trq Lim Ki* are set up to run stable. These should not need to be tuned except for extreme situations.

The output of the regulator, when enabled, will add or subtract to the speed reference in the Ramp Generator block and become part of *FreqRampOut*.

6-2.5 CLOSED LOOP OVER VOLTAGE LIMITER (See Appendix A-10)



Parameters	Type	Default
<i>Cl Ovr Vlt En</i>	EN	Disable
<i>Cl Ovr Vlt Ref</i>	CAL	118%
<i>Cl Ovr Mtr Lim</i>	CAL	100%
<i>Cl Ovr Vlt Kp</i>	CAL	50
<i>Cl Ovr Vlt Ti</i>	CAL	15

Description:

Unlike the other limiters the close loop over voltage limiter modifies the torque producing current to the motor.

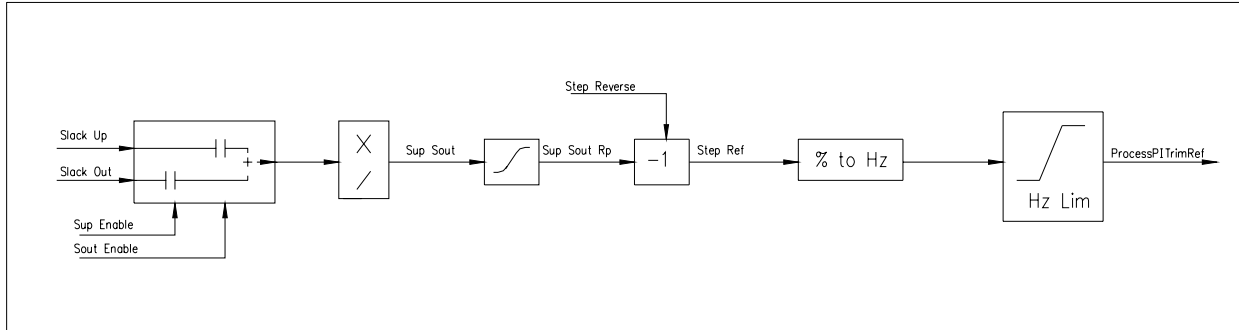
The controller is a PI regulator that will try and keep the DC-voltage below *Cl Ovr Vlt Ref* percent of nominal bus voltage.

Cl Ovr Vlt Kp and *Cl Ovr Vlt Ti* are setup to run stable. These should not need to be tuned except for extreme situations.

Cl Ovr Vlt Kp0 is an additional gain added from field weakening frequency to zero frequency. This feature is changeable in our standard speed/tension software.

6-3 SPEED STEP REFERENCE (See Appendix A-2)

FreqRampOut is the final ramped speed reference after the limiters. Droop and step inputs are then added to this value before going to the velocity controller. Depending if the section is configured for open or closed loop, this section varies slightly.



6-3.1 SPEED STEP REFERENCES

Parameters	Type	Default
<i>Sup Enable</i>	BCFG	Zero Bit
<i>Sout Enable</i>	BCFG	Zero Bit
<i>Slack Up</i>	ACFG	<i>Spd Slk Up</i> = 10.00 %
<i>Slack Out</i>	ACFG	<i>Spd Slk Out</i> = -10.00%
<i>Slack Mult</i>	ACFG	<i>Int Hundred</i> = 1.00
<i>Slack Div</i>	CAL	100
<i>Sup Sout</i>	APB	
<i>Slk No Ramp</i>	BCFG	One Bit
<i>Slack Rate</i>	CAL	10.0 % / second
<i>Sup Sout Rp</i>	APB	

Description:

Slack Up and *Slack Out* inputs are available to inject step changes into the speed reference. If both are enabled the values are added. These can be used for tuning or current sharing. The outer tension loop can also be configured to one of these inputs for speed trim control.

Slack Mult and *Slack Div* are available to scale or multiply the slack reference. This can be used to provide a percentage step. $Sup\ Sout = \text{the enabled input} \times Slack\ Mult / Slack\ Div$. *Slack Div* is used to keep the decimal points correct.

A rate-of-change limit can then be applied to *Sup Sout* to become *Sup Sout Rp*. This can be used if a pure step is too harsh for the system. *Slack Rate* is the rate and is entered in percent change per second. The ramp limit is defaulted to be bypassed (*Slk No Ramp* = One Bit).

6-3.2 SPEED STEP SCALING, REVERSE AND LIMITS

Parameters	Type	Default
<i>Sup Sout Rp</i>	APB	
<i>Step Reverse</i>	BCFG	Zero Bit
<i>Step Ref</i>		APB
<i>LS_to_Freq</i>	CAL	60
<i>LS_Scl_Div</i>	CAL	100
<i>Speed Step</i>	CAL	0
<i>Freq Max</i>	CAL	60 Hz
<i>Freq Ramp Out</i>	APB	
<i>ProcessPITrimRef</i>	APB	

Description:

Step Reverse enables the inverse polarity of *Sup Sout Rp*. The signal then becomes *Step Ref*.

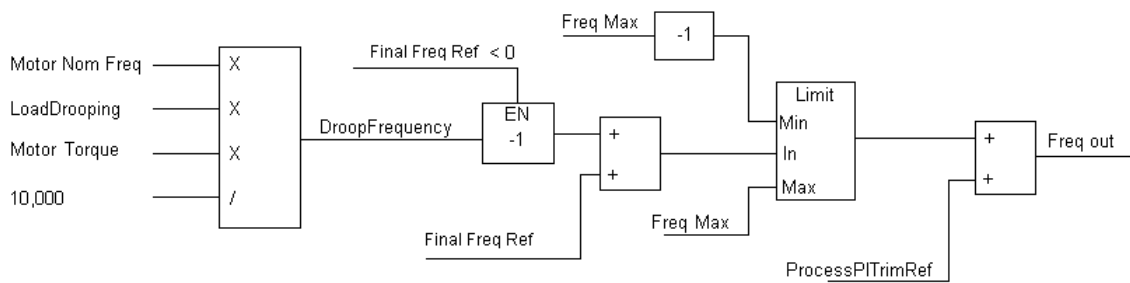
LS to Freq and *LS Scl Div* are used to scale the speed step from process units to motor hertz.

Caution: The same scaling factors are used to re-scale the speed ramp reference.

Speed Step is used by ADDaptACC to assist in tuning the speed loop. Can be toggled and set via the program.

Since this reference gets added to the ramped speed reference and goes directly to the speed loop error, limit checking must be done. The limits are set to *FreqMax* plus or minus the output of *Freq Ramp Out*.

6-3.3 OPEN LOOP STEP REFERENCE (See Appendix A-9)



Parameters	Type	Default
<i>Motor Nom Freq</i>	CAL	60.00 Hz
<i>LoadDrooping</i>	CAL	0
<i>Motor Torque</i>	APB	
<i>DroopFrequency</i>	APB	
<i>Final Freq Ref</i>	APB	
<i>Freq out</i>	APB	
<i>Freq Max</i>	CAL	60.00 Hz

Description:

Final Freq Ref is modified by the droop control. Droop gain is set from the *LoadDrooping* parameter. A setpoint of 100 equals 100% speed droop at 100% torque.

Example:

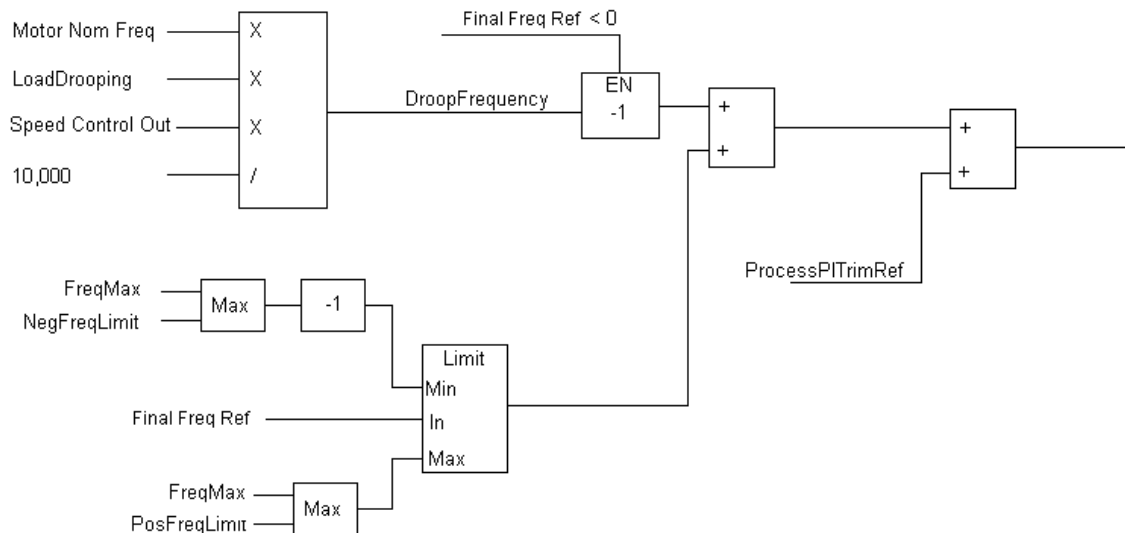
LoadDroop = 5.00%
Motor Nom Freq = 60.00 Hz
Motor Torque = 25.0%

DroopFrequency would be equal to 0.75 Hz.

DroopFrequency is positive if the section is in motoring quadrant, so the value subtracted from the speed if running forward and added if running reverse.

The speed reference is then checked to be within +/- *FreqMax* limit and added to the *ProcessPITrimRef* from the slack step inputs. The final value that goes to the open loop regulator is called *Freq out*.

6-3.4 CLOSED LOOP STEP REFERENCE (See Appendix A-10)



Parameters	Type	Default
<i>Motor Nom Freq</i>	CAL	60.00 Hz
<i>Motor Torque</i>	APB	
<i>LoadDrooping</i>	CAL	0
<i>Speed Cntrl Out</i>	APB	
<i>DroopFrequency</i>	APB	
<i>Freq Max</i>	CAL	60.00 Hz
<i>ProcessPITrimRef</i>	APB	

Parameters	Type	Default
<i>Pos Freq Limit</i>	CAL	60.00 Hz
<i>Neg Freq Limit</i>	CAL	-60.00 Hz
<i>Final Freq Ref</i>	APB	

Description:

Final Freq Ref is checked to make sure it is within the minimum and maximum limits

This is then modified by the droop control. Droop gain is set from the *LoadDrooping* parameter. A setpoint of 100 equals 100% speed droop at 100% torque.

Example:

LoadDroop = 5.00%

Motor Nom Freq = 60.00 Hz

Motor Torque = 25.0%

DroopFrequency would be equal to 0.75 Hz.

DroopFrequency is positive if the section is in the motoring quadrant, so the value is subtracted from the speed if running forward and added if running reverse.

DroopFrequency is then added to the *ProcessPITrimRef* from the slack step inputs. The final value that goes to the close loop regulator.

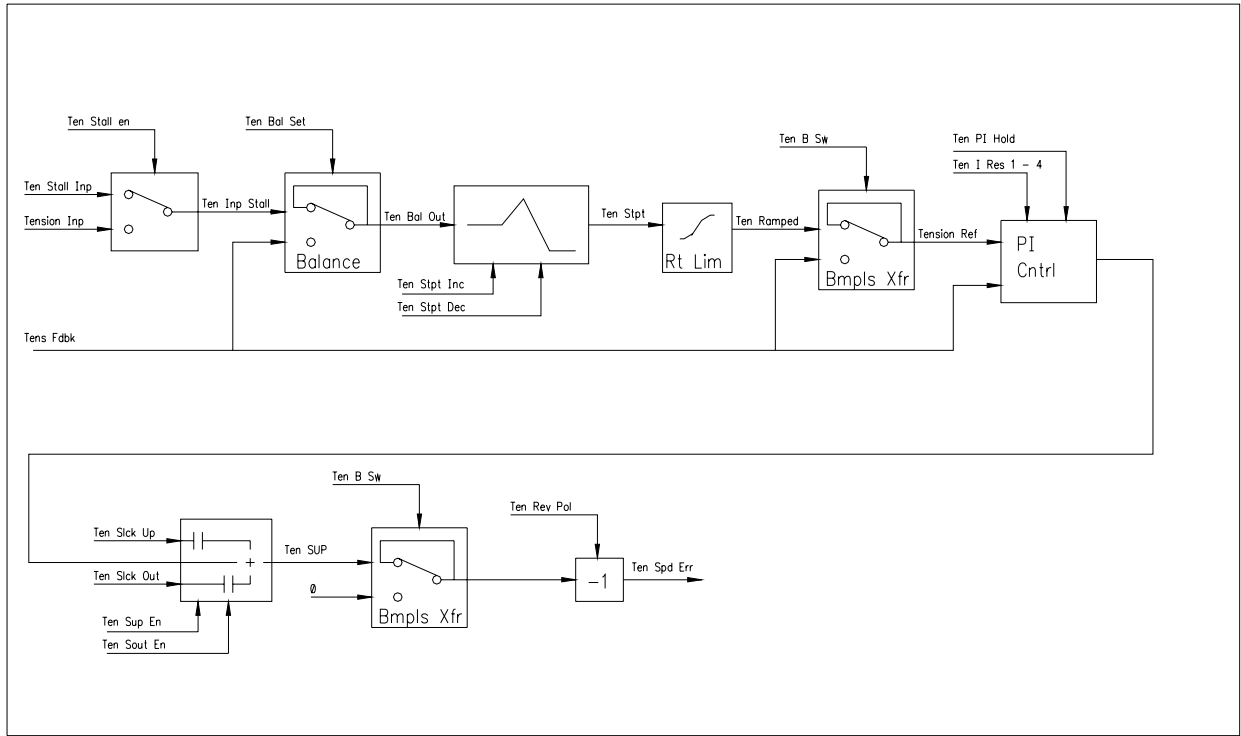
6-4 TENSION LOOP (See Appendix A-3)

The tension loop is fully configurable to be used as tension, pressure, temperature, dancer, or any other process control.

The output of the tension loop can control the drive as a speed trim, speed reference, or torque reference.

The output can also be configured to an analog output or to the communications words to control an external function not related to the drive, such as an unwind brake or pressure controller.

The tension loop is broken down into tension reference blocks and tension loop blocks.



6-4.1 TENSION REFERENCE – SETPOINTS

Parameters	Type	Default
Ten Stall En	BCFG	Zero Bit
Ten Stall Inp	ACFG	Ten Stall = 10.00%
Tension Inp	ACFG	Ten Ref = 50.00%
Ten Inp Stall	APB	
Ten Bal Ret	BCFG	Zero Bit
Ten Bal Dif	APB	
Ten Bal Set	BCFG	One Bit
Tens Fdbk	ACFG	Zero Analog
Ten Bal out	APB	
Ten Stpt Up	E	Disable
Ten Dec Rate	CAL	5.00 %/s
Ten Inc Rate	CAL	5.00 %/s
Ten Stpt Res	BCFG	Zero Bit
Ten Stpt Max	CAL	100.00 %
Ten Stpt Min	CAL	0.00%
Ten Stpt Inc	BCFG	Zero Bit
Ten Stpt Dec	BCFG	Zero Bit
Ten Stpt Dif	APB	
Ten Stpt	APB	
Ten Stpt Max	DPB	
Ten Stpt Min	DPB	

Description:

The tension reference can come from any combination of inputs.

- Selection between *Ten Stall Inp* or *Tension Inp*. Both of these can be left at their default calibration value or configured to get its reference from an external source.
- The balance block can be used to sample *Tens Fdbk* and use that value as the reference. It can then be modified by changing *Tension Inp*. This is used when the operator gets the machine to where he likes the running conditions then switches it over to tension control to hold it there.
- The setpoint block is used either to set the tension reference from increase/decrease push buttons or modify the input reference. The block has settable rates and limits along with auto reset on input updates.

6-4.2 TENSION REFERENCE – RAMP AND TRANSFER

Parameters	Type	Default
<i>Ten Stpt</i>		APB
<i>Ten Rmp Res</i>	BCFG	<i>Zero Bit</i>
<i>Ten Ramp Rate</i>	CAL	5 s
<i>Ten Ramped</i>	APB	
<i>Ten B Sw</i>	BCFG	<i>One Bit</i>
<i>Ten B Rate</i>	CAL	5.00 s
<i>Tens Fdbk</i>	ACFG	<i>Zero Analog</i>
<i>Tension Ref</i>	APB	

Description:

The tension reference (*Ten Stpt*) goes through a linear ramp with an adjustable rate called *Ten Ramp Rate*. From here the value is enabled via the bumpless switch. This ramps the reference from the feedback value to its running value when tension is enabled. This provides a smooth transition into tension mode. The rate of the transfer is set by *Ten B Rate*. Once the transition is complete, the block passes its input to the output. *Tension Ref* then goes to the tension PI block.

6-4.3 TENSION LOOP

Parameters	Type	Default
<i>Ten I Res 1</i>	BCFG	<i>Cntrl Inhib</i>
<i>Ten I Res 2</i>	BCFG	<i>One Bit</i>
<i>Ten I Res 3</i>	BCFG	<i>Ten At Max</i>
<i>Ten I Res 4</i>	BCFG	<i>Ten At Min</i>
<i>Ten PI Hold</i>	BCFG	<i>Zero Bit</i>
<i>Ten Preload</i>	ACFG	<i>Zero Analog</i>
<i>Ten P Inp</i>	ACFG	<i>Ten P Gain = .01</i>
<i>Ten I Inp</i>	ACFG	<i>Ten I Gain = 1.00</i>
<i>Ten PI Out</i>	APB	
<i>Ten Max Lmt</i>	CAL	10.00 %
<i>Ten Min Lmt</i>	CAL	-10.00%
<i>Ten PI Gn Scale</i>	CAL	1
<i>Tension Ref</i>	APB	
<i>Tens Fdbk</i>	ACFG	<i>Zero Analog</i>
<i>Ten PI Min</i>	DPB	
<i>Ten PI Max</i>	DPB	

Description:

The PI regulator can be reset from one of four selectable bits. The defaults are:

- *Cntrl Inhib*, which goes high after the drive is stopped.
- *Ten At Max*, *Ten At Min*, which disable the PI block and enable the slack steps. Helpful for dancer control.
- *One Bit*, which disables the loop unless needed.

When reset, the output can be set to a preload value by setting *Ten Preload* to the desired input.

When *Ten PI Hold* goes high, the tension regulator is held at its last output. The reset inputs have a higher priority than the hold input.

The proportional gain value of 1.0 will produce an output of 1 with an error of 1. The integral gain is in repeats per gain. With an I gain value of 5.00 and an error of 10, the output will ramp by 10 every five seconds.

Ten PI Gn Scale is a direct multiply on the error. This has the net affect of increasing both the P and the I gains.

The output of the regulator is limited by *Ten Max Lmt* and *Ten Min Lmt*. If the output is a speed reference trim, then these limits affect the amount the speed can change.

6-4.4 TENSION LOOP – OUTPUT

Parameters	Type	Default
<i>Ten Sup En</i>	BCFG	<i>Ten At Min</i>
<i>Ten Sout En</i>	BCFG	<i>Ten At Max</i>
<i>Ten PI Out</i>	APB	
<i>Ten Slck Up</i>	ACFG	<i>Ten Slk Up</i> = 10.00%
<i>Ten Slck Out</i>	ACFG	<i>Ten Slk Out</i> = -10.00%
<i>Ten SUP</i>	APB	
<i>Spd Bump Sw</i>	BCFG	<i>Zero Bit</i>
<i>Spd B Rate2</i>	CAL	5.00 %/s
<i>Ten Rev Pol</i>	BCFG	<i>Zero Bit</i>
<i>Ten Spd Err</i>	APB	

Description:

The output of the Tension regulator passes through the following enable blocks before it is used in the control. The summing block allows additional references to be added after the regulator. It is defaulted to add or subtract 10% reference if the tension feedback is out of range. To disable this feature, set the associated configuration bits to *Zero Bit* (1002).

The bumpless switch is used to smoothly transfer out of tension control back to speed control. It will ramp its output to zero by the *Spd B Rate2* value in % per second.

Ten Rev Pol corrects *Ten Spd Err* for the proper polarity to the control reference.

Ten Spd Err can be configured to become a speed reference trim or torque reference, or configured to an analog output for external control.

6-4.5 TENSION LOOP – FEEDBACK COMPARATOR

Parameters	Type	Default
<i>Ten Cmp Stp</i>	ACFG	<i>Max Tension</i> = 100.00%
<i>Max Ten Set</i>	CAL	90.00%
<i>Min Ten Set</i>	CAL	10.00%
<i>Max Ten Hys</i>	CAL	5.00%
<i>Tens Fdbk</i>	ACFG	<i>Zero Analog</i>
<i>Ten HL Decimal</i>	CAL	2
<i>Ten At Max</i>	DPB	
<i>Ten_At_Min</i>	DPB	

Description:

The tension feedback comparator can be used to shut down the line on overtension or perform a web loss detection. It can also be used on dancer control to take the section out of tension control and add a speed slack up until the dancer is lifted. The compare block setting is a percentage of *Ten Cmp Stp*.

Ten At Max will go high when *Tens Fdbk* goes above the *Max Ten Set* percentage of *Ten Cmp Stp*.

Ten At Min will go high when *Tens Fdbk* goes below the *Min Ten Set* percentage of *Ten Cmp Stp*.

6-5 SPARE BLOCKS (See Appendix A-6)

Spare blocks are logic blocks that can be used and inserted anywhere in the software. The following lists the blocks available.

6-5.1 SPARE REFERENCE BLOCKS

Parameters	Type	Default
Table Block		
<i>Sp_Tbl0 Inp</i>	ACFG	<i>One Analog</i>
<i>Sp_Tbl0 Xin</i>	ACFG	<i>Zero Analog</i>
<i>Sp_Tbl0 Gn</i>	CAL	1.00
<i>Table 0</i>	Array	Table 0 32 values
<i>Sp Tbl0 Out</i>	APB	
Table Block		
<i>Sp_Tbl1 Inp</i>	ACFG	<i>One Analog</i>
<i>Sp_Tbl1 Xin</i>	ACFG	<i>Zero Analog</i>
<i>Sp_Tbl1 Gn</i>	CAL	1.00
<i>Table 1</i>	Array	Table 1 32 values
<i>Sp Tbl1 Out</i>	APB	
Table Block		
<i>Sp_Tbl2 Inp</i>	ACFG	<i>One Analog</i>
<i>Sp_Tbl2 Xin</i>	ACFG	<i>Zero Analog</i>
<i>Sp_Tbl2 Gn</i>	CAL	1.00
<i>Table 2</i>	Array	Table 2 32 values
<i>Sp Tbl2_Out</i>	ACFG	<i>Zero Analog</i>
Muldiv Block		
<i>Sp MD1 Val</i>	ACFG	<i>Zero Analog</i>
<i>Sp MD1 Mul</i>	ACFG	<i>Sp MD1 Mlt = 1.00</i>
<i>Sp MD1 Div</i>	ACFG	<i>Sp MD1 Dv = 1.00</i>
<i>Sp MD1 Out</i>	APB	
Muldiv Block		
<i>Sp MD2 Val</i>	ACFG	<i>Zero Analog</i>
<i>Sp MD2 Mul</i>	ACFG	<i>Sp MD2 Mlt = 1.00</i>
<i>Sp MD2 Div</i>	ACFG	<i>Sp MD2 Dv = 1.00</i>
<i>Sp MD2 Out</i>	APB	
Add Block		
<i>Sp Add1 In1</i>	ACFG	<i>Sp Add Val = 0.00</i>
<i>Sp Add1 In2</i>	ACFG	<i>Sp Add Val = 0.00</i>
<i>Sp Add1 Out</i>	APB	
Sub Block		
<i>Sp Sub1 In1</i>	ACFG	<i>Sp Sub Val = 0.00</i>
<i>Sp_Sub1 In2</i>	ACFG	<i>Sp Sub Val = 0.00</i>
<i>Sp Sub1 Out</i>	APB	

Low Pass Block

<i>Sp LP Fil TC</i>	CAL	0.1 sec
<i>Sp LP Fil In</i>	ACFG	<i>Zero Analog</i>
<i>Sp LP Fil Out</i>	APB	

ABS Block

<i>Sp ABS In</i>	ACFG	<i>Zero Analog</i>
<i>Sp ABS Out</i>	APB	

Sum Block

<i>Sp Sum1 EnA</i>	BCFG	<i>Zero_Bit</i>
<i>Sp Sum1 EnB</i>	BCFG	<i>Zero_Bit</i>
<i>Sp Sum1 EnC</i>	BCFG	<i>Zero_Bit</i>
<i>Sp Sum1 InA</i>	ACFG	<i>Sp Sum1 StA = 0.00</i>
<i>Sp Sum1 InB</i>	ACFG	<i>Sp Sum1 StB = 0.00</i>
<i>Sp Sum1 InC</i>	ACFG	<i>Sp Sum1 StC = 0.00</i>
<i>Sp Sum1 Out</i>	APB	

Bumpless Block

<i>Sp Bmp Sw</i>	BCFG	<i>Zero_Bit</i>
<i>Sp Bmp In1</i>	ACFG	<i>Sp Bmp St1 = 0</i>
<i>Sp Bmp Rate1</i>	CAL	0
<i>Sp Bmp In2</i>	ACFG	<i>Sp Bmp St2 = 0</i>
<i>Sp Bmp Rate2</i>	CAL	0
<i>Sp Bmp Hold</i>	BCFG	<i>Zero Bit</i>
<i>Sp Bmp Dn1</i>	DPB	
<i>Sp Bmp Dn2</i>	DPB	
<i>Sp Bmp Out</i>	APB	

Sel Block

<i>Sp Sel1 En1</i>	BCFG	<i>Zero_Bit</i>
<i>Sp Sel1 In0</i>	ACFG	<i>Sp Sel1 ST0 = 0</i>
<i>Sp Sel1 In1</i>	ACFG	<i>Sp Sel1 ST1 = 0</i>
<i>Sp Sel1 Out</i>	APB	

Sel Block

<i>Sp Sel2 En1</i>	BCFG	<i>Zero_Bit</i>
<i>Sp Sel2 In0</i>	ACFG	<i>Sp Sel2 ST0 = 0</i>
<i>Sp Sel2 In1</i>	ACFG	<i>Sp Sel2 ST1 = 0</i>
<i>Sp Sel2 Out</i>	APB	

Lim Block

<i>Sp Lim Min</i>	CAL	-100.00
<i>Sp Lim Max</i>	CAL	100.00
<i>Sp Lim Inp</i>	ACFG	<i>Zero_Analog</i>
<i>Sp Lim Out</i>	APB	

WParamVal

<i>Sp WPVal Inp</i>	ACFG	<i>Zero_Analog</i>
<i>Sp WPVal ID</i>	ACFG	0

WParamVal

<i>Sp WPVal2 Inp</i>	ACFG	<i>Zero_Analog</i>
<i>Sp WPVal2 ID</i>	ACFG	0

Description:

Each of these blocks is an individual block as described in the block functional specification.

6-5.2 SPARE LOGIC BLOCKS

Parameters	Type	Default
HL Comp Block		
<i>Sp HL Stpt</i>	ACFG	<i>Sp HL Stpt</i> = 100.00
<i>Sp HL High</i>	CAL	90.00
<i>Sp HL Low</i>	CAL	10.00
<i>Sp HL Hyst</i>	CAL	<i>Sp HL Hyst</i> = 1.00
<i>Sp HL Inp</i>	ACFG	<i>Zero Analog</i>
<i>Sp LH Decimal</i>	CAL	2
<i>Sp HL Max</i>	DPB	
<i>Sp HL Min</i>	DPB	
Comp Block		
<i>Sp Cmp1 In</i>	ACFG	<i>Sp Cmp1 Stpt</i> = 50.00
<i>Sp Cmp1 Thres</i>	ACFG	<i>Sp Cmp1 Stpt</i> = 50.00
<i>Sp Cmp1 Hyst</i>	CAL	1.00
<i>Sp Cmp1 Out</i>	DPB	
<i>Sp Cmp1 Eq</i>	DPB	
Comp Block		
<i>Sp Cmp2 In</i>	ACFG	<i>Sp Cmp2 Stpt</i> = 50.00
<i>Sp Cmp2 Thres</i>	ACFG	<i>Sp Cmp2 Stpt</i> = 50.00
<i>Sp Cmp2 Hyst</i>	CAL	1.00
<i>Sp Cmp2 Out</i>	DPB	
<i>Sp Cmp2 Eq</i>	DPB	
Delay Block		
<i>Sp Dly1 TON</i>	CAL	0.100 seconds
<i>Sp Dly1 TOFF</i>	CAL	0.100 seconds
<i>Sp Dly1 In</i>	BCFG	<i>Zero Bit</i>
<i>Sp Dly1 Out</i>	DPB	
Delay Block		
<i>Sp Dly2 TON</i>	CAL	0.100 seconds
<i>Sp Dly2 TOFF</i>	CAL	0.100 seconds
<i>Sp Dly2 In</i>	BCFG	<i>Zero Bit</i>
<i>Sp Dly2 Out</i>	DPB	
Latch Block		
<i>Sp Ltch1 L</i>	BCFG	<i>Zero Bit</i>
<i>Sp Ltch1 H1</i>	BCFG	<i>One Bit</i>
<i>Sp Ltch1 H2</i>	BCFG	<i>One Bit</i>
<i>Sp Ltch1 Out</i>	DPB	
Latch Block		
<i>Sp Ltch2 L</i>	BCFG	<i>Zero Bit</i>
<i>Sp Ltch2 H1</i>	BCFG	<i>One Bit</i>
<i>Sp Ltch2 H2</i>	BCFG	<i>One Bit</i>
<i>Sp Ltch2 Out</i>	DPB	
Latch Block		
<i>Sp Ltch3 L</i>	BCFG	<i>Zero Bit</i>
<i>Sp Ltch3 H1</i>	BCFG	<i>One Bit</i>
<i>Sp Ltch3 H2</i>	BCFG	<i>One Bit</i>
<i>Sp Ltch3 Out</i>	DPB	

Parameters	Type	Default
BInv Block		
<i>Sp Inv1 In</i>	BCFG	<i>Zero Bit</i>
<i>Sp Inv1 Out</i>	DPB	
BInv Block		
<i>Sp Inv2 In</i>	BCFG	<i>Zero Bit</i>
<i>Sp Inv2 Out</i>	DPB	
BInv Block		
<i>Sp Inv3 In</i>	BCFG	<i>Zero Bit</i>
<i>Sp Inv3 Out</i>	DPB	
Or Block		
<i>Sp Or1 In1</i>	BCFG	<i>Zero Bit</i>
<i>Sp Or1 In2</i>	BCFG	<i>Zero Bit</i>
<i>Sp Or1 Nin3</i>	BCFG	<i>One Bit</i>
<i>Sp Or1 Out</i>	DPB	
Or Block		
<i>Sp Or2 In1</i>	BCFG	<i>Zero Bit</i>
<i>Sp Or2 In2</i>	BCFG	<i>Zero Bit</i>
<i>Sp Or2 Nin3</i>	BCFG	<i>One Bit</i>
<i>Sp Or2 Out</i>	DPB	
Or Block		
<i>Sp Or3 In1</i>	BCFG	<i>Zero Bit</i>
<i>Sp Or3 In2</i>	BCFG	<i>Zero Bit</i>
<i>Sp Or3 Nin3</i>	BCFG	<i>One Bit</i>
<i>Sp Or3 Out</i>	DPB	
And Block		
<i>Sp And1 In1</i>	BCFG	<i>One Bit</i>
<i>Sp And1 In2</i>	BCFG	<i>One Bit</i>
<i>Sp And1 Nin3</i>	BCFG	<i>Zero Bit</i>
<i>Sp And1 Out</i>	DPB	
And Block		
<i>Sp And2 In1</i>	BCFG	<i>One Bit</i>
<i>Sp And2 In2</i>	BCFG	<i>One Bit</i>
<i>Sp And2 Nin3</i>	BCFG	<i>Zero Bit</i>
<i>Sp And2 Out</i>	DPB	
And Block		
<i>Sp And3 In1</i>	BCFG	<i>One Bit</i>
<i>Sp And3 In2</i>	BCFG	<i>One Bit</i>
<i>Sp And3 Nin3</i>	BCFG	<i>Zero Bit</i>
<i>Sp And3 Out</i>	DPB	

SECTION VII

MOTOR CONTROL MODE

7-1 TORQUE REFERENCE (See Appendix A-2)

The torque reference is used when *Motor Ctrl Mode / Motor Ctrl Mode2* is selected for torque control. The reference can be used with speed control as a torque limit.

7-1.1 TORQUE REFERENCE BLOCKS

Parameters	Type	Default
<i>En Trq RefA</i>	BCFG	<i>Zero Bit</i>
<i>En Trq RefB</i>	BCFG	<i>Zero Bit</i>
<i>En Trq RefC</i>	BCFG	<i>Zero Bit</i>
<i>Trq Ref</i>	ACFG	<i>Trq Ref StA = 0.0</i>
<i>Trq RefB</i>	ACFG	<i>Trq Ref StB = 0.0</i>
<i>Trq RefB Mlt</i>	ACFG	<i>Trq RefB MSt = 1.00</i>
<i>Trq RefB Div</i>	CAL	1.00
<i>Trq Ref C</i>	ACFG	<i>Trq Ref StB = 0.0</i>
<i>Control Place</i>	CAL	0
<i>Trq Dir</i>	BCFG	<i>Zero Bit</i>
<i>Keypad_Trq_Dir</i>	DPB	

Control Place determines if the reference is coming from the keypad or from the reference sum block. It also determines where the invert reference bit comes from.

A sum block adds together the inputs that are enabled. The main torque reference is usually configured to *Trq Ref*. *Trq RefB* and *Trq Ref C* are used for load sharing. *Trq RefB* is used if a ratio load share is desired, while *Trq Ref C* is used for a difference sharing.

If *Control Place* is set for local control, then the torque reference comes from the drive's keypad.

The torque polarity is set by either *Trq Dir* or *Keypad Trq Dir* depending on *Control Place*.

7-1.2 TORQUE REFERENCE ENABLE, RAMP AND LIMITS

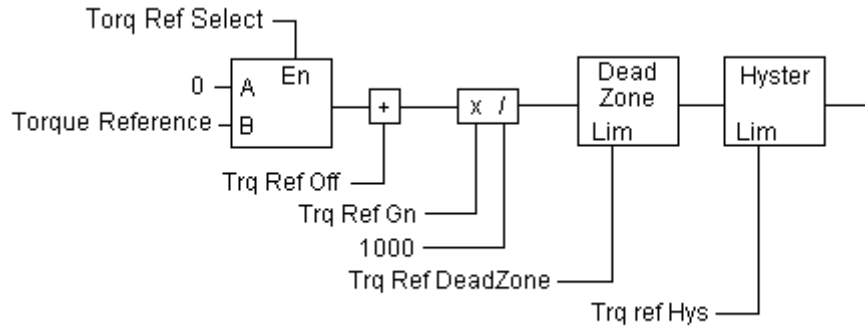
Parameters	Type	Default
<i>Trq Ref En</i>	BCFG	Zero Bit
<i>Trq No Ramp</i>	BCFG	One Bit
<i>Trq Rmp Rate</i>	CAL	5 % / second
<i>Trq_Ref_Min</i>	CAL	100.0%
<i>Trq Ref Max</i>	CAL	0%
<i>Torque Reference</i>	APB	

To enable the torque reference, *Motor Ctrl Mode* must be selected as torque control and *Trq Ref En* must be set high.

The Torque reference can go through an optional ramp limiter. To enable this, set *Trq No Ramp* to *Zero Bit*. *Trq Rmp Rate* is entered in % torque per second rate.

The reference is then checked for its limits before going to the firmware as *Torque Reference*.

7-1.3 TORQUE REFERENCE FIRMWARE, PART I



Parameters	Type	Default
<i>SC Trq Chain Sel</i>	En	0 = Not used
<i>Torque Reference</i>	APB	
<i>Trq Ref Gn</i>	CAL	1000
<i>Trq Ref Off</i>	CAL	0
<i>Trq Ref DeadZone</i>	CAL	0
<i>Trq Ref Hyst</i>	CAL	0

SC Trq Chain Sel determines the operation of the torque reference as follows:

- 0 = Not Used
- 1 = Torque limit to the speed loop
- 2 = Torque reference added to speed loop (Or only reference)
- 4 = Position control (See closed loop speed loop description)

Torque Ref Select enables *Torque Reference* setpoint.

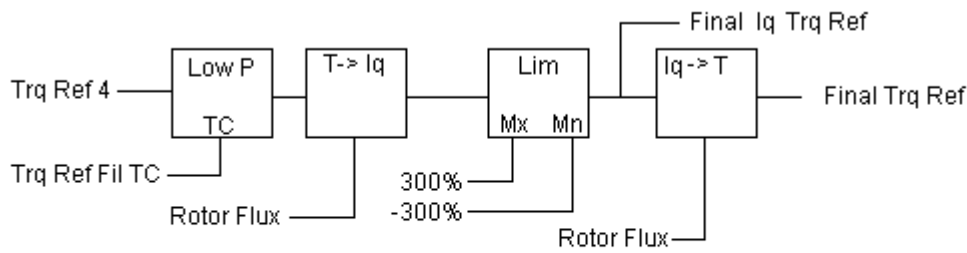
$$\text{Trq Ref 3} = (\text{Torque Reference} + \text{Trq Ref Off}) \times \text{Trq Ref Gn} / 1000$$

The torque reference is forced to zero if it is less than +/- *Trq Ref DeadZone* in percent torque. This is used to ignore small values.

Trq ref Hys sets a limit around zero to which the setpoint will not be allowed to go. The polarity of the torque will depend on the polarity of the Torque command when it falls below this limit.

Trq Ref 4 is the value after the dead zone and hysteresis blocks.

7-1.4 TORQUE REFERENCE FIRMWARE, PART II



Parameters	Type	Default
<i>Trq Ref Fil TC</i>	CAL	0 ms
<i>Torque Step</i>	CAL	0
<i>Final Iq Trq Ref</i>	APB	
<i>Final Trq Ref</i>	APB	

Trq Ref 4 goes through a second order low-pass filter with a time constant of *Trq Ref Fil TC*.

Torque Step is available for the ADDaptACC program to provide step changes for tuning.

The reference is then converted to motor current by taking into account the estimated *Rotor Flux*.

After being checked to be within +/- 300% current, the *Final Iq Trq Ref* is created. Also, converting back to torque reference is done to create *Final Trq Ref*.

7-2 OPEN LOOP CONTROL (See Appendix A-9)

Open loop control is set by having *Motor Ctrl Mode* = 0 – 2.

- 0 = Frequency control (Volts/Hertz)
- 1 = Open loop speed control (Open loop vector speed control)
- 2 = Open loop torque control (Open loop vector torque control)

Each mode has its own regulator scheme. In each open loop mode there are three stabilizers: Torque, DC-Link, and Flux. Each of these are factory-set, but are explained for reference.

7-2.1 TORQUE STABILIZER

The Torque stabilizer is used to dampen possible oscillations in the estimated torque calculations. This loop comes into affect above 3 hertz and is factory tuned. The reference to the controller is the derivative of the estimated torque value. The stabilizer control is a proportional-only controller with a variable gain. The gain is changed linearly between zero and field weaken frequency. The Zero and field weaken gain points are be TorqStabGain and TorqStabGainFWP.

TorqStabGainHwDtcFWP is an additional gain with dead time compensation above the field weaken point.

The output of the regulator is also limited by TorqStabLimit. The output of the controller goes through a damping block to reduce spikes from the derivative input based on parameter *TorqStabDamp*.

The torque stabilizer is factory set and the parameters are not editable.

- TorqStabGain = 100 gain
- TorqStabGainFWP = 50 gain
- TorqStabGainHwDtcFWP = 50
- TorqStabLimit. = 150 Hz/FreqScale
- TorqStabDamp = 900

7-2.2 DC-LINK STABILIZER

The DC-link Stabilizer operates similar to the Torque stabilizer and also operates above 3 hertz. The reference to the controller is the derivative of the DC-link voltage. The proportional gain is variable by estimated motor torque. As the torque increases from 10% to 50%, the controller gain decreases from VoltStabGain to zero gain.

VoltStabGainHwDtc is an additional gain with dead time compensation.

The output of this stabilizer is limited by VoltStabLimit. The output of the controller goes through a damping block to reduce spikes from the derivative input based on parameter VoltStabDamp.

The Voltage stabilizer is factory set and the parameters are not editable.

VoltStabGain = 100 gain
VoltStabGainHwDtc = 50 gain
VoltStabLimit = 150 Hz/FreqScale
VoltStabDamp = 900

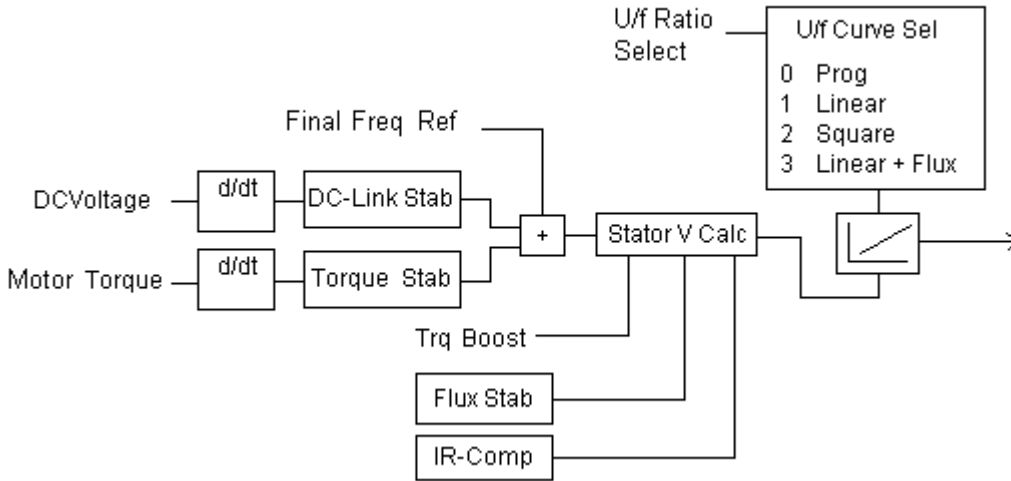
7-2.3 FLUX STABILIZER

The Flux stabilizer purpose is to stabilize the magnetizing current. The error to the controller is from the difference between filtered and unfiltered magnetizing current. The filtered signal has a time constant of ldsFiltCoeff (in ms). The Flux stabilizer is a proportional-only controller with a gain of ldsStabGAinRef.

The Flux stabilizer is factory set and the parameters are not editable.

ldsFiltCoeff = 64 ms.
ldsStabGAinRef = 500 gain

7-2.4 OPEN LOOP FREQUENCY REFERENCE (*Motor Ctrl Mode = 0*)



Parameters	Type	Default
<i>Motor Ctrl Mode</i>	CAL	0 = Open Loop Frequency mode
<i>DCVoltage</i>	APB	
<i>Motor Torque</i>	APB	
<i>Freq out</i>	APB	
<i>U/f Optimization</i>	CAL	0
<i>Meas Rs V Drop</i>	CAL	0
<i>Ir Add Mtr Scl</i>	CAL	100
<i>Ir Add Gen Scl</i>	CAL	0
<i>Ir Add 0 Pt V</i>	CAL	0
<i>U/F Ratio Select</i>	CAL	0 = Linear
<i>Zero Freq Voltg</i>	CAL	0
<i>Voltage at FWP</i>	CAL	100.00
<i>U/F Mid Freq</i>	CAL	50.00 HZ
<i>U/F Mid Voltg</i>	CAL	100.00

If *Motor Ctrl Mode = 0*, then *Freq out* becomes the drives motor frequency reference in volts per hertz mode.

The torque and DC-link voltage stabilizer output is added straight to the frequency reference. Both of these stabilizers are zero mean additions to the output frequency. The Torque stabilizer is to dampen possible oscillations in the estimated torque calculations and DC-Link stabilizer is to dampen changes in the DC bus voltage.

The Stator Voltage calculation block takes the output of *Freq out* modified by the stabilizers and calculates the correct stator voltage. Inputs to this calculation are the torque boost and IR compensation.

Torque boost is enabled by setting *U/F Optimization = 1*. The torque boost is to compensate for the voltage drop due to stator resistance. This is done in the following ways.

- If the *Meas Rs V Drop* is set, then this value is used. This can be set by the user or the drive will calculate it if DC-brake is active for longer than two seconds.
- If the *Meas Rs V Drop* is not used, then the drive will estimate the voltage drop. This estimation can be viewed at *DefRsVoltageDrop*.

The IR compensation scaling is broken up into two values, depending if the drive is in motoring or in generation mode. The two variables are *Ir Add Mtr Scl* and *Ir Add Gen Scl*. These are scaled in percentage of the amount to add to the reference. The IR compensation value then goes through a low-pass filter with a time constant of *IrAddFilterTC*, which is hard coded to 8 ms. The gain of this filter goes from zero to full scale at *IrAddFreqLimit*, which is hard coded to 1 Hz. Between zero and this *IrAddFreqLimit*, a constant voltage *IrAddZeroPointVoltage* can be added.

The output voltage is then determined by going through one of three volts per hertz curves. Selection of a curve is done with the *U/F Ratio Select* parameter.

- *U/F Ratio Select* = 0 = Linear curve – As the name implies, this performs a linear curve between the *Zero Freq Voltg* and *Voltage at FWP*. *Zero Freq Voltg* is entered in percent of nominal voltage and is the starting voltage for the drive.

Voltage at FWP is entered in percent of nominal voltage and is the ending voltage when the field weakening frequency has been reached.

- *U/F Ratio Select* = 1 = Squared – The same parameters as Linear curve are used except, instead of a linear interpolation between the two points, a squared curve is used.
- *U/F Ratio Select* = 2 = Programmable – This is automatically selected if the drive has completed its identification with run and built the frequency-to-voltage curve. Three voltage, frequency points are found and used to define the curve. The points are:

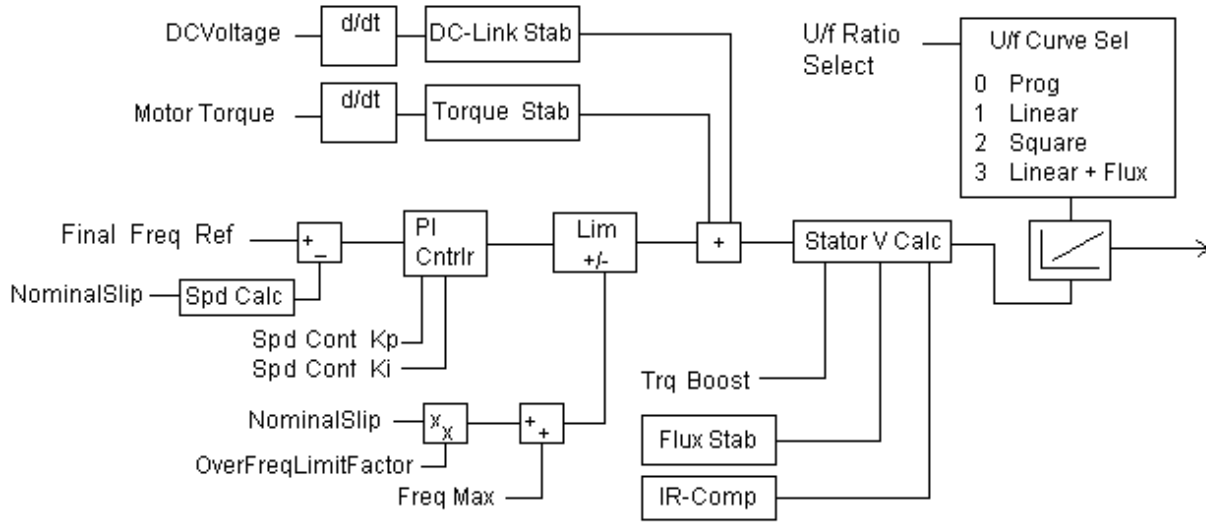
UFZeroPointVoltage

U/f Mid Freq

Voltage at FWP

- *UFRatio* = 3 = Linear with Flux optimization – Uses the linear curve with voltage being drooped during constant operation. The advantage of this modification is to reduce motor losses. The disadvantage is a lag in the torque loop.

7-2.5 OPEN LOOP SPEED CONTROL (*Motor Ctrl Mode = 1*)



Parameters	Type	Default
<i>Motor Ctrl Mode</i>	CAL	0 = Open Loop Frequency mode
<i>Freq out</i>	APB	
<i>Spd Cont Kp</i>	CAL	3000 Gain
<i>Spd Cont Ki</i>	CAL	300 Gain
<i>Freq Max</i>	CAL	60 Hz

If *Motor Ctrl Mode*= 1, then *Freq out* becomes the drive’s open loop speed reference.

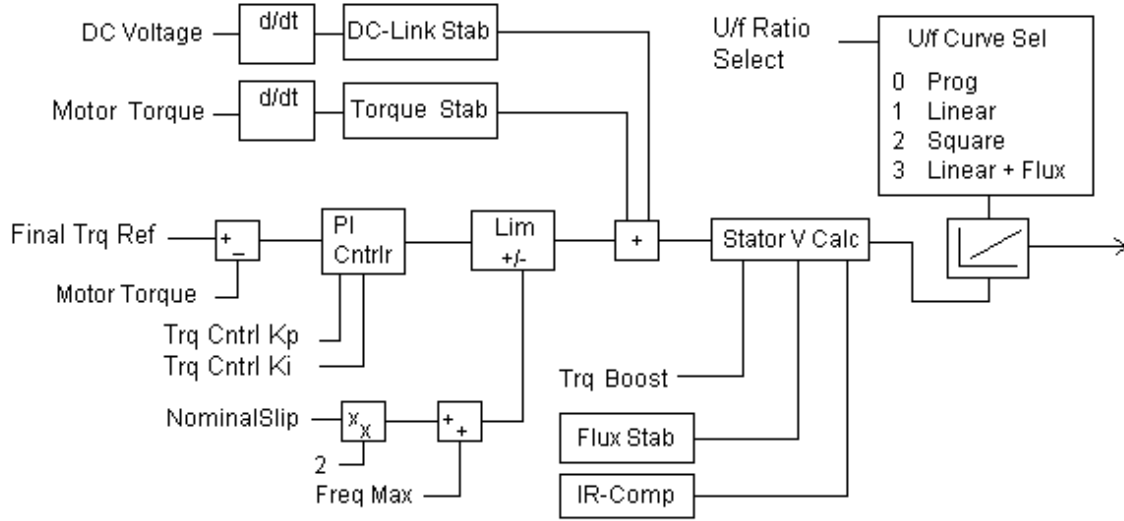
The motor speed feedback is calculated from the motor voltage and the estimated slip value (*NominalSlip*).

The error is then passed to a Speed PI regulator. The proportional gain is set by *Spd Cont Kp* and the integral gain is set by *Spd Cont Ki*.

The output of the PI regulator is limited to *Freq Max* plus the value of *NominalSlip* x *OverFreqLimitFactor*. *OverFreqLimitFactor* is factory-set for 300 and allows the motor to get to its rated speed.

After the frequency limiter, the reference goes through the same stabilizers and volts per hertz curve as the open loop frequency reference. See the section prior to setup of these control sections.

7-2.6 OPEN LOOP TORQUE CONTROL (*Motor Ctrl Mode = 2*)



Parameters	Type	Default
<i>Motor Ctrl Mode</i>	CAL	0 = Open Loop Frequency mode
<i>Final TrqRef</i>	APB	
<i>Motor Torque</i>	APB	
<i>Trq Cntrl Kp</i>	CAL	150 Gain
<i>Trq Cntrl Ki</i>	CAL	10 Gain
<i>Freq Max</i>	CAL	60 Hz
<i>Torq Speed Limit</i>	E	1 = Freq Ref

If *Motor Ctrl Mode = 2*, then *Final Trq Ref* becomes the drive’s open loop torque reference. See section 7-1 for the origin of this signal.

The drive goes into torque control if the drive is not in a limit controller and if the operating frequency is above 3 Hertz. The error from *Final Trq Ref* and *Mtr Torq Unfil* passes to a torque PI regulator. The proportional gain is set by *Trq Cntrl Kp* and the integral gain is set by *Trq Cntrl Ki*.

The output of the torque PI regulator is limited to *Torq Speed Limit* plus the value of *NominalSlip x 2*. This allows the motor to get to its rated speed. *Torq Speed Limit* can be set to either *Freq Max* or *Freq Ref*.

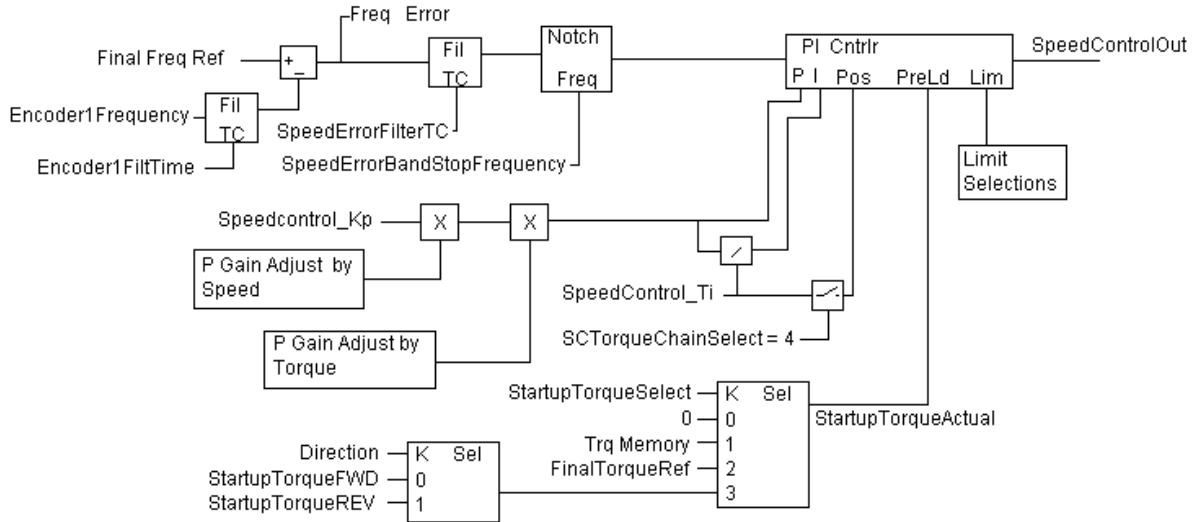
After the frequency limiter, the reference goes through the same stabilizers and volts per hertz curve as the open loop frequency reference. See the section prior to setup of these control sections.

7-3 CLOSED LOOP CONTROL (See Appendix A-10)

Closed loop control is set by having *MotorControlMode*= 3 or 4.

- 3 = Closed loop speed control
- 4 = Closed loop torque control

7-3.1 CLOSED LOOP SPEED CONTROL (*Motor Ctrl Mode* = 3)



Parameters	Type	Default
<i>Motor Ctrl Mode</i>	CAL	0 = Open Loop Frequency mode
<i>Final Freq Ref</i>	APB	
<i>Encoder1FiltTime</i>	CAL	0 ms
<i>Freq Error</i>	APB	
<i>Spd Err Fil TC</i>	CAL	0 ms
<i>Spd Err LP Freq</i>	CAL	100 Hz
<i>Spd Err Bnd Frq</i>	CAL	0 Hz
<i>Speed Control Kp</i>	CAL	30 Gain
<i>Speed Control Ti</i>	CAL	30.0 ms
<i>Spd Cntrl F0</i>	CAL	0 Hz
<i>Spd Cntrl F1</i>	CAL	0 Hz
<i>Spd Cntrl Kp F0</i>	CAL	100%
<i>Spd Cntrl Kp FW</i>	CAL	100%
<i>Spd Cntrl Kp T0</i>	CAL	100%
<i>Spd Cntrl T0</i>	CAL	
<i>SC Trq Chain Sel</i>	CAL	0 = Not Used.
<i>Startup Trq Sel</i>	CAL	0 = No Preload
<i>StartupTorq FWD</i>	CAL	0%
<i>StartupTorq REV</i>	CAL	0%
<i>Mtr Cur Lim Scl</i>	ACFG	<i>Mtr Cur Limit</i> = 100%
<i>Final Trq Ref</i>	APB	
<i>Motoring Trq Lim</i>	CAL	300%
<i>Gener Trq Lim</i>	CAL	300%
<i>Trq Lim FWD</i>	CAL	300%

Parameters	Type	Default
<i>Trq Lim REV</i>	CAL	300%
<i>Speed Cntrl Out</i>	APB	

If *Motor Ctrl Mode* =3, then *Final Freq Ref* becomes the drive’s closed loop speed reference. See Speed Reference (section 6-1.1) and Speed Step Reference (section 6-1.2) in this manual for the origin of this signal.

The Speed feedback comes from the first encoder board input detected by the drive. This value is represented on the diagram as Encoder1Frequency but is not available for viewing. This frequency can be filtered by a low pass filter with a time constant of *Encoder1FilTime*.

The speed loop error signal is can be viewed with the parameter *Freq Error*, which is in Freqscale units.

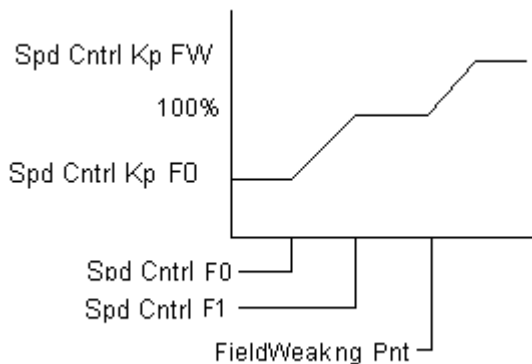
The error signal passes through two filters before going to the PI regulator. The first filter is a low pass filter with a time constant of *Spd Err Fil TC* and a cutoff frequency of *Spd Err LP Freq*. The second is a notch filter centered around *Spd Err Bnd Frq*.

The filtered error is then passed to the speed loop PI regulator. This regulator is an anti-windup proportional integrator controller with variable gains.

The standard proportional gain is set by *Speed Control Kp*. The standard integral component is a ratio of the *Speed Control Kp / Speed Control Ti*.

Two algorithms are used to modify the speed loop gains. Both are defaulted such that 100% of *Spd Cntrl Kp* goes to the controller.

A) P Gain Adjust by Speed



The P gain adjust by speed has two parts associated with it: First, the gain can be modified at lower frequencies, and gain modified above the field weaken range. *Spd Cntrl F0* and *Spd Cntrl F1* define the frequency window which will modify the gain. The block gain will change linearly from the setpoint *Spd Cntrl Kp F0* at *Spd Cntrl F0* to 100% at *Spd Cntrl F1*.

Second, the gain can then be modified in the field weakened range. The percent output will increase linearly from 100% to *Spd Cntrl Kp FW* when the motor speed reaches maximum frequency.

B) P Gain Adjust by Torque

Spd Cntrl Kp T0 is the P gain percent adjust at zero torque. The percentage will go to 100% when torque reaches the *Spd Cntrl T0* point.

The Speed loop regulator has the option for Type II speed control or position control. This is enabled by setting *SC Trq Chain Sel* = 4. When enabled, a second proportional gain equal to *Speed Control Ti* is added to the integrator error. The idea is to keep zero position error by keeping the speed loop integrator equal to zero. When activated, *Speed Control Ti* may need re-tuning.

C) Closed Loop Speed Control Preload

The speed loop can be preloaded on start to provide initial torque. Preload can come from four sources, depending on *Startup Trq Sel*.

- *Startup Trq Sel* = 0 (Default) No preload.
- *Startup Trq Sel* = 1 (Torque Memory). The torque the drive was commanding prior to the last stop command being activated will be used.
- *Startup Trq Sel* = 2 (Torque Reference). The regulator will be preloaded with *Final Trq Ref* value. See section 7-1 for configuration.
- *Startup Trq Sel* = 3 (Starting Torque Setpoint). Depending on the direction commanded on the start, will decide if *Startup Torq FWD* or *Startup Torq REV* will be used to preload the regulator.

D) Closed Loop Speed Regulator Output Limits

The output of the speed control regulator has several limits that can be applied. Some are based on which quadrant the drive is running. The final limit is the least value of all of the following and can be viewed at *MotorCurLimit*.

Mtr Cur Lim Scl is a percentage of the *Motor Nom Currnt* setpoint that is used as the main current limit. This limits the current in all quadrants. It is defaulted to 100%, which is the lowest default limit. Since *CurrentLimitOption.B0* is factory-set to zero, this current limit is the motor maximum current times the motor's power factor.

The overvoltage limiter controller will also limit the speed loop output if enabled. See section 6-2.6.

If *SC Trq Chain Sel* is set = 1, then *Final Trq Ref* becomes an output limit to the controller.

1. Quadrant #1: Forward Motoring
 - *Motoring Trq Lim* which is defaulted to 300%
 - *Trq Lim FWD* which is defaulted to 300%
 - *MotoringPowerLim* which is factory set at 300%

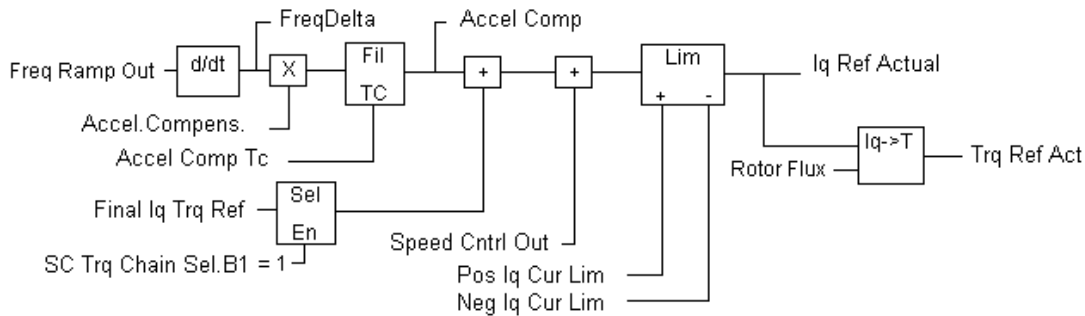
2. Quadrant #2: Reverse Generating
 - *Gener Trq Lim* which is defaulted to 300%
 - *Trq Lim REV* which is defaulted to 300%
 - *GeneratorPowerLim* which is factory set at 300%

3. Quadrant #3: Reverse Motoring
 - *Motoring Trq Lim* which is defaulted to 300%
 - *Trq Lim REV* which is defaulted to 300%
 - *MotoringPowerLim* which is factory set at 300%

4. Quadrant #4: Forward Generating
 - *Gener Trq Lim* which is defaulted to 300%
 - *Trq Lim FWD* which is defaulted to 300%
 - *GeneratorPowerLim* which is factory set at 300%

E) Closed Loop Speed Control Current Reference

The output of the speed regulator can be viewed at *Speed Cntrl Out* in percent motor torque.



Parameters	Type	Default
<i>Freq Ramp Out</i>	APB	
<i>FreqDelta</i>	APB	
<i>Accel.Compens.</i>	CAL	0 s
<i>Accel Comp Tc</i>	CAL	0 ms

Parameters	Type	Default
<i>Accel Comp</i>	APB	
<i>Final Iq Trq Ref</i>	APB	
<i>SC Trq Chain Sel.B1</i>	CAL	0 Not Used
<i>Speed Cntrl Out</i>	APB	
<i>Rotor Flux</i>	APB	
<i>Trq Ref Act</i>	APB	

The output of the speed loop regulator gets added to the inertia compensation and optional torque adder reference.

The inertial compensation value is determined by taking the derivative of *Freq Ramp Out*, which will yield the acceleration rate in motor hertz per second (*FreqDelta*). *Accel.Compens.* is the gain of the inertia compensation. This value is scaled in the amount of time it takes to accelerate the drive with nominal torque to nominal speed. If *Freq Ramp Out* is coming from an external signal a low pass filter is required to make the gain stable. *Accel Comp Tc* is the time constant in ms for this filter. The inertia compensation torque reference can be viewed at *Accel Comp*.

Final Iq Trq Ref is the output of the torque reference blocks and can be configured to add to the speed controller output. This would be used as a load anticipation signal.

After the signals are added together, the sum is then checked to be within the torque and current limits as defined based on the quadrant the drive is running. See the section before for details.

The reference can be viewed as torque using *Trq Ref Act*.

7-3.2 CLOSED LOOP TORQUE CONTROL (*Motor Ctrl Mode* = 4) (See Appendix A-2)

Parameters	Type	Default
<i>Final Trq Ref</i>	APB	
<i>Final Iq Trq Ref</i>	APB	
<i>TC Pos Freq Lim</i>	APB	
<i>TC Neg Freq Lim</i>	APB	
<i>TC Spd Lim Sel</i>	CAL	0 – No ramping
<i>Trq Spd Lim Mode</i>	CAL	0 – Max Min
<i>Freq Ramp Out</i>	APB	
<i>Win Pos Width</i>	CAL	0 Hz
<i>Win Neg Width</i>	CAL	0 Hz

In closed loop torque control, *FinalTrq Ref* and *Final Iq Trq Ref* is used as the drive's torque command. See section 7-1 for how to setup the references.

While in closed loop torque control, there are several methods to limit the motor's speed. To use these, it must be noted that the speed loop must be tuned for stable operation. The method is selected by *Trq Spd Lim Mode* and *TC Spd Lim Sel* parameters. The output limits of the different methods can be viewed by *TC Pos Freq Lim* and *TC Neg Freq Lim*.

- A) *Trq Spd Lim Mode* = 0 = Maximum Limits. The section will be in torque control until motor speed exceeds either *PosFreqMaxActual* or *NegFreqMaxActual*.
- B) *Trq Spd Lim Mode* = 1 = Absolute value of speed reference. The section will be in torque control until the motor exceeds the absolute value of *Freq Ramp Out*, which is the ramped speed reference.
- C) *Trq Spd Lim Mode* = 2 = Speed reference and Min Frequency. The section will be in torque control until the motor exceeds *Freq Ramp Out* or *NegFreqMaxActual*.
- D) *Trq Spd Lim Mode* = 3 = Max frequency and Speed reference. The section will be in torque control until the motor exceeds *PosFreqMaxActual* or *Freq Ramp Out*.
- E) *Trq Spd Lim Mode* = 4 = Window. The section will be in torque mode as long as the speed is within a window around *Freq Ramp Out*.

The positive side is *Freq Ramp Out* + *Win Pos Width*. The negative side = *Freq Ramp Out* – *Win Neg Width*.

- F) *Trq Spd Lim Mode* = 5 = Speed reference and zero. The section will be in torque control until the motor exceeds *Freq Ramp Out* and zero frequency. *Freq Ramp Out* is either the maximum limit or the minimum limit based on motor direction.
- G) *Trq Spd Lim Mode* = 6 = Window select. This mode is not available and should not be selected.

The changes to *TC Pos Freq Lim* and *TC Neg Freq Lim* can be ramped to avoid fast speed changes. These limits are changed when *Trq Spd Lim Mode* is changed while running or transferring into torque mode from speed control. The *TC Spd Lim Sel* word determines how the limits are ramped. *TC Spd Lim Sel* is defaulted to 0, which disables limit ramping.

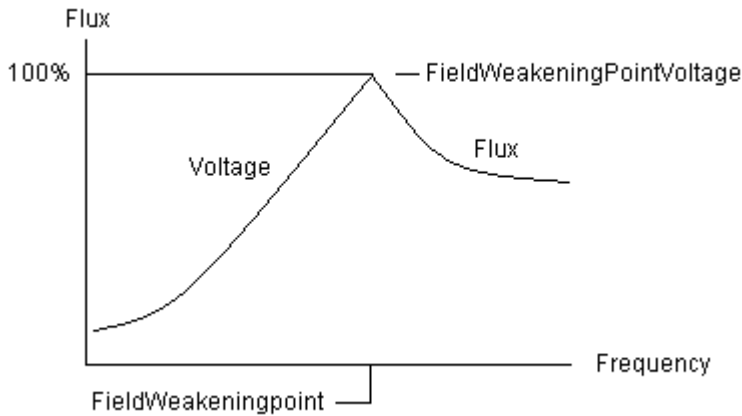
The speed reference ramp times are used when the limit ramping is enabled.

- A) *TC Spd Lim Sel.B0* = 1 = Ramp out of torque control. When enabled, the speed reference will ramp at its current value to *Freq Ramp Out* when the mode is transferred from torque control to speed control.
- B) *TC Spd Lim Sel.B1* = 1 = Smart ramp down. If the speed limit is reduced as a step change, the drive will ramp the limit from the current motor running speed to the new limit.
- C) *TC Spd Lim Sel.B2* = 1 = Ramp Up. If the speed limit is increased as a step change, the drive will ramp the limit up to its new value.
- D) *TC Spd Lim Sel.B3* = 1 = Ramp Down. If the speed limit is decreased as a step change, the drive will ramp the limit down to its new value.
- E) *TC Spd Lim Sel.B4* = 1 = Follow Actual. Used with *TC Spd Lim Mode* = 6, which is not available in this software version.
- F) *TC Spd Lim Sel.B5* = 1 = Force Ramp stop. On removal of run, the limits will step to the actual motor speed, then ramp to zero.
- G) *TC Spd Lim Sel.B6* = 1 = Max speed. Sets *TCPosFreqLimitActual* to motor speed when transitioning into torque mode from speed mode. If Ramp Up is also enabled, the upper limit will then ramp to its setpoint creating a smooth transition into torque mode.
- H) *TC Spd Lim Sel.B7* = 1 = Speed Limits. Similar to *TC Spd Lim Sel.B6*, except that both limits are set to the motor speed on the transition into torque mode. Then based on the Ramp Up and Ramp Down bits, they will ramp to the setpoints. Provides a smooth transition into torque mode regardless of if the torque is higher or lower than the desired torque when enabled.

7-3.3 FLUX REFERENCE (See Appendix A-11)

Parameters	Type	Default
<i>MagnCurrent</i>	CAL	Tune
<i>Motor Nom Currnt</i>	CAL	SetId
<i>Id Ref</i>	APB	
<i>Field Weakengpnt</i>	CAL	60.00 Hz
<i>Voltage at FWP</i>	CAL	100.00 volts
<i>Start DC-Brake Tm</i>	CAL	0 ms
<i>DC-Brake Current</i>	CAL	54.0 amps
<i>Strt 0 Spd Time</i>	CAL	100 ms.
<i>Stop 0 Spd Time</i>	CAL	100 ms.
<i>Stop St Magn I</i>	CAL	50%
<i>Stop St Magn Tim</i>	CAL	30 seconds

The magnetizing current reference for the motor is set by the parameter *Magn Current*. This value is in motor amps and gets converted to percentage by dividing it by *Motor Nom Currnt* x 100. This is the full magnetizing current during normal operation giving full rotor flux. Additional references are added before starting, after stop, and during field weakening operations. *Id Ref* is the final Id current reference.



Id Ref is adjusted during the field weakened range of the motor. *Field Weakengpnt* defines the frequency to start reducing the motor flux. The drive also monitors motor voltage and reduces the flux to keep the value below *Voltage at FWP*. Another voltage limit is also used to keep the motor voltage below the DC-Link voltage. The motor voltage is limited by *ModIndexLimit* x measured motor volts. *ModIndexLimit* is factory-set to 100%.

FluxCurrentRampTime defines the rate of change limit for the Flux current except at a start. This value is factory set to 200 ms.

At a run command, the flux has an accelerated ramp time defined by *StartBoostRiseTime* which is factory-set to 10 ms.

The time between when the drive is commanded to run and the ramp is released is defined by *Strt 0 Spd Time*. During that time, *DC-Brake Current* can be added for the length of time defined by *Start DC-Brake Tm*. After *Start DC-Brake Tm* has timed out, the flux returns to its full value by the *FluxCurrentRampTime*.

After the run command is removed and the section has ramped to zero, the motor flux stays at its nominal value until *Stop 0 Spd Time* has elapsed. The current then ramps to the *Stop St Magn I* percentage for the *Stop St Magn Tim*. This keeps the field at a lower level for a period of time for operations that perform a lot of quick start and stops.

7-3.4 FLUX MODELING (See Appendix A-11)

Parameters	Type	Default
<i>Slip Adjust</i>	CAL	100%
<i>Flux Curve a</i>	CAL	10%
<i>Flux Curve b</i>	CAL	20%
<i>Flux Curve c</i>	CAL	30%
<i>Flux Curve d</i>	CAL	40%
<i>Flux Curve e</i>	CAL	50%
<i>Flux Curve f</i>	CAL	60%
<i>Flux Curve g</i>	CAL	70%
<i>Flux Curve h</i>	CAL	80%
<i>Flux Curve i</i>	CAL	90%
<i>Flux Curve j</i>	CAL	100%
<i>Flux Curve k</i>	CAL	110%
<i>Flux Curve l</i>	CAL	120%
<i>Flux Curve m</i>	CAL	130%
<i>Flux Curve n</i>	CAL	140%
<i>Flux Curve_o</i>	CAL	150%

The flux model of the drive uses the motor nameplate data, measured currents, and motor speeds and outputs flux angle, rotor flux frequency, and flux amplitude. The flux angle is used to perform field-oriented control that separates the magnetizing current and torque producing current. The rotor flux frequency is used to control the field weakening operations. The estimated flux verses motor current is adjusted by the programmable flux curve.

The rotor time constant is needed to perform the flux model. This time constant is estimated from the nominal motor speed, current, frequency, and cos (magnetizing current). This calculated value is then adjusted by *Slip Adjust*. Slip adjust is for manual tuning of the motor slip. A value less than 100% decreases the slip which, in turn, increases the rotor time constant.

Motor magnetizing current is related to the estimated motor flux by a preset saturation curve. This curve has 15 points (*Flux Curve a* to *Flux Curve o*). Each point represents the flux at each step of the magnetizing current range, from 0 to 150% at 10% steps. The default is a linear line.

7-3.5 CURRENT CONTROL LOOP (See Appendix A-11)

Parameters	Type	Default
<i>CurrentControlKp</i>	CAL	4000 Gain
<i>Curr Cntrl_Ti</i>	CAL	15 ms
<i>Motor Type</i>	E	0 = Induction

In closed loop mode, a faster current control loop is selected. The motor phase currents are measured and the corresponding vector reference is calculated. The actual current regulation is performed with two PI controllers. The IdReference controller regulates magnetizing current. The IqReference controller regulates motor torque. *CurrentControlKp* and *Curr Cntrl Ti* modify the gain of the regulators.

The output of the current regulators determines motor voltage vector.

Other factors that determine the final current loop output are encoder angle calculation from the encoder, Motor CEMF, and inverter bridge dead time.

The current loop regulator runs at 140 microsecond time frame.

SECTION VIII

MISCELLANEOUS CONTROLS

This section deals with all the control blocks and firmware parameters that do not fit into any other category.

8-1 OVERSPEED AND AT ZERO SPEED (See Appendix A-8)

Spd Fdbk is defaulted to *Motor Speed* but can be reconfigured to an encoder input or analog input.

Spd Fdbk is passed through a low pass filter with a time constant of *Spd Cmp Fil TC* before it goes to the speed comparator.

The speed comparator setpoints are a percentage of the value *Ovr Spd Inp*, which is defaulted to parameter *Max RPM*.

The zero speed setpoint is defined by *Zero Detect* which is defaulted to 2.00%. *At Zero Spd* bit will go high when the percentage of *Spd Fdbk* falls below this value minus the hysteresis value *Spd Hyst*.

The Overspeed setpoint is defined by *Ovr Spd Stp*, which is defaulted to 110.00%. Over Speed will go high when the percentage of *Spd Fdbk* goes above this value plus the hysteresis value *Spd Hyst*.

Spd Decimal is defaulted to 2. Modify this if the compare block setpoint decimal place needs to be moved due to integer limitations.

8-2 MOTOR BRAKING (See Appendix A-11)

8-2.1 DC Braking

Parameters	Type	Default
<i>DC-Brake Current</i>	CAL	3.70 Amps
<i>MC Run</i>	DPB	
<i>Start DC-BrakeTm</i>	CAL	0.00 s
<i>DC Brk Cmd</i>	BCFG	<i>Zero Bit</i>
<i>Stop DC-BrakeFr</i>	CAL	1.50 Hz
<i>DC Tim Rmp Stp</i>	CAL	0.00 s
<i>DC Tim Cst Stp</i>	CAL	0.00 s
<i>DC Brake Current</i>	APB	

The drive can be setup to deliver DC current to the motor during start and stopping. This converts the regenerative power back into the motor windings causing heat. *DC Brk Cmd* enables this feature and *DC-Brake Current* sets the amount of amps to deliver to the motor.

On start DC can be injected into the motor to keep it from moving until brakes are released. *Start DC-BrakeTm* sets the amount of time to deliver the current.

During stop if enabled the drive will put out DC current when it reaches below the *Stop DC-BrakeFr* setting. It will keep the current on for the amount of time set by either *DC Tim Rmp Stp* or *DC Tim Cst Stp*.

8-2.2 Flux Braking

Parameters	Type	Default
<i>FluxBrakeCurrent</i>	CAL	3.70 Amps
<i>Flux Brake</i>	E	Off

Flux braking is similar to DC braking as it converts the stopping energy into motor heat. The difference is that instead of putting pure DC into the windings it controls a slip and voltage differential to be able to control the stop.

8-3 SWITCHING FREQUENCY (See Appendix A-11)

The motor switching frequency is set by *Switching Freq* parameter. The default for this is frame size dependent.

8-4 PARAMETER SETS

The Keypad can store two sets of parameter values. These can be downloaded or saved via the keypad menu. The drive can not be running during this transition. The logic in control block diagrams *Param_Set_1* and *Param_Set_2* prevents the transitions or starting a run before the transition is complete.

Warning: The drive does not know which parameter set is loaded.

SECTION IX

COMMUNICATIONS

The drive can communication through a wide variety of communication boards that can be inserted into slots D and E. Examples of some of the protocols include:

- Ethernet – Modbus TCP, Etherent IP, EGD
- Devicenet
- System Bus – Master Slave
- Profibus DP
- Modbus serial link

Each communication board has its own manual that details the protocol and connections. This section will discuss the generic software control blocks that are used for each protocol.

There are usually two methods of reading and writing data to the drive. The protocols either have preset messages such as defined in the EDS sheets for Devicenet or they can read or write to a particular address. The parameter ID number represents its address in most of the message structures. The drive appendices include the ID number with the parameter name. Not all parameters have an ID number.

ID numbers 0 – 1000 are designated for firmware variables.

ID numbers 1001 – 2000 are designated for the application variables.

9-1 READ AND WRITE STANDARD ID NUMBERS (See Appendix A-7)

The following parameters are set aside for write messages to the drive. The addresses are grouped together so one write message can get them all. The drive can then be configured to use these locations for proper function.

There are four words where bits can be written to:

- 1) *FB Fix Cntl Wrd* (ID 1621) – Depending on which protocol is used several of these bits are predetermined.
- 2) *FB Gen Cntl Wrd* (ID 1630) – None of the bits are predefined and open to user choice.
- 3) *FB Word Out 8* (ID 1618) – Alternate word if more than one communication channel needs to write bits.
- 4) *SB In Cntl Word* (ID 1530) – Used for input bits from the system bus.

The above words can be unpacked to the following bits based on the selector.

ID	Parameter Name	Bit Location	Selector
1040	<i>FB Bit00</i>	0	<i>FB Bit Sel 1</i>
1041	<i>FB Bit01</i>	1	<i>FB Bit Sel 1</i>
1042	<i>FB Bit02</i>	2	<i>FB Bit Sel 1</i>
1043	<i>FB Bit03</i>	3	<i>FB Bit Sel 1</i>
1044	<i>FB Bit04</i>	4	<i>FB Bit Sel 2</i>
1045	<i>FB Bit05</i>	5	<i>FB Bit Sel 2</i>
1046	<i>FB Bit06</i>	6	<i>FB Bit Sel 2</i>
1047	<i>FB Bit07</i>	7	<i>FB Bit Sel 2</i>
1048	<i>FB Bit08</i>	8	<i>FB Bit Sel 3</i>
1049	<i>FB Bit09</i>	9	<i>FB Bit Sel 3</i>
1050	<i>FB Bit10</i>	10	<i>FB Bit Sel 3</i>
1051	<i>FB Bit11</i>	11	<i>FB Bit Sel 3</i>
1052	<i>FB Bit12</i>	12	<i>FB Bit Sel 4</i>
1053	<i>FB Bit13</i>	13	<i>FB Bit Sel 4</i>
1054	<i>FB Bit14</i>	14	<i>FB Bit Sel 4</i>
1055	<i>FB Bit15</i>	15	<i>FB Bit Sel 4</i>

Each bit selector unpacks four bits from any of the four field bus words.

Example:

If *FB Bit Sel 1* is set to Gen Ctrl W then *FB Bit00 – FB Bit03* is unpacked from the first 4 bits of *FB Gen Cntl Wrđ*.

Write integer to the drive:

ID	Parameter Name
1611	<i>FB Word In 1</i>
1612	<i>FB Word In 2</i>
1613	<i>FB Word In 3</i>
1614	<i>FB Word In 4</i>
1615	<i>FB Word In 5</i>
1616	<i>FB Word In 6</i>
1617	<i>FB Word In 7</i>
1618	<i>FB Word In 8</i>
1619	<i>FB Word In 9</i>
1620	<i>FB Word In 10</i>

The following parameters are set aside for read messages from the drive. The addresses are grouped together so one read message can get them all. Any parameter with an ID number can be configured to these locations.

16 configurable points are available to pack bits into two words for reading by the communications. The bits are directly written in order to *FB Gen Sts Word* . All the bits except for the lower 4 are written to *SB Out Cntl Word*.

Read bits from the drive:

Configuration Parameter	Bit Set
<i>FB Bit Cfg Out00</i>	00
<i>FB Bit Cfg Out01</i>	01
<i>FB Bit Cfg Out02</i>	02
<i>FB Bit Cfg Out03</i>	03
<i>FB Bit Cfg Out04</i>	04
<i>FB Bit Cfg Out05</i>	05
<i>FB Bit Cfg Out06</i>	06
<i>FB Bit Cfg Out07</i>	07
<i>FB Bit Cfg Out08</i>	08
<i>FB Bit Cfg Out09</i>	09
<i>FB Bit Cfg Out10</i>	10
<i>FB Bit Cfg Out11</i>	11
<i>FB Bit Cfg Out12</i>	12
<i>FB Bit Cfg Out13</i>	13
<i>FB Bit Cfg Out14</i>	14
<i>FB Bit Cfg Out15</i>	15

Read integer from the drive:

ID	Parameter Name	Configuration Parameter
1622	<i>FB Word Out 1</i>	<i>FB Word Cfg Out1</i>
1623	<i>FB Word Out 2</i>	<i>FB Word Cfg Out2</i>
1624	<i>FB Word Out 3</i>	<i>FB Word Cfg Out3</i>
1625	<i>FB Word Out 4</i>	<i>FB Word Cfg Out4</i>
1626	<i>FB Word Out 5</i>	<i>FB Word Cfg Out5</i>
1627	<i>FB Word Out 6</i>	<i>FB Word Cfg Out6</i>
1628	<i>FB Word Out 7</i>	<i>FB Word Cfg Out7</i>
1629	<i>FB Word Out 8</i>	<i>FB Word Cfg Out8</i>

9-2 SPECIAL FIELD BUS VARIABLES

For certain predefined field bus messages, certain parameters are used in the firmware.

FBActSpd_ID is used for several predefined messages for Devicenet and Profibus DP. This parameter is set to *Motor Speed* .

FB Spd Ref is defaulted to get the desired reference by some field bus protocols. *Master Ref* needs to be configured to this to become the drives speed reference.

9-3 FAULTS

- A) Slot Fault – Field bus fault is set when either SlotDBoardStatus or SlotEBoardStatus indicates a problem. This bit can go to a fault block that can be configured for a drive warning or a fault.

- B) Watchdog Bit - Logic is built into the drive to allow for an external device to toggle a bit to create a communication watchdog. The system bus has separate watchdog timer logic.

Configure *Watchdog In* to the field bus input bit that the PLC is going to toggle.
 Configure the fieldbus output bit to *Watchdog Out*.

The external device should read bit *Watchdog Out* and return the inverse of the bit that gets configured to *Watchdog In*.

When *Com WD* is enabled, Com WD fault will go high (*WD Trip*) after the bit stops toggling for *WD Com Dly* amount of time in ms.

WD Init Dly Tim delays this fault on power up to give the communications a chance to establish.

Set *WD Flt Response* for the action the drive will take on a communication failure.

9-4 SYSTEM BUS (See Appendix A-7)

The Speed/Tension software supports the Master/Slave configuration of the system bus.

Each node on the network must have an ID from 0 to 63. *SBIId* sets the section ID. Also set *SBNextId* parameter for the next section's ID.

The parameter *SB Mode* determines if a drive is the master or a slave section. Only one master can be set up on the fiber network. The master sends out five integers which all slaves connected read and can act upon.

A) Master Section Output Packet

Integer	Parameter name	Description
1	<i>SB Out Cnt1 Word</i>	Control Bits
2	<i>Freq out</i>	Ramped speed reference
3	<i>Trq Ref Act</i>	Torque reference
4	<i>SB Out Int1</i>	Configurable variable
5	<i>SB Out Int2</i>	Configurable variable

B) Slave Section Input Packet

Integer	Parameter name	Description
1	<i>SB In Cnt1 Word</i>	Control Bits
1 bit 1	<i>MD Drive OK</i>	From master <i>MC Ready</i>
1 bit 2	<i>MD Run Enable</i>	From master <i>Run Enable</i>
1 bit 3	<i>MD Watchdog</i>	From master <i>SB WD Pulse</i>
2	<i>SB In Freq Ref</i>	Optional speed reference
3	<i>SB In Trq Ref</i>	Optional torque reference
4	<i>SB In Int1</i>	Unused variable
5	<i>SB In Int2</i>	Unused variable

C) Faults and Watchdog timer bit

The Master section sends out a watch dog bit called *SB WD Pulse* which toggles every 100 ms. This come into the slave as *MD Watchdog* which is the default to *MD WD*. If the bit does not toggle in 1 second, then *MD WD OK* will go low, which can be used to stop the section or fault the drive out.

The *MD_Watchdog* and *SB Comm Lost* bits are used to create *SB Comm Flt* after failure for *SB Comm Flt Tim* ms. When *SB Comm Flt* goes low, *SB Comm Flt Resp* will set a warning or fault the drive out.

SECTION X

FAULT CODES

(See Appendix A-8)

Drive faults can be derived from either hard coded firmware faults or from the application Fault block.

The firmware faults have no options associated with them. They will fault the drive with a coast stop and record the event in the FIFOs. *MC Fault* bit will go high when a fault has occurred and has not been reset. *MC Warning* goes high when a drive warning is active.

The application Fault block allows different options such as drive action, Stop type, recording, and ability to reset the fault. See the Fault block in the function block library for in depth description of the Fault block. Fault block triggers can come from either the firmware or from the application program.

10-1 FAULT ACTIONS

Fault action is decided by the FMode input of the Fault block. There are three options available.

- 0 = Disabled
- 1 = Warning – No drive action but the information is stored in the Fault FIFO
- 2 = Fault – Drive performs a stop.

10-2 STOP ACTION

The type of drive stop command is decided with the Stop input of the Fault block. There are three options available.

- 0 = Coast stop – Highest priority if multiple faults occur
- 1 = Normal stop mode
- 2 = Ramp stop.

10-3 FAULT RESET

A fault can be reset by several methods. The parameter *Fault Reset* will reset all active faults.

Each fault block also has an individual fault reset input, called Reset, that can be used.

The drive can be set up to auto reset on certain faults. The drive will allow the fault to auto reset so many times per the following table within *Auto Rst SVTime*. After a fault the drive will wait

Auto Rst Wait time before resetting. *Auto Rst StartM* determines how the drive will start after an auto reset (0 = Ramp, 1 = Flying start, 2 = Start Function parameter).

Fault Code	Fault Text	Trails
1	Overcurrent	<i>Auto Rst OC Trls</i>
2	Overvoltage	<i>Auto Rst OV Trls</i>
9	Undervoltage	<i>Auto Rst UV Trls</i>
16	Mot.Overtemp	<i>Auto Rst Mtr OT</i>
17	MotorUnderld	<i>Auto Rst Uload T</i>
31	IGBT Temp	<i>Auto Rst OC Trls</i>
41	IGBT Temp	<i>Auto Rst OC Trls</i>
51	Ext Fault	<i>Auto Rst ExtF T</i>

10-4 RECORDING

There are two fault FIFOs: active fault FIFO which records 10 faults, and history table FIFO that records 30 faults/warnings.

The Hist input of the Fault block determines how it is recorded into the FIFO. There are 4 options available:

- 0 = Fault always will be stored.
- 1 = If a fault occurs several times, each event will be logged unless they occur within the time frame defined by the Wait input. The wait input is set in 10 ms increments.
- 2 = Fault will be recorded if different than the previous fault recorded.
- 3 = Not recorded.

The last active fault code can be viewed at *Active Flt Last* value.

10-5 DRIVE FAULTS

Fault Code	Fault Text	Possible Cause	Solution
1	Overcurrent	Over 400% nominal current detected. - Sudden increase in load. - Needs tuning - Shorted motor / cables - Unsuitable or bad motor	- Check section for binding or excessive loads. - Check motor tuning - Check motor leads and motor shorts - Replace drive - Replace motor
2	Overvoltage	DC bus has exceeded its upper limit. - Braking resistor not working properly - Deceleration too rapidly - Unstable or utility voltage spikes.	- Check brake resistor and chopper unit - Check deceleration rates - Verify proper incoming voltage
3	Earth Fault	Sum of motor current do not equal zero. - Motor cable or motor short to ground. - Bad current sensing	- Check motor cables for shorts to ground - Check motor for short to ground. - Replace drive inverter.
5	Charging Switch	The charging switch was open when a run command was given. - Faulty operation - Component Failure	- Reset the fault and try to restart. - Replace charging unit
6	Emergency Stop	Input board not found or not seated properly.	- Reseat I/O boards. - Replace I/O boards.
7	Saturation	Very high overload - Cable / motor short - Defective component	- Cannot be reset must cycle power. - If occurs with Fault #1 then check motor and motor cables.
8	System Fault	Additional information will be stored in FIFOs. - Component Failure	- Replace processor board.
9	Undervoltage	DC bus has dropped below its lower limit. - Supply voltage too low - Converter fault - Excessive loading	- Check incoming voltage level - Check for Convert fault - Check motor loading - Replace converter
10	Input Phase	Input line phase missing. - Bad external fuse - Bad voltage sensing	- Check each input phase - Replace Converter
11	Output Phase	No current detected in one of the output motor leads. - Bad motor lead or motor. - Bad current sensor	- Check motor cables for an open phase. - Check motor for open winding - Replace Drive inverter
12	Brk Chopper Supr	Brake Chopper operation failure. - Bad resistor - Chopper failure	- Check and replace braking resistor - Replace brake chopper components
13	Undertemp	Heat sink temperature under -10°C. - Ambient temperature too low. - Thermister failure	- Heat drive enclosure - Replace drive power components.
14	Overtemp	Heatsink over 90° C. - Ambient temperature too high. - Drive cooling not adequate - Bad temperature sensor	- Lower drive enclosure ambient temperature. - verify fan operation

Fault Code	Fault Text	Possible Cause	Solution
15	Motor Stall	Motor stall protection tripped. - Motor is binding - Not enough motor torque available. - Stall protection set too tight.	- Check to make sure motor is not binding. - Retune to get proper magnetizing current. - Check stall protection for proper setup. - Verify motor is getting current. - Replace motor - Replace inverter
16	Mot.Overtemp	Motor over heating detected by temperature model.	- Check for excessive motor loading - Check motor cooling - Check motor current to verify proper tuning.
17	MotorUnderld	Motor underload protection trip.	- Check process for load. - Check shafts and couplings - Check Under load parameters for proper setting.
22/23	Chksum Flt	EEProm has checksum fault.	- Verify parameters are set properly - Replace microprocessor board.
24	Changed data warning	Changes may have occurred during power interruption	- Check parameters against saved file - re-download parameters - Replace microprocessor board.
25	Micro Watchdog	Microprocessor timed out.	- Redownload the system and application software. - Replace microprocessor board.
29	Thermistor	Thermistor out of range.	- Replace thermistor
31	IGBT Temp	IGBT temperature exceeded its limit.	- Check ambient temperature - Check drive fan - Check for excessive build up of material on heat sink - Observe operation for high drive loading.
32	Fan cooling	Detection of a fan failure	- Replace Fan - Replace Fan controller - Replace drive
37	Device Change	Option board changed.	- Enter correct parameters for new option board. - Check I/O board seating - Replace option board.
38	Device Added	Option board or different drive size changed.	- Enter correct parameters for new hardware. - Check I/O board seating. - Check microprocessor board connection. - Replace drive
39	Device Removed	Option board or drive removed from microprocessor.	- Check I/O board seating - Check microprocessor board connection. Replace drive.
40	Device Unknown	Unknown option board added to the drive.	- Check I/O board seating - Replace I/O board
41	IGBT Temp	Same as fault 31	Same as fault 31
50	Anlg In Flt	Analog input is below its low limit.	- Check signal source - Check connections - Verify correct option board and jumpers. - Replace option board
51	Ext Fault	User configured PB_Ext_Fault_Inp is high.	- Determine external fault reason - Verify proper external fault setup
52	Keypad Comm	Connection between keypad and drive is broken.	- Verify keypad cable connections or proper seating of keypad - Replace keypad - Replace microprocessor board.

Fault Code	Fault Text	Possible Cause	Solution
53	FBCommunicat	Field bus fault fro D_FB_Fault bit. Bit is set when board failure is noted	- Check fieldbus board seating. - Replace fieldbus board
54	Slot Communic	Communication to a smart I/O option board is lost	- Check board seating in slots C-E. - Replace option boards - Replace microprocessor board
56	PT100 Temp	PT100 exceeds either the temperature warning or fault limit	- Check device for over heating. - Check PT100 device - Check for proper temperature probe connections. - Check for proper limits - Replace PT100 option board
57	Identification	Identification is completed	- Verify Identification parameter is set to a value other than 0.
60	Com Watchdog	Communication watchdog bit is not toggling	- Verify communications is working. - Verify watchdog bit is being toggled by host device.
61	User Fault 1	PB_User_Flt_1 is configured to a value that is High.	- Check configuration for function.
62	User Fault 2	PB_User_Flt_2 is configured to a value that is High.	- Check configuration for function.
63	User Fault 3	PB_User_Flt_3 is configured to a value that is High.	- Check configuration for function.
64	User Fault 4	PB_User_Flt_4 is configured to a value that is High.	- Check configuration for function.
65	Overspeed Flt	Drive tripped out on overspeed.	- Check for sudden loss of load. - verify proper speed feedback device and scaling. - Check overspeed setup
66	SB Comm Fault	System bus watchdog trip or board failure.	- Verify all drives on the system bus is up and running. - Verify system bus cabling. - Replace system bus cabling - Replace system bus board.
70	Loc Stop Flt	Keypad stop button pressed for two seconds.	- Replace keypad.

10-6 DRIVE FAULT OPTIONS

Fault Code	Fault Text	Fault Mode	Stop Mode	Warning Bit
1	Overcurrent	Fault	Coast Stop	<i>OC Warn</i>
2	Overvoltage	Fault	Coast Stop	<i>OV Warn</i>
3	Earth Fault	<i>Earth Fault</i>	<i>Earth Fault</i>	
5	Charging Switch	Fault	Coast Stop	
6	Emergency Stop	Fault	Coast Stop	
7	Saturation	Fault	Coast Stop	
8	System Fault	Fault	Coast Stop	
9	Undervoltage	Fault	Normal Stop	<i>UV Warn</i>
10	Input Phase	<i>Input Ph. Superv</i>	<i>Input Ph. Superv</i>	
11	Output Phase	<i>Phase Supv F</i>	<i>Phase Supv F</i>	
12	Brk Chopper Supr	Fault	Coast Stop	
13	Undertemp	Fault	Coast Stop	
14	Overtemp	Fault	Coast Stop	
15	Motor Stall	<i>Stall Protection</i>	<i>Stall Protection</i>	
16	Mot.Overtemp	<i>Therm Prot F</i>	<i>Therm Prot F</i>	<i>Mtr OT Warn</i>
17	MotorUnderld	<i>ULoad Protect F</i>	<i>ULoad Protect F</i>	
22/23	Chksum Flt	Fault	Coast Stop	
24	Changed data warning	Fault	Coast Stop	
25	Micro Watchdog	Fault	Coast Stop	
29	Thermistor	<i>ThermistorF.Resp</i>	<i>ThermistorF.Resp</i>	<i>Therm Warn Act</i>
31	IGBT Temp	Fault	Coast Stop	<i>Over Temp Warn</i>
32	Fan Control	Fault	Coast Stop	
37	Device Change	Fault	Coast Stop	
38	Device Added	Fault	Coast Stop	
39	Device Removed	Fault	Coast Stop	
40	Device Unknown	Fault	Coast Stop	
41	IGBT Temp	Fault	Coast Stop	
50	Anlg In Flt	Fault	Coast Stop	
51	Ext Fault	<i>Ext Flt Resp</i>	<i>Ext Flt Resp</i>	
52	Keypad Comm	Fault	Normal Stop	
53	FBCommunicat	<i>FBComm.FaultResp</i>	<i>FBComm.FaultResp</i>	
54	Slot Communic	<i>SPI Flt Resp</i>	<i>SPI Flt Resp</i>	
57	Identification	Warning	Coast Stop	
60	Com Watchdog	<i>WD Flt Response</i>	<i>WD Flt Response</i>	
61	User Fault 1	<i>User Flt1 Resp</i>	<i>User Flt1 Resp</i>	
62	User Fault 2	<i>User Flt2 Resp</i>	<i>User Flt2 Resp</i>	
63	User Fault 3	<i>User Flt3 Resp</i>	<i>User Flt3 Resp</i>	
64	User Fault 4	<i>User Flt4 Resp</i>	<i>User Flt4 Resp</i>	
65	Overspeed Flt	<i>Overspeed Resp</i>	<i>Overspeed Resp</i>	
66	SB Comm Fault	<i>SB Comm Flt Resp</i>	<i>SB Comm Flt Resp</i>	
70	Loc Stop Flt	Fault	Coast Stop	

10-7 SPECIFIC FAULT SETUP

10-7.1 User Faults

Parameters	Type	Default
<i>Ext Fault Inp</i>	BCFG	<i>Zero Bit</i>
<i>Ext Warn</i>	DPB	
<i>Ext Flt Resp</i>	E	2 = Fault
<i>User Flt 1</i>	BCFG	<i>Zero Bit</i>
<i>User Flt 2</i>	BCFG	<i>Zero Bit</i>
<i>User Flt 3</i>	BCFG	<i>Zero Bit</i>
<i>User Flt 4</i>	BCFG	<i>Zero Bit</i>
<i>User Flt1 Resp</i>	E	2 = Fault
<i>User Flt2 Resp</i>	E	2 = Fault
<i>User Flt3 Resp</i>	E	2 = Fault
<i>User Flt4 Resp</i>	E	2 = Fault

Ext Fault Inp and the four user faults can be configured to any bit ID to trigger a drive fault. The drive will fault if the response is set = 2 Fault and the input goes high.

When *Ext Flt Resp* is set to warning *Ext Warn* will go high when Ext Fault Inp goes high.

10-7.2 Motor Over Temp

Parameters	Type	Default
<i>MotAmbTempFactor</i>	CAL	0
<i>Mot Therm 0 spd</i>	CAL	40.0
<i>Mtr Therm TC</i>	CAL	10
<i>Motor Duty Cycle</i>	CAL	100
<i>Motor Current</i>	APB	
<i>Motor Speed</i>	APB	
<i>MtrCalc Temp</i>	APB	
<i>Therm Prot F</i>	E	2 = Fault

A motor thermal model is built into the drive to determine if the AC motor is getting hot. Settings for this model are:

- *MotAmbTemFactor* = Percentage to adjust the percentage of the ambient temperature. 0 = nominal.
- *Mot Therm 0 Spd* = Motor cooling ability at zero speed.
- *Mtr Therm TC* = Motor thermal time constant in minutes.
- *Motor Duty Cycle* = Motor rated duty cycle in percentage.

With the above setting and the motor current and speed the model calculates the temperature as *MtrCalc Temp* as a percentage of maximum temperature.

10-7.3 Motor Stall

Parameters	Type	Default
<i>Stall Cur Lim</i>	CAL	480
<i>Motor Current</i>	APB	
<i>Stall Freq</i>	CAL	25.00 Hz
<i>Motor Speed</i>	APB	
<i>Stall Time</i>	CAL	15.00 s
<i>Stall Protection</i>	E	0 = No Action

Motor stall fault will occur if the motor current Exceeds *Stall Cur Lim* and the motor speed is below *Stall Freq* for *Stall Time* amount of seconds and is enabled by *Stall Protection*.

10-7.4 Thermistor

The drive has a thermistor fault available which is set by digital configuration point *Thermistor*

10-7.5 Under Load

Parameters	Type	Default
<i>Under Ld Trq Nom</i>	CAL	50.0 %
<i>Under Ld Trq 0</i>	CAL	10.0%
<i>Motor Speed</i>	APB	
<i>Motor Torque</i>	APB	
<i>Under Ld Stat T</i>	CAL	20.00 sec
<i>ULoad Protect F</i>	E	0 = No Action

The under load torque limit changes by speed. At zero speed the limit is *Under Ld Trq 0*. The limit changes linearly to nominal speed where the limit is set by *Under Ld Trq Nom*. If the torque falls below this limit for *Under Ld Stat T* seconds and its enable by *ULoad Protect F* then the drive will fault on Under Load fault

SECTION XI

QUICK STARTUP

The drive has two functions to help the user get started. The first is the startup wizard, which will assist in setup of the most basic motor parameters. The second is the identification routine, which will find the motor characteristics.

11-1 STARTUP WIZARD

The startup wizard can be accessed via the keypad under System Menu/Security. Setting this to **Yes** will enable the wizard on the next powerup of the drive.

The following parameters are presented for entry within the startup wizard:

Parameter	Default	Description
Language	English	Changes certain parameter names
Application	Spd/Ten	Application program
<i>Min Frequency</i>	0 Hz	Set to the minimum running motor frequency
<i>Freq Max</i>	60 Hz	Set to maximum motor frequency
<i>Accel Time 1</i>	10.0 s	Time to accelerate to nominal motor speed
<i>Decel Time 1</i>	10.0 s	Time to stop from, nominal motor speed
<i>Motor Nom Voltg</i>	460 V	Motor nominal voltage
<i>Motor Nom Freq</i>	60 Hz	Motor base running frequency
<i>Motor Nom Speed</i>	1750 rpm	Motor base running speed in RPM
<i>Motor Nom Currnt</i>	Varies by drive size	Motor 100% running current
<i>Motor Cos Phi</i>	0.85	Power factor value of drive

After completing the entry, the option is given to repeat the wizard in case a variable was missed. After accepting the wizard, it will be disabled.

11-2 IDENTIFICATION

The Motor Identification program is used to scale motor parameters that are not listed on the nameplate. The parameters listed in the startup wizard must be entered.

The Identification parameter (*Self Tune Motor*) is located in the parameters\motor menu of the drive. Three options are available.

- 0 = No Action
- 1 = ID No Run
- 2 = ID With Run

After selecting the action desired, the user has 20 seconds to activate a drive Run before the parameter switches back to 0 = No Action.

If possible, perform ID With Run with no load connected to the motor.

At any time during the Identification process, the stop button can be pressed to abort.

After identification is complete, the drive will fault on *Ident Warn*, and after 20 seconds, the *Self Tune Motor* parameter will go back to 0 = No Action. .

The motor control mode determines what parameters are adjusted.

- *Self Tune Motor* = ID No Run
 - a) For open loop motor control:
 - U/f curve, stator resistance, and torque boost are found
 - b) For close loop motor control:
 - Magnetizing current
 - Rotor time constant

- *Self Tune Motor* = ID With Run
 - a) For open loop motor control
 - U/f curve, stator resistance, and torque boost are found
 - b) For close loop motor control
 - Magnetizing current
 - Rotor time constant
 - 15 point flux linearization curve

During the self tuning of the motor, a couple of parameters can be monitored with ADDaptACC to see the progress of the tuning. These are firmware parameters not found in the parameter list.

- Identification parameter:
 - B0= Programming U/f curve
 - B1 = Tr/Lm identification at a stand still
 - B2 = Magnetizing current testing
 - B3 = Saturation curve testing
 - B4 = Encoder zero position test
 - B5 = Magnetizing current Default
 - B14 = Phase Check
 - B15 = Synch check

- *Mtr Cur ID* = Value found from self tune

- *Mk Flux Time* = Time constant found during self tune

- *Mk Flux Voltage, Mk Flux V Hw Dt* = Flux voltage found during self tune

- IdentOptions:
 - B0= Enable U/f curve tuning
 - B1 = Enable close loop tuning
 - B2 = Enable encoder direction check
 - B3 = Automatic magnetizing current check with motor change

- IdentRSVoltageDrop = Voltage drop found during self tune.
- *Pwr IU Offset* = Offset hardware measurement.
- *Pwr IV Offset* = Offset hardware measurement.
- *Pwr IW Offset* = Offset hardware measurement.

APPENDIX A

SOFTWARE BLOCK DIAGRAMS