



**FlexPak 3000 Digital DC Drive
Software Reference Manual
Version 4.3**

Instruction Manual D2-3405-2

Rockwell
Automation

The information in this manual is subject to change without notice.

Throughout this manual, the following notes are used to alert you to safety considerations:



ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss.

Important: Identifies information that is critical for successful application and understanding of the product.

The thick black bar shown on the outside margin of this page will be used throughout this instruction manual to signify new or revised text or figures.



ATTENTION: Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, operate, or service this equipment. Read and understand this manual in its entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

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1.1 Before You Start

This manual assumes that the hardware has already been installed. See the FlexPak 3000 drive hardware manual, D2-3404, for detail.

Important: Before operating the drive, you must perform Quick Start and the self-tuning procedure, described in the OIM manual. Quick Start lets you configure the most commonly used parameters through one menu and includes self-tuning. This helps you set up the drive as quickly as possible.

See the OIM manual for information on configuring parameters and using Quick Start.

1.2 Where to Find Information

This manual describes the software of the FlexPak 3000 drive DC drive. It does not describe hardware or the operator interface. To find information on:

- Hardware, including installation and wiring information: See D2-3404, FlexPak 3000 DC Drive Hardware Reference.
- The Operator Interface Module (OIM), including setting parameters, saving parameters, and using Quick Start: See D2-3344, FlexPak 3000 Drive Operator Interface Module (OIM) User Guide.
- Kits: See the instruction manual supplied with the kit.

This manual groups parameters by function. To find a specific parameter, see the index or Appendix D, Numeric Parameter List, for a list of parameters with their page numbers.

As you change parameter values, you can record them using the table in Appendix C, Parameter Settings Record.

1.3 Conventions

Parameter names: In most instances, parameter names are shown as the parameter name followed by the parameter number. For example: ACCELERATION TIME (P.001).

For text parameter options, the options are shown in all caps. For example: TERMBLK.

1.4 Getting Assistance from Reliance Electric

If you have any questions or problems with the products described in this instruction manual, contact your local Reliance Electric sales office. For technical assistance, call 1-800-726-8112.

1.5 Drive Description

The FlexPak 3000 drive is a full-wave power converter without back rectifier, complete with a digital current minor loop and a digital major loop for armature voltage or speed regulation by tachometer or encoder feedback. Figure 1.1 shows the block diagram of the drive.

The drive employs a wireless construction and uses a keypad (OIM) for drive setup, including parameter adjustments and measurement unit selection, monitoring, and diagnostics. Multiple language capability in English, French, German, Spanish, and Italian is built-in. Reference, feedback, and metering signals can be interfaced to the drive.

The drive can be controlled:

- Locally by the Operator Interface Module (OIM).
- Remotely by using the terminals at the Regulator board terminal strip.
- Remotely by the CS3000 software or a an optional network kit (AutoMax, ControlNet, or others).

The reference source (KEYPAD, TERMBLK, NETWORK, or SERIAL) can be selected through the OIM.

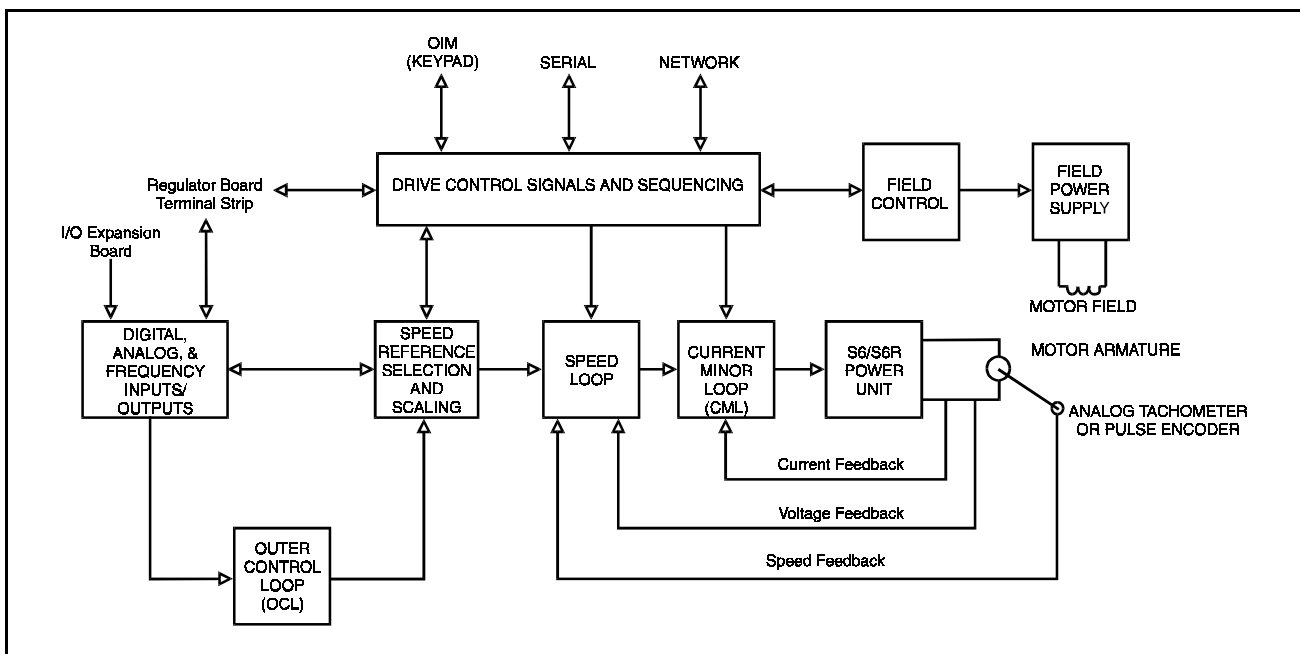


Figure 1.1 – Block Diagram of the FlexPak 3000 Drive

CHAPTER 2

Drive Sequencing

This chapter describes run, jog, and stop sequencing of the FlexPak 3000 drive.

Figure 2.1 shows an overview of the sequencing of the drive.

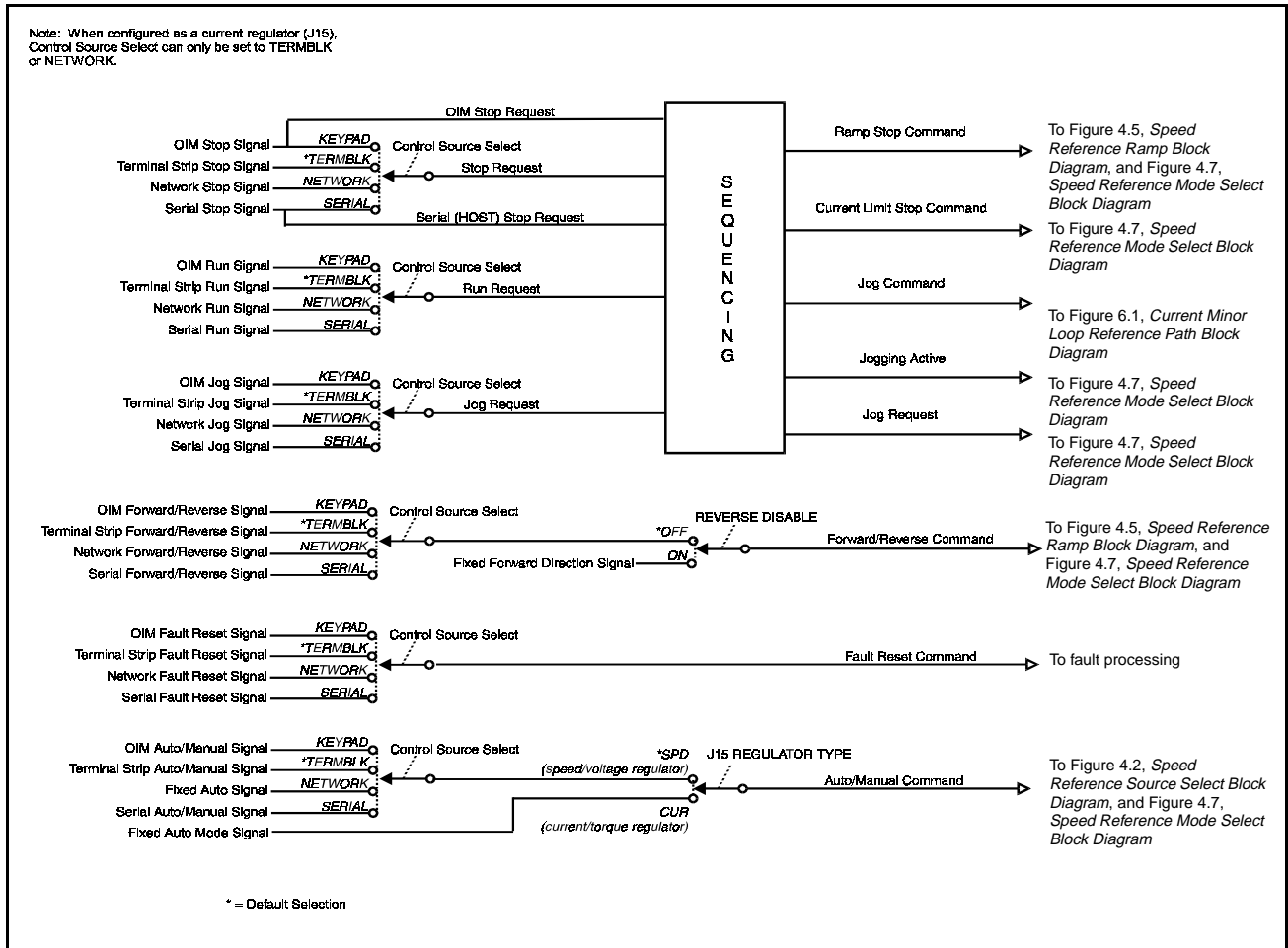


Figure 2.1 – Drive Sequencing Overview

2.1 Run and Jog Sequencing

When powered, the drive is in one of three operating states:

- armature not active (main contactor open)
- run mode
- jog mode

The drive is in run mode if it was started by the RUN input. It remains in run mode until the completion of a stop sequence.

Important: The drive is in jog mode if it was started by the JOG input. It remains in jog mode until the completion of a stop sequence or until the RUN input is asserted. If the RUN input is asserted, the drive switches from jog mode to run mode. You cannot switch from run mode to jog mode by asserting the JOG input. You must stop the drive before switching to jog mode.

If you switch from jog mode to run mode, the drive accelerates or decelerates to the selected run reference as configured by ACCELERATION TIME (P.001) or DECELERATION TIME (P.002).

2.2 Stop Sequencing



ATTENTION: The user must provide an external, hardwired emergency stop circuit outside of the drive circuitry. This circuit must disable the system in case of improper operation. Uncontrolled machine operation can result if this procedure is not followed. Failure to observe this precaution could result in bodily injury.

The FlexPak 3000 drive can be stopped by:

- Asserting an active stop input
- Opening a permissive input (coast/DB interlock or customer interlock)
- Deasserting the jog input if the drive is in jog mode. Deasserting the jog input will not initiate the stop sequence until the speed feedback is less than or equal to STOP SPEED THRESHOLD (P.113) or until the JOG OFF DELAY TIME (P.121) is exceeded, whichever occurs last.
- Detecting a fault condition

There are three types of stop sequences: Coast/DB, ramp, and current limit. The type of stop sequence used depends on the source of the stop and your parameter configuration, as described below.

If a run or jog command is received while the drive is in a ramp or current limit stop sequence, the stop sequence will be aborted and the drive will continue running or jogging. Coast/DB stop sequences cannot be aborted.

Coast/DB Stop Sequencing

Coast/DB stop sequencing is used when one of these conditions occurs:

- an active stop input is asserted and STOP MODE SELECT (P.114) is set to COAST/DB
- a permissive input is opened
- a fault condition is detected

In a coast/DB stop sequence:

1. Armature firing angle is forced to a small non-zero value.
2. The drive waits until armature current reaches discontinuous conduction.
3. The main contactor is opened and the DB contactor is closed.

Ramp Stop Sequencing (Run Mode)

Run mode ramp stop sequencing is used when all of these conditions exist:

- an active stop input is asserted
- STOP MODE SELECT (P.114) is set to RAMP STOP
- the drive is in run mode

In a ramp stop sequence from run mode:

1. A zero reference is input to the S-curve block.
2. The speed reference ramps toward zero at the rate set by DECELERATION TIME (P.002) or RAMP STOP DECEL TIME (P.018) (as determined by the setting of STOP DECEL SELECT (P.122)).
3. The drive waits until speed feedback falls below STOP SPEED THRESHOLD (P.113).
4. A zero reference is input to the current minor loop reference path.
5. The drive waits until armature current reaches discontinuous conduction.
6. The main contactor is opened and the DB contactor is closed.

Ramp Stop Sequencing (Jog Mode)

In jog mode, ramp stop sequencing is used when all of these conditions exist

- STOP MODE SELECT (P.114) is set to RAMP STOP
- the drive is in jog mode
- the jog input is deasserted
- Speed feedback is less than or equal to STOP SPEED THRESHOLD (P.113) or JOG OFF DELAY TIME (P.121) is exceeded, whichever occurs last

In a ramp stop sequence from jog mode:

1. A zero reference is input to the jog reference ramp block.
2. The jog reference ramps toward zero at the rate set by JOG ACCEL/DECEL TIME (P.013).
3. The drive waits until speed feedback falls below STOP SPEED THRESHOLD (P.113).

4. A zero reference is input to the current minor loop reference path.
5. The drive waits until armature current reaches discontinuous conduction.
6. The main contactor is opened and the DB contactor is closed.

Current Limit Stop Sequencing

Current limit stop sequencing is used when one of these conditions occurs:

- an active stop input is asserted, STOP MODE SELECT (P.114) is set to CURRENT LIMIT, and the drive is in run mode
- the jog input is deasserted when the drive is in jog mode and STOP MODE SELECT (P.114) is set to CURRENT LIMIT. Deasserting the jog input will not initiate the stop sequence until the speed feedback is less than or equal to STOP SPEED THRESHOLD (P.113) or until the JOG OFF DELAY TIME (P.121) is exceeded, whichever occurs last.

In a current limit stop sequence:


1. From run mode: A zero reference is input to the speed loop reference path at the speed loop summing junction.
From jog mode: A zero reference is input to the jog reference ramp block.
2. Jog mode only: The jog reference ramps toward zero at the rate set by JOG ACCEL/DECEL TIME (P.013).
3. The drive waits until speed feedback falls below STOP SPEED THRESHOLD (P.113).
If the drive is regenerative (S6R), this phase of the current limit stop sequence takes little time. If the drive is non-regenerative (S6), the motor coasts during this phase of the current limit stop sequence.
4. A zero reference is input to the current minor loop reference path.
5. The drive waits until armature current reaches discontinuous conduction.
6. The main contactor is opened and the DB contactor is closed.

Initial Configuration

This chapter describes settings you might need to make when initially starting your drive, including selecting a control source and changing the settings of the AC line parameters. Before using the parameters in this chapter, perform Quick Start (see the OIM manual for detail).


3.1 Selecting a Control Source

The control source determines the source of drive control signals. Control signals include drive operating signals, such as run and jog, and the drive reference.

You can select the control source on the OIM using the front panel key (). See your OIM manual.

CONTROL SOURCE (P.000)

Selects the source of the drive control signals.

Parameter Range:	KEYPAD SERIAL TERMBLK NETWORK
Default Setting:	KEYPAD
Parameter Type:	Configurable
OIM Menu Path(s):	On OIM keypad: 

If the drive is configured as a current (torque) regulator (jumper J15 is set to CURRENT), the control source can only be set to TERMBLK or NETWORK.

The possible control sources are:

- KEYPAD: Control is through the keypad.
- TERMBLK: Control is through Regulator board terminals 16 through 20. See the hardware manual for terminal descriptions and wiring instructions.
- NETWORK: Control is through a network such as the AutoMax Network Communication kit, DeviceNet Interface kit, or ControlNet Network Communication kit.
- SERIAL: Control is through a personal computer running the CS3000 software.

3.2 Configuring the AC Line Parameters

In addition to performing Quick Start, you might need to configure the AC line parameters for your application. Generally, you only need to configure these parameters if the default values for these parameters are incorrect for your application. These parameters should be configured before completing Quick Start. See the OIM manual for information on Quick Start.

NOMINAL AC LINE FREQ (P.306)

The nominal AC line frequency (typically 50 or 60 Hz).

Parameter Range:	48 to 62 Hz
Default Setting:	60 Hz
Parameter Type:	Configurable
OIM Menu Path(s):	Current Minor Loop (CML) - Three Phase AC Line

NOMINAL AC LINE VOLTS (P.307)

The nominal AC line RMS voltage.

Parameter Range:	200 to 575 VAC
Default Setting:	230 VAC
Parameter Type:	Configurable
OIM Menu Path(s):	Current Minor Loop (CML) - Three Phase AC Line

3.3 Self-Tuning Parameters

See the OIM manual for detail on using self-tuning and the self-tuning parameters.

SELF TUNE BRIDGE (P.220)

Determines the direction the motor shaft will rotate during the speed loop self-tune process by selecting the SCR bridge. If the reverse bridge will be predominant in the application, select REVERSE.

Parameter Range:	FORWARD REVERSE
Default Setting:	FORWARD
Parameter Type:	Tunable
OIM Menu Path(s):	Current Minor Loop (CML) - Tuning - Self Tuning Setup Speed/Voltage Loop (SPD) - Tuning - Self Tuning Setup

For non-regenerative (S6) drives, this is fixed to FORWARD.

Must be set before starting speed loop self-tuning.

SELF TUNE FIELD RANGE (P.218)

Ratio of motor top speed to base speed. Typical value is 1.00, where TOP SPEED (P.011) is equal to base speed. Applies to speed loop tuning only.

Parameter Range:	0.90 to 5.00
Default Setting:	1.00
Parameter Type:	Tunable
OIM Menu Path(s):	Current Minor Loop (CML) - Tuning - Self Tuning Setup Speed/Voltage Loop (SPD) - Tuning - Self Tuning Setup

Must be set before starting speed loop self-tuning.

SELF TUNE STABILITY (P.219)

Determines the self-tune stability, which configures the performance of the speed loop.

Parameter Range:	10 to 100
Default Setting:	25
Parameter Type:	Tunable
OIM Menu Path(s):	Current Minor Loop (CML) - Tuning - Self Tuning Setup Speed/Voltage Loop (SPD) - Tuning - Self Tuning Setup

Low values increase the speed loop response. High values decrease the speed response, but result in more stability. The typical value is 25. This parameter applies to speed loop tuning only.

Must be set before starting speed loop self-tuning.

Configuring the Speed Reference

The FlexPak 3000 drive can be configured as a speed regulator or as an armature voltage regulator, depending on the value of FEEDBACK SELECT (P.200). In this chapter, the phrase “speed loop” refers to either configuration unless otherwise noted.

The drive can also be configured as either a speed/voltage or current regulator. If the drive is to be configured as a current regulator, skip this chapter and see Chapter 6.

The speed reference is the speed the speed loop tries to maintain. The drive processes and scales the speed reference input for use by the speed loop.

The speed loop uses the selected reference value and attempts to keep the speed feedback from the motor equal to the reference value. If the feedback is less than the reference, the speed loop increases the motor speed by commanding more current to the motor. If the reference is less than the feedback, the speed loop decreases the motor speed by commanding less current to the motor. The speed loop tries to minimize the amount of error between the speed reference and the speed feedback. The speed and accuracy with which the speed loop responds to reference or motor load changes is determined by the speed loop parameters.

Processing the speed reference consists of three major blocks, shown in figure 4.1.

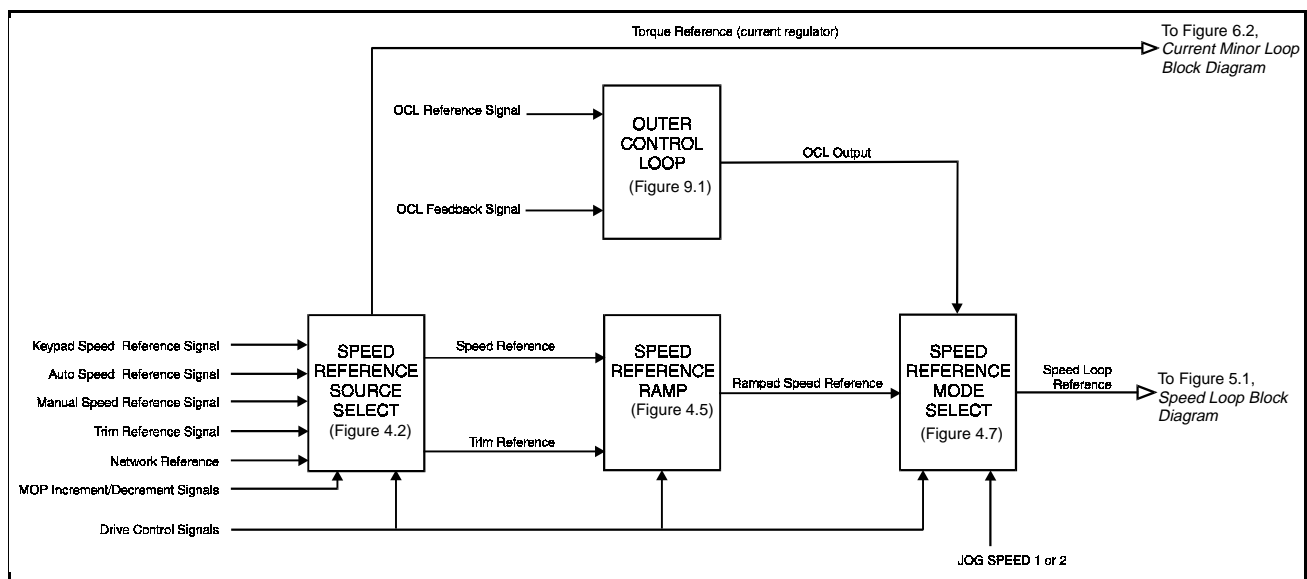


Figure 4.1 – Speed Reference Overview

In the speed reference source select block, the selected reference is scaled and the amplitude is limited. See section 4.1.

In the speed reference ramp block, the reference value from the speed reference source select block is modified based on your parameter settings. For example, trim and rate limiting are applied. See section 4.3.

In the speed reference mode select block, the ramped speed reference signal is summed with current compounding and outer control loop outputs. See section 4.3.


4.1 Configuring the Speed Reference Source Block

The speed reference can be either automatic or manual. An automatic (auto) reference usually comes from a device such as a PLC or a network master. A manual reference typically comes from a speed potentiometer or the OIM keypad. See the OIM manual for information on auto and manual references.



ATTENTION: When switching from auto to manual or from manual to auto, the drive will ramp to the reference level provided by the new source at the rate specified by ACCELERATION TIME (P.001) or DECELERATION TIME (P.002). Be aware that an abrupt speed change might occur, depending on the new reference and the rate specified in these parameters. Failure to observe this precaution could result in bodily injury.


If an I/O Expansion kit is installed, the selected speed reference can be overridden by a preset speed reference if selected (terminals 59 and 60). See section 4.1.7.

Table 4.1 shows the possible control source and reference source settings. It also shows the display for the key indicator under .

Most systems will use one primary reference source. For example, you might use a network for your reference most of the time, but have the terminal strip reference available for occasions when the network is not running or for troubleshooting.

The block diagram for the speed reference source is shown in figure 4.2.

Table 4.1 – Effect of Control Source and Reference Settings

Control Source	Reference Set Through:	OIM  Key Indicator	OIM Reference Display (Monitor Mode)	Units
KEYPAD	Automatic reference from the terminal strip as set by AUTO REFERENCE SELECT (P.103)	AUTO	TERMBLK REF	RPM, percentage, or user-defined units
	OIM	MANUAL	KEYPAD REF	
TERMBLK (Regulator type is speed/voltage)	Automatic reference from the terminal strip as set by AUTO REFERENCE SELECT (P.103)	AUTO	TERMBLK REF	
	Manual reference from the terminal strip as set by MANUAL REF SELECT (P.106)	MANUAL		
SERIAL	Automatic reference from the terminal strip as set by AUTO REFERENCE SELECT (P.103)	AUTO	SERIAL REF	
	Serial device (PC)	MANUAL		
NETWORK	Network	AUTO (Manual not available)	NETWORK REF	From network
TERMBLK (Regulator type is current/torque)	Automatic reference from the terminal strip as set by AUTO REFERENCE SELECT (P.103)	AUTO (Manual not available)	TORQUE REF	MOTOR LOAD units

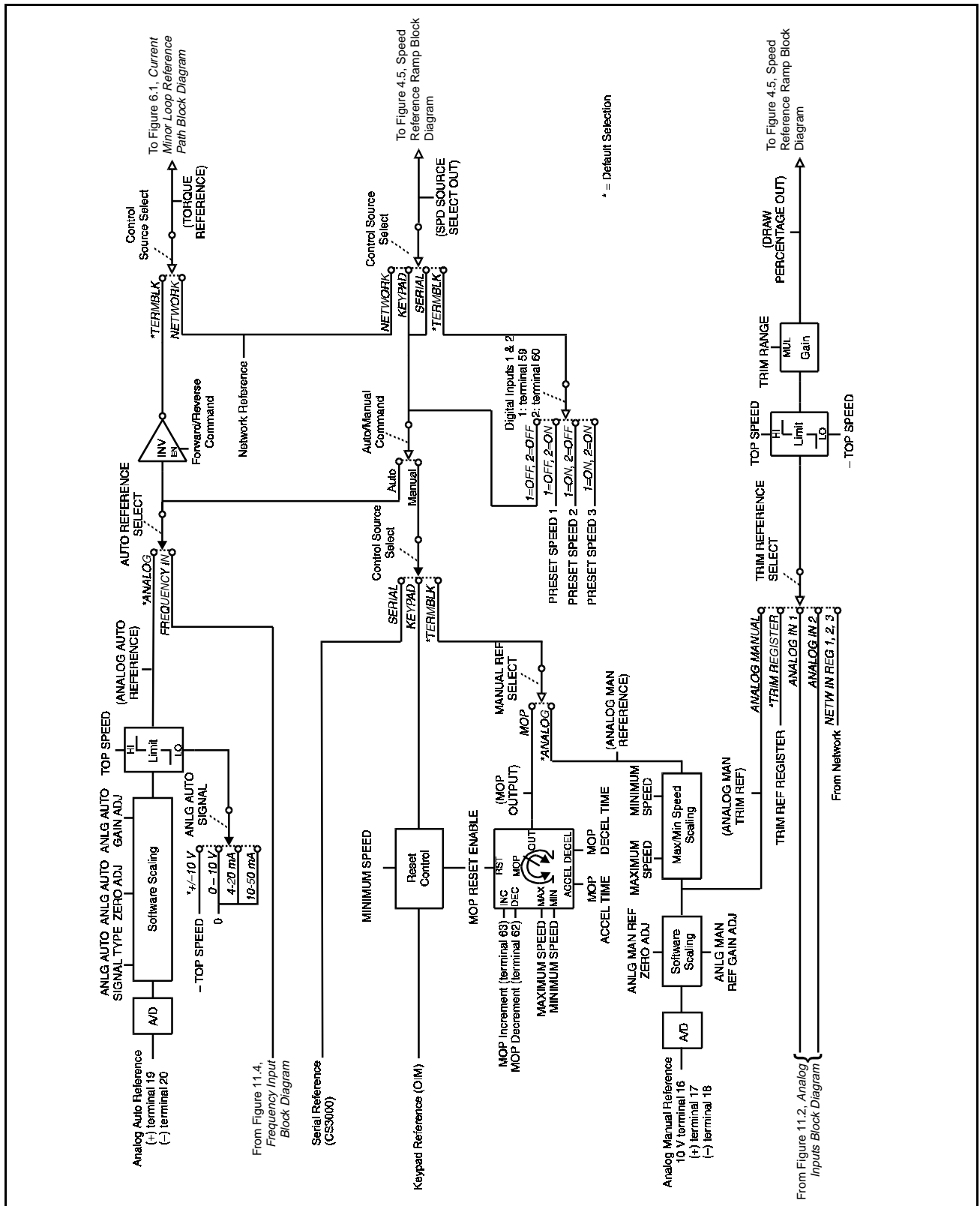


Figure 4.2 – Speed Reference Source Select Block Diagram

4.1.1 Configuring the Keypad (OIM) Speed Reference

CONTROL SOURCE SELECT must be set to KEYPAD to use the keypad reference. When manual mode is selected, you enter the speed reference manually through the OIM. See the OIM manual for information on setting the speed reference through the OIM.

The keypad reference cannot be configured to less than MINIMUM SPEED (P.003) or greater than MAXIMUM SPEED (P.004). The default value of the keypad reference is MINIMUM SPEED (P.003).



ATTENTION: When switching from auto to manual or from manual to auto, the drive will ramp to the reference level provided by the new source at the rate specified by ACCELERATION TIME (P.001) or DECELERATION TIME (P.002). Be aware that an abrupt speed change might occur, depending on the new reference and the rate specified in these parameters. Failure to observe this precaution could result in bodily injury.

4.1.2 Configuring the Analog Auto Reference

CONTROL SOURCE SELECT must be set to TERMBLK, SERIAL, or KEYPAD to use the analog auto input as a speed reference. When you use this speed reference, the signal is the analog auto reference from terminals 19(+) and 20(-) of the Regulator board. Note that this input can also be used as a current reference to the current minor loop.

You must specify the type of signal that is at terminals 19 and 20 by setting ANLG AUTO SIGNAL TYPE (P.100) and jumpers J10 and J12 on the Regulator board. The settings of ANLG AUTO SIGNAL TYPE (P.100) and the jumpers must be the same. See the hardware manual for information on setting the jumpers.

The drive used the ANLG AUTO GAIN ADJ (P.101), ANLG AUTO SIGNAL TYPE (P.100), and ANLG AUTO ZERO ADJ (P.102) to scale the analog auto reference signal from terminal 19 and 20 of the Regulator board to produce the ANALOG AUTO REFERENCE (P.188) signal.

ANALOG AUTO REFERENCE (P.188)

The analog reference value in auto mode. This is the value output by the drive after all hardware and software scaling.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Reference - Drive Reference Scaling Drive Reference - Test Points

ANLG AUTO GAIN ADJ (P.101)

Scales the analog auto reference signal after it is conditioned by the drive hardware.

Parameter Range:	0.750 to 1.250
Default Setting:	1.000
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Scaling

Typically, this parameter is set to 1.000.

Example

If ANLG AUTO SIGNAL TYPE (P.100) is set to 0-10V, a 0 to 8.2VDC signal produces only 82% of the drive's full scale value. To produce the drive's full scale value, change ANLG AUTO GAIN ADJ to properly scale the signal to $1.22 \left(\frac{10}{8.2} = 1.22 \right)$.

Important: Adjust the zero point (ANLG AUTO ZERO ADJ (P.102)) before setting the gain adjust.

ANLG AUTO SIGNAL TYPE (P.100)

Selects the type of signal applied to the drive analog auto reference input. This is the signal at terminals 19 and 20 on the Regulator board.

Parameter Range:	0–10V +/-10V 4-20mA 10-50mA
Default Setting:	0–10V
Parameter Type:	Configurable
OIM Menu Path(s):	Drive Reference - Drive Reference Configure

Important: Jumpers J10 and J12 must be set for the type of analog auto reference selected. See the hardware manual for instruction.

ANLG AUTO ZERO ADJ (P.102)

Removes any offset from the analog auto reference signal.

Parameter Range:	-200 to 200
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Scaling

If ANALOG AUTO REFERENCE (P.188) is not equal to zero when the analog auto reference signal is set to its minimum value (for example, 0 volts or 4mA), adjust ANLG AUTO ZERO ADJ up or down until ANALOG AUTO REFERENCE (P.188) equals zero.

AUTO REFERENCE SELECT (P.103)

AUTO REFERENCE SELECT determines if the drive uses a frequency or analog input reference source when the drive is in AUTO mode and CONTROL SOURCE SELECT is set to KEYPAD, TERMBLK, or SERIAL.

Parameter Range:	ANALOG FREQUENCY IN
Default Setting:	ANALOG
Parameter Type:	Configurable
OIM Menu Path(s):	Drive Reference - Drive Reference Configure

When AUTO REFERENCE SELECT is set to FREQUENCY IN, the reference is from the frequency input (terminals 39, 40, and 41 on the I/O Expansion kit).

When AUTO REFERENCE SELECT is set to ANALOG, the reference is from the analog auto input (terminals 19 and 20 on the Regulator board).

If the I/O Expansion kit is not installed, this parameter is automatically configured to ANALOG and cannot be changed.

4.1.3 Configuring the Analog Manual Reference

CONTROL SOURCE SELECT must be set to TERMBLK to use the analog manual reference input as a speed reference. This reference can only be used when the drive is configured as a speed regulator and MANUAL REF SELECT (P.106) is set to ANALOG.

When you use this speed reference, the drive uses the analog manual reference from terminals 16(+10V), 17(+), and 18(-) of the Regulator board.

The software uses the parameters described in this section to scale the analog manual reference signal at terminal 16, 17, and 18 to produce the ANALOG MAN REFERENCE (P.192) signal.

The analog manual reference input can also be used for the trim reference. Make sure they are not being used for both functions at the same time.

ANALOG MAN REFERENCE (P.192)

The analog reference value in manual mode. This is the value output by the drive after all hardware and software scaling.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Reference - Drive Reference Scaling Drive Reference - Drive Reference Test Points

This parameter is only used when the drive is configured as a speed/voltage regulator.

ANLG MAN REF GAIN ADJ (P.104)

Scales the analog manual speed reference signal after it is conditioned by the drive hardware.

Parameter Range:	0.750 to 1.250
Default Setting:	1.000
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Scaling

Typically, this parameter is set to 1.000.

Important: Adjust the zero point (ANLG MAN REF ZERO ADJ (P.105)) before setting the gain adjust.

ANLG MAN REF ZERO ADJ (P.105)

Removes any offset from the analog manual reference signal.

Parameter Range:	-200 to 200
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Scaling

If ANALOG MAN REFERENCE (P.192) is not equal to zero when 0 volts is applied to terminal 17 on the Regulator board, adjust the analog auto reference signal is set to its minimum value (for example, 0 volts or 4mA), adjust ANLG MAN ZERO ADJ up or down until ANALOG MAN REFERENCE (P.192) equals zero.

MANUAL REF SELECT (P.106)

Sets the source of the reference for the speed loop when the drive is in manual mode and CONTROL SOURCE SELECT is set to TERMBLK.

Parameter Range:	ANALOG MOP
Default Setting:	ANALOG
Parameter Type:	Configurable
OIM Menu Path(s):	Drive Reference - Drive Reference Configure

When set to ANALOG, the analog MANUAL reference input (terminals 16, 17 and 18 on the Regulator board) is the speed reference.

When set to MOP, MOP OUTPUT (P.191) is the speed reference. This reference can be adjusted through terminals 62 and 63 on the I/O Expansion kit. See the I/O Expansion kit manual for more information.

If the I/O Expansion kit is not installed, the parameter value is fixed to ANALOG.

4.1.4 Configuring the Serial Speed Reference

CONTROL SOURCE SELECT must be set to SERIAL (in the FlexPak 3000 drive or through the CS3000 software) and AUTO/MANUAL must be set to MANUAL to use the serial speed reference.

If you are using the serial reference from a source such as the CS3000 software, the reference is input directly from the serial source to the speed reference ramp. The only parameter related to the serial speed reference is SPD SOURCE SELECT OUT (P.193). You can use this parameter to check the reference value.

4.1.5 Configuring the Network Speed Reference

CONTROL SOURCE SELECT must be set to NETWORK to use the network speed reference. When the control source is NETWORK, the drive is forced into automatic mode.

The only parameter related to the network speed reference is SPD SOURCE SELECT OUT (P.193). You can use this parameter to check the reference value.

4.1.6 Configuring the Motor-Operated Potentiometer (MOP) Reference

The MOP function can be used as a manual reference for the speed loop. To use the MOP function:

- The I/O Expansion kit must be installed.
- CONTROL SOURCE SELECT must be set to TERMBLK.
- MANUAL REF SELECT (P.106) must be set to MOP.
- Switches must be attached to digital inputs 3 and 4 (terminals 63 and 64) of the I/O Expansion kit. These inputs decrement and increment, respectively, the MOP OUTPUT (P.191) value.
- The MOP block is shown in figure 4.3.

The MOP output is incremented when digital input 4 (terminal 63) is ON and decremented when digital input 3 (terminal 62) is ON. MOP OUTPUT is limited between MAXIMUM SPEED (P.004) and MINIMUM SPEED (P.003). If both digital inputs are ON at the same time, the MOP output remains at its present value.

MOP ACCEL TIME (P.115) and MOP DECEL TIME (P.120) set the time in which the MOP OUTPUT can change from zero to TOP SPEED and vice versa. To prevent the S-curve block from limiting the rate of change from the MOP OUTPUT, MOP ACCEL TIME has a low limit equal to ACCELERATION TIME. MOP DECEL TIME has a low limit equal to DECELERATION TIME.

To obtain a negative MOP reference, the reverse direction must be selected.

When MOP RESET ENABLE is ON, the MOP output goes to MINIMUM SPEED at the moment when the drive is stopped following a run or jog. If it is OFF, the MOP OUTPUT remains at its present level when the drive is stopped. MOP RESET ENABLE also affects the operation of the keypad reference, even if the I/O Expansion kit is not installed.

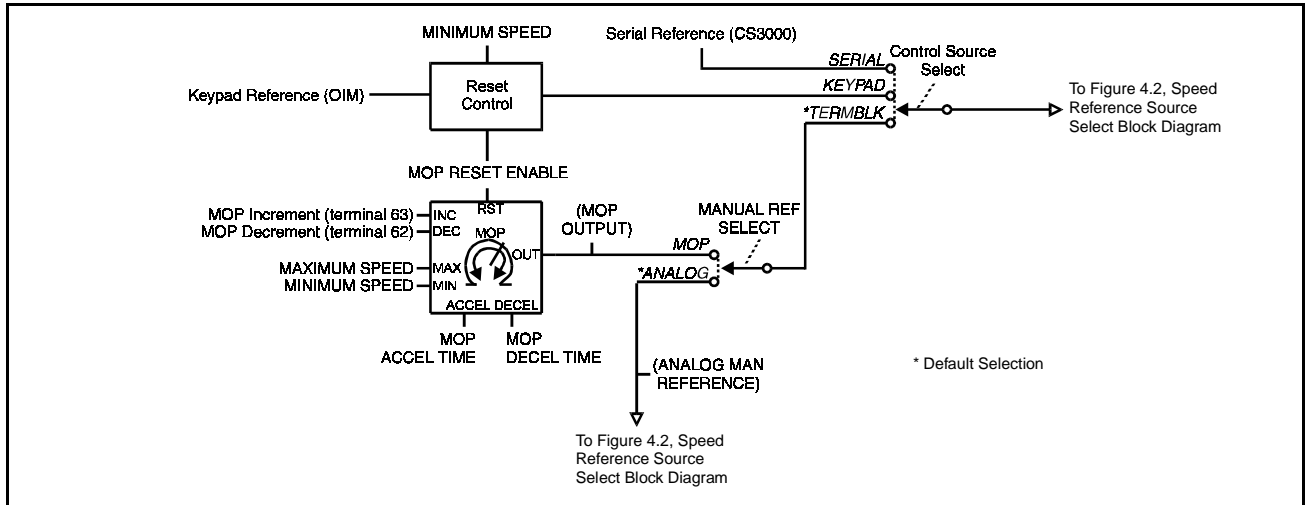


Figure 4.3 – MOP Block Diagram

DIG IN 3 (P.497)

The state of digital input 3 (terminal 62 on the I/O Expansion kit), which is the MOP decrement input.

Parameter Range:	ON OFF
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Input/Output - Digital I/O

The input is ON when +24VDC is applied for more than 10 msec. It is OFF when 0VDC is applied.

DIG IN 4 (P.498)

The state of digital input 4 (terminal 63 on the I/O Expansion kit), which is the MOP increment input.

Parameter Range:	ON OFF
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Input/Output - Digital I/O

The input is ON when +24VDC is applied for more than 10msec. It is OFF when 0VDC is applied.

MOP ACCEL TIME (P.115)

Minimum time in which MOP OUTPUT can change from zero to TOP SPEED.

Parameter Range:	ACCELERATION TIME to 300.0 seconds
Default Setting:	5.0 seconds
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Ramp

MOP DECEL TIME (P.120)

Minimum time in which MOP OUTPUT can change from TOP SPEED to zero.

Parameter Range:	DECELERATION TIME to 300.0 seconds
Default Setting:	5.0 seconds
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Ramp

MOP OUTPUT (P.191)

The output of the motor-operated potentiometer (MOP).

Parameter Range:	MINIMUM SPEED to MAXIMUM SPEED
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Reference - Drive Reference Test Points

To get a negative MOP reference, the reverse direction must be selected.

If the I/O Expansion kit is not installed, MOP OUTPUT is meaningless.

MOP RESET ENABLE (P.116)

Determines if MOP OUTPUT (P.191) and the keypad reference values reset or stay at the present level when the drive stops.

Parameter Range:	OFF ON
Default Setting:	OFF
Parameter Type:	Configurable
OIM Menu Path(s):	Drive Reference - Drive Reference Configure

When MOP RESET ENABLE is set to ON (enabled), MOP OUTPUT and the keypad reference are reset to MINIMUM SPEED (P.003) when the drive is stopped, even if the I/O Expansion kit is not installed. If it is set to OFF (disabled), MOP OUTPUT and the keypad reference remain at their present levels when the drive is stopped.

4.1.7 Configuring the Preset Speed References

These parameters are only available if the I/O Expansion kit is installed.

The three preset speed references override the auto or manual speed/voltage loop reference when CONTROL SOURCE SELECT is set to TERMBLK. Preset speed references are selected using one or two digital inputs. When both digital inputs are in the OFF state, no preset speed is selected. When one or both digital inputs are in the ON state, one of the three preset speed references is selected as shown in table 4.2.

Table 4.2 – Preset Speed Reference Selections

Digital Input 1 (Terminal 59)	Digital Input 2 (Terminal 60)	Speed/Voltage Loop Reference
OFF	OFF	Selected auto or manual reference
OFF	ON	PRESET SPEED 1 (P.117)
ON	OFF	PRESET SPEED 2 (P.118)
ON	ON	PRESET SPEED 3 (P.119)

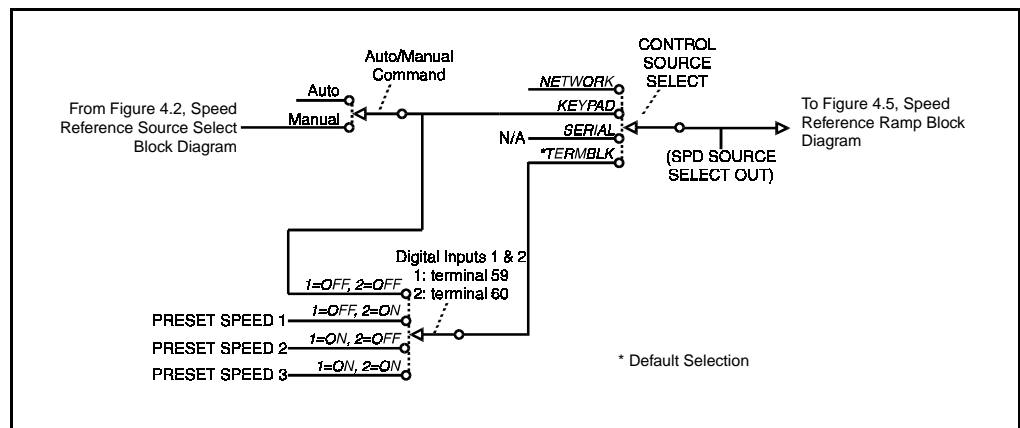


Figure 4.4 – Preset Speed Block Diagram

DIG IN 1 (P.495)

The state of digital input 1 (terminal 59 on the I/O Expansion kit).

Parameter Range:	ON OFF
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Input/Output - Digital I/O

Digital inputs 1 and 2 (terminals 59 and 60) select which, if any, PRESET SPEED is used as the reference for the speed/voltage control loop.

The input is ON when +24 VDC is applied for more than 10 msec. It is OFF when 0VDC is applied.

DIG IN 2 (P.496)

The state of digital input 2 (terminal 60 on the I/O Expansion kit).

Parameter Range:	ON OFF
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Input/Output - Digital I/O

Digital inputs 1 and 2 (terminals 59 and 60) select which, if any, preset speed is used as the reference for the speed/voltage control loop.

The input is ON when +24 VDC is applied for more than 10 msec. It is OFF when 0VDC is applied.

PRESET SPEED 1 (P.117)

PRESET SPEED 2 (P.118)

PRESET SPEED 3 (P.119)

These parameters set up to three preset speed references when the REGULATOR TYPE jumper (J15 on the Regulator board) is set for the speed/voltage control loop.

Parameter Range:	MINIMUM SPEED to MAXIMUM SPEED (RPM or user-defined units)
Default Setting:	250 RPM
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Configure

To use these speeds, CONTROL SOURCE SELECT must be set to TERMBLK.

The preset speeds are selected through digital input 1 and digital input 2 on the I/O Expansion kit, as shown in table 4.2.

If the I/O Expansion kit is not installed, the digital inputs are set to OFF and cannot be changed. The selected auto or manual reference is used for the reference.

The preset speed reference passes through the same control blocks as other speed references.

4.2 Configuring Trim

The trim feature allows an offset to be added to or subtracted from the speed reference. The amount of trim can be proportional to the upstream speed reference or incremental. An incremental trim signal is derived from the resultant DRAW PERCENTAGE OUT (P.196) and the specified TOP SPEED (P.011).

Trim is based on the signal from the source you select in TRIM REFERENCE SELECT (P.108). The choices are:

- ANALOG MANUAL: The trim reference signal is based on the analog manual reference signal (terminals 16, 17, and 18) after it has been limited and scaled.
- REGISTER: The trim reference signal is based on the value set in TRIM REF REGISTER (P.107).
- ANALOG IN 1 or 2: (I/O Expansion kit only.) The trim reference signal is based on analog in 1 or 2 from the I/O Expansion kit.
- NETW IN REG 1, 2, OR 3: (Network only.) The trim reference signal is based on network input register 1, 2, or 3.

The selected trim reference is limited to within \pm TOP SPEED and multiplied with TRIM RANGE (P.109) to generate DRAW PERCENTAGE OUT (P.196). DRAW PERCENTAGE OUT modifies DECELERATION TIME and ACCELERATION TIME when TRIM REFERENCE SELECT is set to PROPORTIONAL.

The input that can be used for the manual trim reference can also be used as the analog manual reference. Make sure this input (terminals 16, 17, and 18 on the Regulator board) is not being used for both functions at the same time.

Example

To use an analog manual reference to generate a 0 to 10% trim adjustment to the speed reference setting, make these settings:

- Set TRIM REFERENCE SELECT (P.108) to ANALOG MANUAL
- Set TRIM RANGE (P.109) to 10%
- Set TRIM MODE SELECT (P.110) to INCREMENTAL

These settings will provide a 0 to 10% trim adjustment through the entire speed range.

ANALOG MAN TRIM REF (P.194)

The trim reference value used when TRIM REFERENCE SELECT (P.108) is set to ANALOG MANUAL.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Reference - Drive Reference Scaling Drive Reference - Drive Reference Test Points

DRAW PERCENTAGE OUT (P.196)

The product of the selected trim reference value and TRIM RANGE value.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Reference - Drive Reference Test Points

DRAW PERCENTAGE OUT dynamically changes the acceleration and deceleration rates when TRIM MODE SELECT is set to PROPORTIONAL.

DRAW PERCENTAGE OUT is also used to generate the TRIM OUTPUT signal, which modifies the speed reference signal when TRIM MODE SELECT is set to PROPORTIONAL or INCREMENTAL.

TRIM MODE SELECT (P.110)

Selects the type of trim mode to be used by the drive.

Parameter Range:	NO TRIM INCREMENTAL PROPORTIONAL
Default Setting:	NO TRIM
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Trim

- NO TRIM: No trim is used.
- INCREMENTAL: Depending on the polarity of the trim reference, adds to or subtracts from the speed reference a constant value that is proportional to TOP SPEED (P.011).
- PROPORTIONAL: Depending on the polarity of the trim reference, adds to or subtracts from the speed reference a value that varies based on the speed reference value. Proportional trim allows multiple drive sections with a common reference to operate and ramp at different values.

Proportional is a type of draw. By using draw, one section can operate 10% faster than an upstream section. When a ramp occurs on the common reference, the two sections will support the 10% draw throughout the ramp. S-CURVE ROUNDING will interfere with the acceleration and deceleration rates so that the draw will not be constant. Therefore, it is recommended that S-CURVE ROUNDING be set to 0% when TRIM MODE SELECT is set to PROPORTIONAL. Incremental trim is not affected by this limitation.

TRIM OUTPUT (P.197)

Actual signal used to trim the selected speed loop reference signal.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Reference - Drive Reference Test Points

TRIM RANGE (P.109)

Uses the selected trim reference signal to generate DRAW PERCENTAGE OUT (P.196). Determines how much the trim signal will affect the drive reference.

Parameter Range:	0.0 to 100.0%
Default Setting:	0.0%
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Trim

TRIM REF REGISTER (P.107)

Drive register to manually set the trim reference value used by the drive when is TRIM REFERENCE SELECT (P.108) is set to REGISTER.

Parameter Range:	±100.0%
Default Setting:	0%
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Trim

TRIM REFERENCE SELECT (P.108)

Trim reference selection.

Parameter Range:	REGISTER ANALOG MANUAL ANALOG IN 1 NETW IN REG 1 NETW IN REG 2 NETW IN REG 3 ANALOG IN 2
Default Setting:	REGISTER
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Trim

The choices are:

- REGISTER: The reference is TRIM REF REGISTER (P.107).
- ANALOG MANUAL: The reference is the analog manual reference input from terminals 16, 17, and 18 of the Regulator board. Do not select this option if this input is being used for the analog manual speed reference.
- ANALOG IN 1 or 2: The reference is from an I/O Expansion kit analog input. These are only available if an I/O Expansion kit is installed.
- NETW IN REG 1, 2, or 3: The reference is from a communication register. These options are available only if a network kit is installed. Note that the network input registers are updated only when Control Source (P.000) is set to NETWORK and the network is active.

4.3 Speed Reference Ramp

From the speed reference source select block, the value of SPD SOURCE SELECT OUT (P.193) is amplitude-limited by a minimum/maximum block. This block limits the reference between MINIMUM SPEED (P.003) and MAXIMUM SPEED (P.004). You can modify the results from this block using REVERSE DISABLE (P.015) and AUTO MODE MIN BYPASS (P.111). The inverter block changes the sign of the signal based on the forward/reverse signal.

If your automatic speed reference signal is already conditioned, you can bypass the S-curve block by using AUTO MODE RAMP BYPASS (P.112). You can also bypass the amplitude limit block while in auto mode by using AUTO MODE MIN BYPASS (P.111)

If you use the S-curve block, S-curve smoothing rounds the SPD SOURCE SELECT OUT (P.193) signal. It provides a smoother transition from constant level speed to the acceleration or deceleration condition. This helps reduce machine wear.

The S-curve block controls how fast the speed reference changes based on the ACCELERATION TIME (P.001), DECELERATION TIME (P.002), and S-CURVE ROUNDING (P.014). Within the S-curve block, S-CURVE ROUNDING specifies the maximum rate of change allowed for ramping. When a step change occurs on the input, the output's rate of change increases by S-CURVE ROUNDING until the acceleration or deceleration rate is reached. The rate is maintained until the output reaches a distance from the input where the rate begins decreasing in S-CURVE ROUNDING intervals.

The speed reference ramp block diagram is shown in figure 4.5.

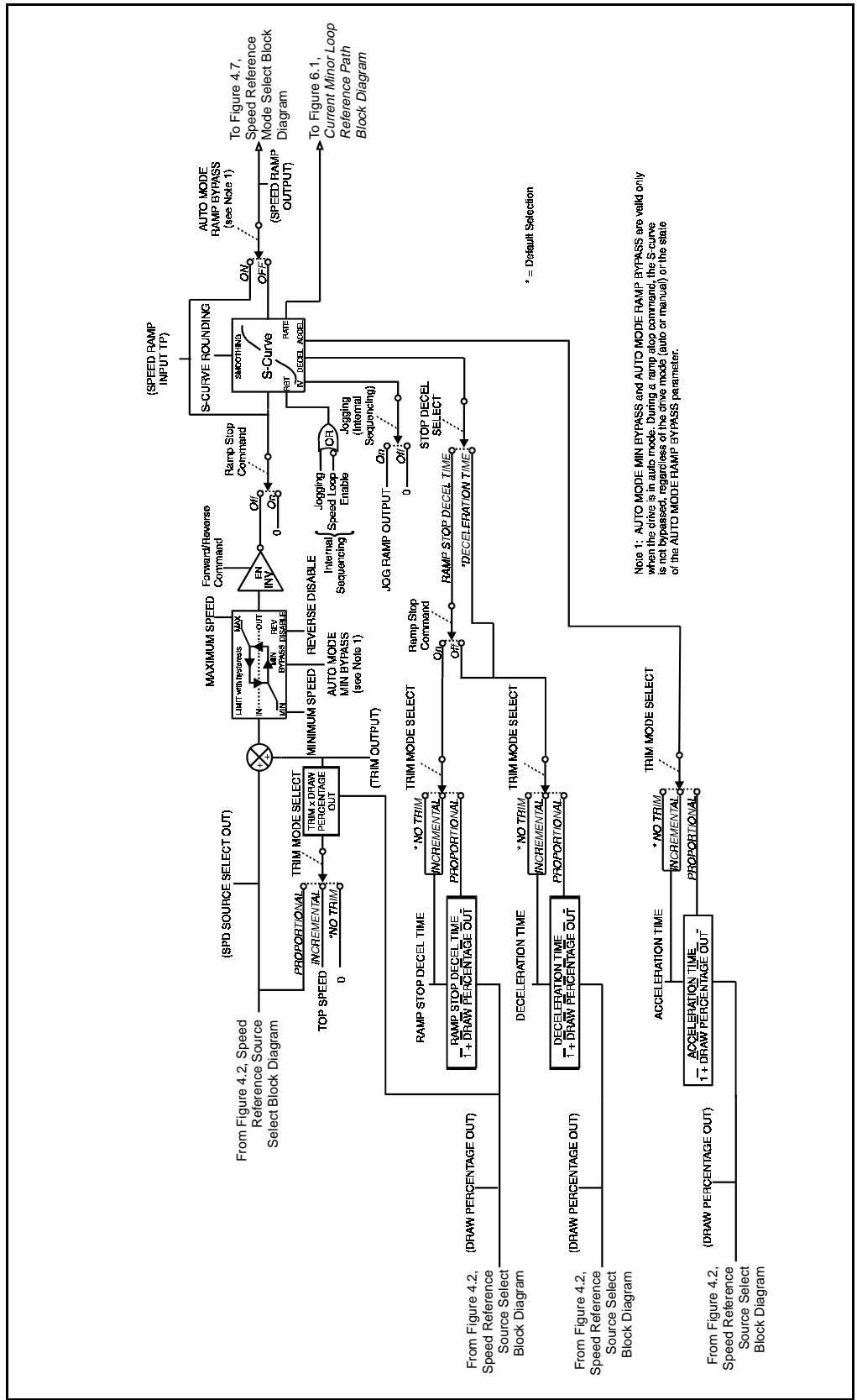


Figure 4.5 – Speed Reference Ramp Block Diagram

4.3.1 Configuring the Speed Reference Ramp

ACCELERATION TIME (P.001)

Sets the minimum time that the selected speed reference can be changed from zero to TOP SPEED (P.011).

Parameter Range:	0.1 to 300.0 seconds
Default Setting:	5.0 seconds
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Ramp Quick Start

If TRIM MODE SELECT (P.110) is set to PROPORTIONAL, the actual time to accelerate might be modified by DRAW PERCENTAGE OUT (P.196). See section 4.2, Configuring Trim.

AUTO MODE MIN BYPASS (P.111)

Disables the MINIMUM SPEED (P.003) limit while in auto mode. If the drive is in manual mode, this parameter has no effect and the MINIMUM SPEED (P.003) limit cannot be bypassed.

Parameter Range:	OFF ON
Default Setting:	OFF
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Limits



ATTENTION: This drive can operate at and maintain zero speed when this parameter is set to ON. The user is responsible for assuring safe conditions for operating personnel by providing suitable guards, audible or visual alarms, or other devices to indicate that the drive is operating at or near zero speed. Failure to observe this precaution could result in severe bodily injury or loss of life.

AUTO MODE RAMP BYPASS (P.112)

Bypasses the speed loop S-curve block while in auto mode. If the drive is in manual mode, this parameter has no effect and the S-curve block cannot be bypassed.

Parameter Range:	OFF ON
Default Setting:	OFF
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Ramp

When AUTO RAMP BYPASS is ON and the drive is in auto mode, the speed loop ramp function is bypassed. The bypass is automatically disabled during a ramp stop sequence and the drive will always ramp to a stop.



ATTENTION: When switching from auto to manual or from manual to auto, the drive will ramp to the reference level provided by the new source at the rate specified by ACCELERATION TIME (P.001) or DECELERATION TIME (P.002). Be aware that an abrupt speed change might occur, depending on the new reference and the rate specified in these parameters. Failure to observe this precaution could result in bodily injury.

DECELERATION TIME (P.002)

Sets the minimum time in which the selected speed reference can change from TOP SPEED (P.011) to 0.

Parameter Range:	0.1 to 300.0 seconds
Default Setting:	5.0 seconds
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Ramp Quick Start

If TRIM MODE SELECT (P.110) is set to PROPORTIONAL, the actual time to decelerate might be modified by DRAW PERCENTAGE OUT (P.196). See section 4.2, Configuring Trim.

MAXIMUM SPEED (P.004)

The maximum speed of the drive that can be supported by the application or process.

Parameter Range:	1 to TOP SPEED (RPM or user-defined units)
Default Setting:	500 RPM
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Limits Quick Start

If raising this value causes MINIMUM SPEED to become less than 10% of MAXIMUM SPEED, an alarm is generated.

This is typically set to base speed from the motor nameplate.



ATTENTION: Do not allow the motor to exceed the maximum safe speed, as determined by the equipment manufacturer, of the motor or the driven equipment. Failure to observe this precaution could result in bodily injury.

MINIMUM SPEED (P.003)

Selects the minimum speed of the drive without being stopped. It is typically greater than zero.

Parameter Range:	0 to MAXIMUM SPEED (RPM or user-defined units)
Default Setting:	250 RPM
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Limits Quick Start

If it is less than 10% of MAXIMUM SPEED, an alarm is generated.



ATTENTION: This drive can operate at and maintain zero speed when this parameter is set to zero. The user is responsible for assuring safe conditions for operating personnel by providing suitable guards, audible or visual alarms, or other devices to indicate that the drive is operating at or near zero speed. Failure to observe this precaution could result in severe bodily injury or loss of life.

RAMP STOP DECEL TIME (P.018)

The deceleration time used during ramp stop sequences when STOP DECEL SELECT is set to RAMP STOP DECEL TIME.

Parameter Range:	0.1 to 300.0 seconds
Default Setting:	5.0 seconds
Parameter Type:	Tunable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

This parameter allows you to configure separate deceleration times for stopping and decelerating.

REVERSE DISABLE (P.015)

When ON, REVERSE DISABLE does not allow the speed reference to drop below zero.

When OFF, the speed reference can drop below zero and the drive can operate in the reverse direction.

Parameter Range:	OFF ON
Default Setting:	OFF
Parameter Type:	Configurable
OIM Menu Path(s):	Drive Reference - Drive Reference Limits Quick Start

REVERSE DISABLE applies only to regenerative drives.

REVERSE DISABLE is forced to ON when:

- The drive has a non-regenerative (S6) power unit.
- FEEDBACK SELECT is set to AC TACH.
- FEEDBACK SELECT is PULSE TACH and PULSE TACH QUADRATURE (P.208) is OFF.

S-CURVE ROUNDING (P.014)

The amount of reference smoothing (rounding) of the speed loop S-curve output.

Parameter Range:	0 to 50%
Default Setting:	0%
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Ramp

S-CURVE ROUNDING is set as a percentage of ACCELERATION TIME (P.001).

Rounding is performed at the beginning and end of a speed loop reference change.

If TRIM MODE SELECT (P.110) is set to PROPORTIONAL, S-CURVE ROUNDING should be set to 0%. If there is S-curve rounding and proportional trim, the actual trim will interfere with the ACCELERATION TIME and the DECELERATION TIME and draw will not be constant. If TRIM MODE SELECT (P.110) is set to INCREMENTAL, ACCELERATION TIME and the DECELERATION TIME are not affected.

If S-CURVE ROUNDING is set to 0%, the speed loop performs a linear ramp function. If it is set to 50%, the entire ramp time is smoothed: 50% at the beginning and 50% at the end. Refer to figure 4.6.

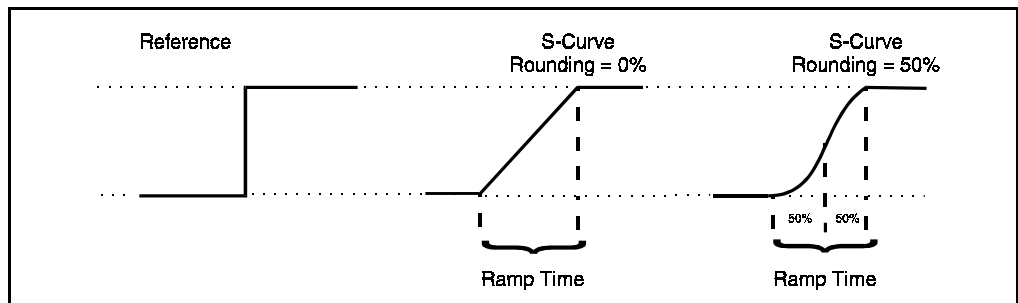


Figure 4.6 – S-Curve Rounding

SPD SOURCE SELECT OUT (P.193)

The selected speed reference source value in RPM or the units you defined. It is an input to the speed reference ramp section.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Reference - Drive Reference Test Points

SPEED RAMP INPUT TP (P.198)

The value of the speed reference signal immediately before the speed loop S-curve block.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Reference – Drive Reference Test Points

SPEED RAMP OUTPUT (P.199)

The value of the speed reference signal immediately after the speed loop S-curve block.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Reference – Drive Reference Test Points

STOP DECEL SELECT (P.122)

Selects which deceleration time will be used for ramp stop sequences, DECELERATION TIME (P.002) or RAMP STOP DECEL TIME (P.018).

Parameter Range:	1 = DECELERATION TIME 2 = RAMP STOP DECEL TIME
Default Setting:	1
Parameter Type:	Configurable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

This only affects ramp stop times. Speed changes when the drive is running use DECELERATION TIME regardless of the STOP DECEL SELECT choice.

STOP MODE SELECT (P.114)

Selects how the drive responds to a normal stop command. Opening a permissive input will always cause a coast stop.

Parameter Range:	RAMP COAST/DB CURRENT LIMIT
Default Setting:	COAST/DB
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Configure

If the drive is configured as a current regulator, only COAST/DB can be selected.

STOP SPEED THRESHOLD (P.113)

Configures the threshold speed below which the main contactor will automatically open after a ramp stop or current limit stop is asserted.

Parameter Range:	0 to MAXIMUM SPEED (RPM or user-defined units)
Default Setting:	50 RPM
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Configure

4.4 Final Speed Reference Logic

In the last part of the speed reference, the signals from the speed reference ramp and current minor loop are summed and limited by TOP SPEED to determine the speed reference sent to the speed loop. The final value that is sent to the speed loop is the SPD LOOP REFERENCE (P.295). The block diagram is shown in figure 4.7.

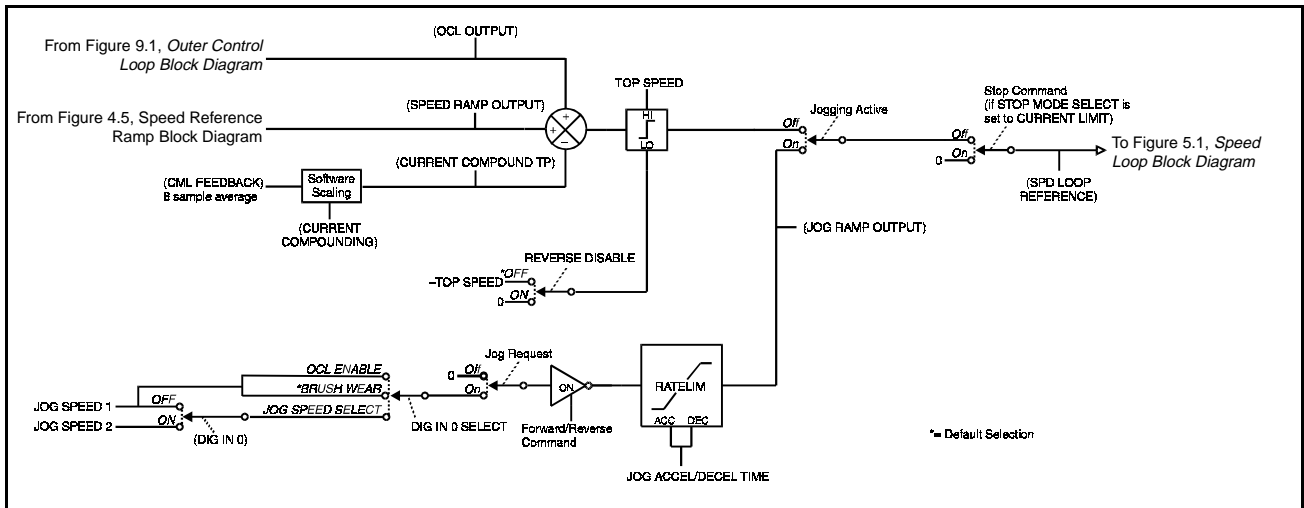


Figure 4.7 – Speed Reference Mode Select Block Diagram

SPD LOOP REFERENCE (P.295)

The final speed loop reference value used by the speed loop regulator in the drive.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	SPD - Speed/Voltage Loop (SPD) Test Points Drive Reference - Drive Reference Test Points

TOP SPEED (P.011)

The highest running speed of the motor. This input is the basis of speed loop scaling.

Parameter Range:	5 to 5000 RPM
Default Setting:	500 RPM
Parameter Type:	Configurable
OIM Menu Path(s):	Drive Reference - Drive Reference Limits Quick Start

TOP SPEED depends on several factors:

- If there is no field weakening, the top speed is typically the same as the motor nameplate base speed.
- If there is field weakening, the top speed is the same as the field-weakened speed. Top speed is typically more than the base speed when field weakening is applied.

Whenever TOP SPEED is changed, you should check the positions of jumpers J11 and J14 to make sure they are set as indicated by J11 ANLG TACH VLT SCL (P.792) and J14 ANLG TACH VLT RNG (P.793). The tachometer wiring might also need to be changed. See the hardware manual for more information.



ATTENTION: Before starting the drive, this parameter must be set to base speed or (if the Field Current Regulator kit is installed) the field weakened speed. The user is responsible for assuring safe conditions for operating personnel by setting this parameter properly. Failure to observe this precaution could result in bodily injury.

ATTENTION: Do not allow the motor to exceed the maximum safe speed of the motor or driven equipment as determined by the equipment manufacturer. Failure to observe this precaution could result in bodily injury.

4.4.1 Configuring Jog

For information on jog sequencing, see section 2.1, Run and Jog Sequencing.

When you use a jog input (terminals 4 and 1 on the Regulator board or pressing



), the jog signal is conditioned as shown in figure 4.7.

If DIG IN 0 SELECT (P.428) is set to JOG SPEED SELECT, you can use digital input 0 (terminals 12 and 14 on the Regulator board) to choose between two jog speeds, as set by JOG SPEED 1 (P.012) and JOG SPEED 2 (P.017).

When digital input 0 is:

- Off (0 V): JOG SPEED 1 (P.012) is selected.
- On (+24 V): JOG SPEED 2 (P.017) is selected.

Switching between the two jog speeds while jogging causes the drive to accelerate or decelerate to the new jog speed at the rate set by JOG ACCEL/DECCEL TIME (P.013).

Only JOG SPEED 1 (P.012) is used if DIG IN 0 SELECT is not set to JOG SPEED SELECT.



ATTENTION: This drive can operate at and maintain zero speed when either of the jog speed parameters (JOG SPEED 1 (P.012) and JOG SPEED 2 (P.017)) is set to zero. The user is responsible for assuring safe conditions for operating personnel by providing suitable guards, audible or visual alarms, or other devices to indicate that the drive is operating at or near zero speed. Failure to observe this precaution could result in severe bodily injury or loss of life.

DIG IN 0 (P.490)

Indicates the state of digital input 0 (terminal 12 on the Regulator board).

Parameter Range:	ON OFF (see table 4.3 for detail)
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

DIG IN 0 is ON when +24VDC is applied for more than 10msec. It is OFF when 0VDC is applied.

Table 4.3 – Conditions Indicated by DIG IN 0 (P.490)

DIG IN 0 SELECT (P.428) Setting	Condition if DIG IN 0 (P.490) Reads:	
	ON	OFF
BRUSH WEAR INPUT	Brushes OK	Brushes Worn
JOG SPEED SELECT	JOG SPEED 2 selected	JOG SPEED 1 selected
OCL ENABLE	OCL enabled	OCL disabled

DIG IN 0 SELECT (P.428)

Determines which function is controlled by digital input 0 (terminal 12 on the Regulator board).

Parameter Range:	1 = BRUSH WEAR INPUT 2 = JOG SPEED SELECT 3 = OCL ENABLE
Default Setting:	1
Parameter Type:	Configurable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

The functions can be:

- **BRUSH WEAR:** The input is from a brush wear indicator. If the input is OFF, the MOTOR BRUSH WEAR LOW alarm is generated. You must have the E.S.P. Brush Monitor Detector kit installed to use this option.
- **JOG SPEED SELECT:** The input determines whether JOG SPEED 1 (P.012) or JOG SPEED 2 (P.017) will be used when the drive is jogging.
- **OCL ENABLE:** Enables the outer control loop if CONTROL SOURCE SELECT is not set to NETWORK and if the I/O Expansion kit is not installed. If an I/O Expansion kit is installed, the outer control loop enable signal is digital input 5. See section 9.1 for information.

JOG ACCEL/DECCEL TIME (P.013)

Sets the minimum time that the jog reference can change from zero to TOP SPEED (P.011) and from TOP SPEED to zero.

Parameter Range:	0.1 to 300.0 seconds
Default Setting:	3.0 seconds
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Ramp Quick Start

The S-CURVE ROUNDING parameter does not affect the setting of this parameter.

JOG OFF DELAY TIME (P.121)

Specifies the minimum delay between removing the jog input and opening of the main contactor in the drive.

Parameter Range:	0.0 to 10.0 seconds
Default Setting:	1.0 second
Parameter Type:	Configurable
OIM Menu Path(s):	Drive Reference - Drive Reference Configure

Releasing the jog input will not cause the contactor to open until the speed feedback is less than or equal to STOP SPEED THRESHOLD or until the JOG OFF DELAY TIME is exceeded, whichever occurs last.

This delay reduces the wear on the contactor when repeatedly opening and closing the JOG input in a short period of time.

JOG RAMP OUTPUT (P.294)

The jog reference value immediately after the jog ramp function.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Reference - Drive Reference Test Points

JOG SPEED 1 (P.012)

The operating speed while the drive is jogging if DIG IN 0 SELECT (P.428) is set to JOG SPEED SELECT and digital input 0 (terminal 12 on the Regulator board) is off.

Parameter Range:	0 to MAXIMUM SPEED (RPM or user-defined units)
Default Setting:	250 RPM
Parameter Type:	Tunable
OIM Menu Path(s):	Drive Reference - Drive Reference Configure Quick Start

JOG SPEED 2 (P.017)

The operating speed when the drive is jogging if DIG IN 0 SELECT (P.428) is set to JOG SPEED SELECT and digital input 0 (terminal 12 on the Regulator board) is on.

Parameter Range:	0 to MAXIMUM SPEED (RPM or user-defined units)
Default Setting:	250 RPM
Parameter Type:	Tunable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

4.4.2 Configuring Current Compounding

Current compounding is used for load sharing between drives. If there is a change in the CML feedback, current compounding either increases or decreases the speed reference. See figure 4.7 for the block diagram.

CURRENT COMPOUND TP (P.293)

The current compounding value that is subtracted from the conditioned speed reference.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) - Test Points

CURRENT COMPOUNDING (P.209)

Sets the level of current compounding.

Parameter Range:	-50 to 50%
Default Setting:	0%
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed Voltage Loop (SPD) Tuning

Configuring the Speed/Voltage Loop

This chapter describes configuring the speed/voltage loop functions. These include jog, lead/lag, speed loop lag, current limits, the speed loop PI block, and winding.

The full speed loop block diagram, including these features, is shown in figure 5.1.

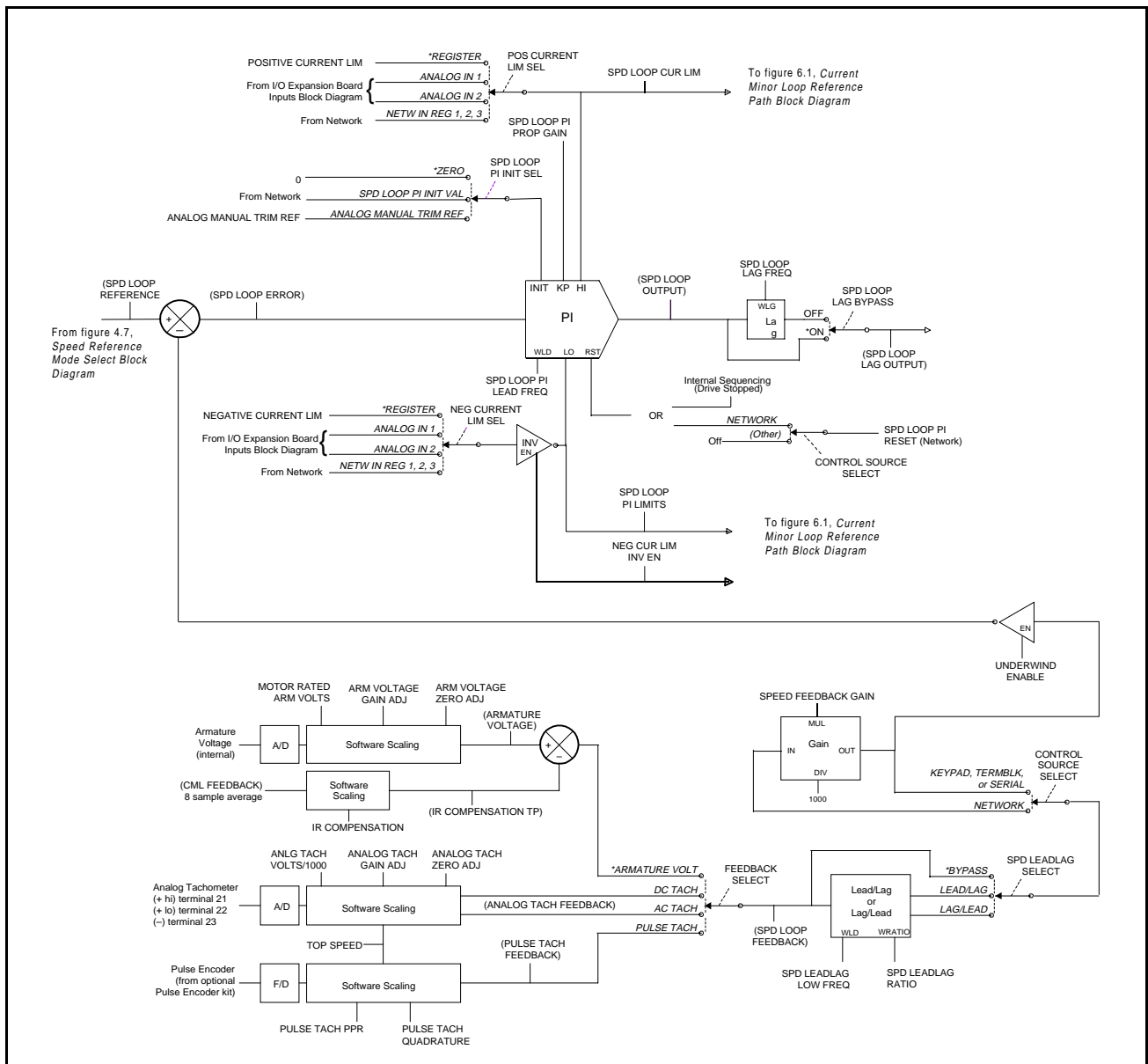


Figure 5.1 – Speed Loop Block Diagram

5.1 Configuring the Speed Loop Scan Time

The scan time of the speed loop can be configured using parameter P.019 (Speed Loop Scan Time). The drive must be stopped to modify the value of this parameter. Note that P.019 applies only to closed loop speed control using actual measured motor velocity via tachometer or encoder-type devices.

SPD LOOP SCAN TIME (P.019)

Selects the speed loop scan time for closed loop operation.

Parameter Range:	0 = 5 msec 1 = 10 msec
Default Setting:	5 msec
Parameter Type:	Configurable
OIM Menu Path(s):	Additional Parameters

When FEEDBACK SELECT (P.200) is set to armature voltage, the active speed loop scan time is fixed at 10 msec regardless of the setting of P.019.

When FEEDBACK SELECT is changed from armature voltage to any other setting, the active speed loop scan time is determined by the parameter setting of P.019.

5.2 Configuring the Speed Loop Feedback

Feedback can come from the armature voltage or from an encoder or tachometer. The parameters you need to configure depend on which feedback source you are using, as set by FEEDBACK SELECT (P.200).

FEEDBACK SELECT (P.200)

Selects the type of feedback signal that is used for the speed/voltage loop.

Parameter Range:	ARMATURE VOLT DC TACH PULSE TACH AC TACH
Default Setting:	ARMATURE VOLT
Parameter Type:	Configurable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed Voltage Loop (SPD) Feedback Quick Start

PULSE TACH and AC TACH can only be selected if the appropriate kit is installed (Pulse Encoder kit or AC Tachometer Feedback kit).

NEGATIVE CURRENT LIM (P.006) is set to 0 and REVERSE DISABLE (P.015) is set ON if:

- AC TACH is selected.
- PULSE TACH is selected and PULSE TACH QUADRATURE (P.208) is set to OFF.



ATTENTION: The incorrect configuration of this parameter can cause an overspeed condition. This parameter must be configured by a qualified person who understands the significance of setting it. Failure to observe this precaution could result in bodily injury.

5.2.1 Configuring Armature Voltage Feedback

If FEEDBACK SELECT is set to armature voltage, the drive reads the internal armature voltage and scales it with the MOTOR RATED ARM VOLTS, ARM VOLTAGE GAIN, and ARM VOLTAGE ZERO parameter values. These values are summed together to produce the armature voltage signal. The armature voltage block is shown in figure 5.2.

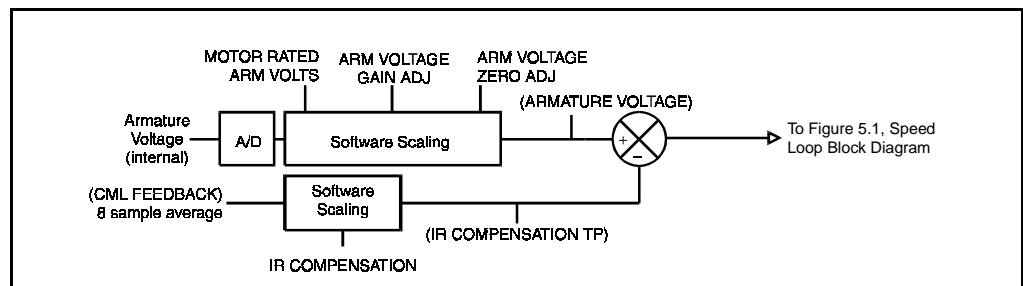


Figure 5.2 – Armature Voltage Block Diagram



ATTENTION: The incorrect configuration of these parameters can cause an overspeed condition. They must be configured by a qualified person who understands the significance of configuring them. Failure to observe this precaution could result in bodily injury.

ARM VOLTAGE GAIN ADJ (P.204)

Scales the armature voltage signal after the drive hardware conditions the signal. In most cases, this parameter is set to 1.000.

Parameter Range:	0.750 to 1.250
Default Setting:	1.000
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Feedback

Important: Adjust the zero point (ARM VOLTAGE ZERO ADJ (P.205)) before configuring gain.

ARM VOLTAGE ZERO ADJ (P.205)

Removes any offset from the armature voltage signal.

Parameter Range:	-200 to 200
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Feedback

If ARMATURE VOLTAGE (P.289) is not equal to zero when the drive is stopped, adjust ARM VOLTAGE ZERO ADJ up or down until ARMATURE VOLTAGE (P.289) equals zero.

ARMATURE VOLTAGE (P.289)

Armature voltage value after all hardware and software scaling but before any IR compensation.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Test Points Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning - Speed/Voltage Loop (SPD) Feedback Current Minor Loop (CML) - CML Feedback Scaling - SCR Diagnostics - Armature Phase Fire Test

IR COMPENSATION (P.206)

Sets the armature voltage loss compensation value used when the drive is configured as a voltage regulator.

Parameter Range:	0 to 50%
Default Setting:	0%
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning Quick Start Field - Field Current Regulator - Field Loop Tuning

This parameter is also used by the Field Current Regulator kit to set the field-weakened threshold. See section 8.3.

IR COMPENSATION is normally determined from the motor data sheet. It should be set to the percent IR drop of the motor.

If this data is not available on the motor data sheet, you can set this empirically so that the no-load and full-load speeds are as close as possible when operating as a voltage regulator.

IR COMPENSATION TP (P.290)

The level of IR COMPENSATION being subtracted from the measured armature voltage.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Test Points

The value of IR COMPENSATION TP is determined by the equation:

$$\text{IR COMPENSATION TP} = \frac{\text{IR COMPENSATION} \cdot \text{CML FEEDBACK} \cdot \text{MAXIMUM CURRENT}}{10,000}$$

MOTOR RATED ARM VOLTS (P.009)

The rated armature voltage as it is listed on the motor nameplate.

Parameter Range:	160 to 675 volts
Default Setting:	240 volts
Parameter Type:	Configurable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Feedback Quick Start

This must always be set properly, regardless of the setting of FEEDBACK SELECT (P.200).

5.2.2 Configuring AC or DC Analog Tachometer Feedback

You only need to configure these parameters if your feedback device is an AC or DC analog tachometer.

If FEEDBACK SELECT is set to DC TACH, feedback is from a DC tachometer. (See the hardware manual and your tachometer manual for wiring information.)

If FEEDBACK SELECT (P.200) is set to AC TACH, feedback is from an AC tachometer connected to an AC Tachometer Feedback kit. See the AC Tachometer Feedback kit manual for information.

The gain and zero parameters for the analog tachometer are a method of eliminating any offset introduced by the tachometer. You only need to set these parameters if you need to adjust the tachometer feedback value.

The analog tachometer block diagram is shown in figure 5.3.

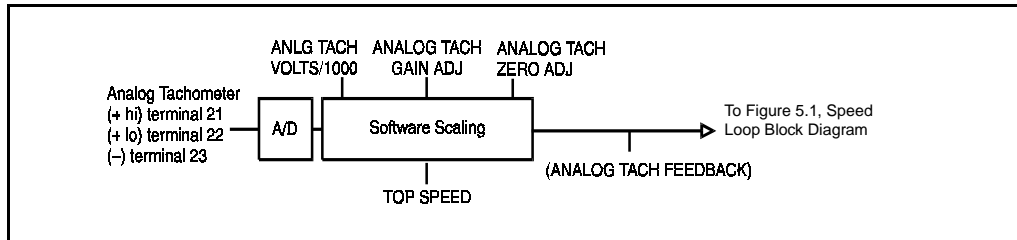



Figure 5.3 – AC or DC Analog Tachometer Feedback Block Diagram



ATTENTION: The incorrect configuration of these parameters can cause an overspeed condition. These parameters must be configured by a qualified person who understands the significance of configuring them. Failure to observe this precaution could result in bodily injury.

ANALOG TACH FEEDBACK (P.291)

The digital value of the analog tachometer feedback input after all hardware and software scaling. For use with analog tachometer feedback (AC or DC) only.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Test Points Speed/Voltage Loop (SPD) Tuning - Speed/Voltage Loop (SPD) Feedback

ANALOG TACH GAIN ADJ (P.201)

Scales the analog tachometer feedback signal after it has been conditioned by the drive hardware. Typically, it will be 1.000.

Parameter Range:	0.750 to 1.250
Default Setting:	1.000
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD)-Speed / Voltage Loop (SPD) Feedback

Important: Adjust the zero point (ANALOG TACH ZERO ADJ (P.202)) before configuring gain.

ANALOG TACH ZERO ADJ (P.202)

Removes any offset from the analog tachometer feedback signal.

Parameter Range:	-200 to + 200
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD)-Speed / Voltage Loop (SPD) Feedback

If ANALOG TACH FEEDBACK (P.291) is not equal to zero when the drive is stopped, adjust ANALOG TACH ZERO ADJ up or down until ANALOG TACH FEEDBACK (P.291) is equal to zero.

ANLG TACH VOLTS/1000 (P.203)

Analog tachometer scaling from the tachometer nameplate in volts per 1000 RPM.

Parameter Range:*	18.0 to 200.0 VOLTS/1000 RPM
Default Setting:	18.0 VOLTS/1000 RPM
Parameter Type:	Configurable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) – Speed/Voltage Loop (SPD) Feedback

Units are volts DC for DC tachometers or volts AC RMS for AC tachometers.

Use of an AC tachometer requires the AC Tachometer Feedback kit.

Whenever ANLG TACH VOLTS/1000 is changed, you should check the positions of jumpers J11 and J14 to make sure they are set as indicated by J11 ANLG TACH VLT SCL (P.792) and J14 ANLG TACH VLT RNG (P.793). The tachometer wiring might also need to be changed. See the hardware manual for more information.

*Depending on the setting of TOP SPEED (P.011), the high limit might be less than 200.0 to prevent the tachometer voltage from exceeding 250V.

J11 ANLG TACH VLT SCL (P.792)

Position in which to set the J11 hardware jumper based on the values of TOP SPEED (P.011) and ANLG TACH VOLTS/1000 (P.203).

Parameter Range:	16 31 62 125 250
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Information - Correct Scaling Jumper Positions Quick Start Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Feedback

J14 ANLG TACH VLT RNG (P.793)

Position in which to set the J14 hardware jumper based on the values of TOP SPEED (P.011) and ANLG TACH VOLTS/1000 (P.203).

Parameter Range:	LOW HIGH
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Information - Correct Scaling Jumper Positions Quick Start Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Feedback

The tachometer wiring must match the setting shown here. See the hardware manual for wiring information.

5.2.3 Configuring the Pulse Encoder Feedback

You only need to configure the pulse encoder feedback parameters if you have the Pulse Encoder (Tachometer) kit installed. If you have a regenerative drive, you must use a quadrature pulse encoder.

The pulse encoder block diagram is shown in figure 5.4.

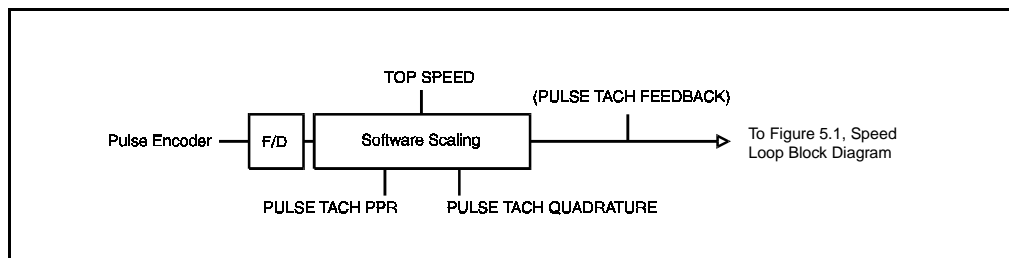


Figure 5.4 – Pulse Encoder Feedback Block Diagram



ATTENTION: The incorrect configuration of these parameters can cause an overspeed condition. These parameters must be set by a qualified person who understands the significance of setting them. Failure to observe this precaution could result in bodily injury.

PULSE TACH FEEDBACK (P.292)

The digital value from the pulse encoder after hardware and software scaling. For use with pulse encoder feedback only.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Test Points

PULSE TACH PPR (P.207)

Pulse encoder pulses per revolution (PPR) from the pulse encoder nameplate.

Parameter Range:	18 to 2500 PPR
Default Setting:	18 PPR
Parameter Type:	Configurable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Feedback

PULSE TACH QUADRATURE (P.208)

Enables or disables pulse encoder quadrature.

A quadrature pulse encoder must be used on regenerative drives that use a pulse encoder.

Parameter Range:	ON OFF
Default Setting:	ON
Parameter Type:	Configurable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Feedback

Set ON for a bidirectional pulse encoder.

Set OFF for a unidirectional pulse encoder.

If PULSE TACH QUADRATURE is set to OFF and PULSE TACH is the selected FEEDBACK SELECT type, NEGATIVE CURRENT LIM (P.006) will be set to 0 and REVERSE DISABLE (P.015) set to ON (preventing reverse direction).

PULSE TACHOMETER KIT (P.798)

Indicates whether or not the Pulse Encoder (Tachometer) kit is installed in the drive and if it has passed diagnostics.

Parameter Range:	INSTALLED NOT INSTALLED FAILED DIAGS
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Information

If the Pulse Encoder (Tachometer) kit has failed diagnostics, the drive is not operable (the armature cannot become active).

5.2.4 Configuring Speed Loop Feedback Lead/Lag Block

Lead/lag adjustments compensate for backlash or coupling issues because of the feedback device.

To enable this block, set SPD LEADLAG SELECT (P.216) to LEAD/LAG or LAG/LEAD. To disable this block, set SPD LEADLAG SELECT (P.216) to BYPASS.

When this block is enabled, the selected feedback signal is fed into the lead/lag block. The SPD LEADLAG LOW FREQ (P.214) and SPD LEADLAG RATIO (P.213) input values are used to calculate the high break frequency. SPD LEADLAG LOW FREQ (P.214) specifies the low break frequency and the SPD LEADLAG RATIO (P.213) is the ratio maintained between the low break and high break frequencies. The low break frequency and ratio settings are multiplied to determine the high break frequency. For example, if the low break frequency is 0.50rad/s and the ratio is 10, high break frequency is 5.00rad/s.

The transfer functions for lead/lag and lag/lead are:

$$\text{Lead/Lag: } \frac{1 + \frac{s}{\omega_{\text{low}}}}{1 + \frac{s}{\omega_{\text{high}}}} \qquad \text{Lag/Lead: } \frac{1 + \frac{s}{\omega_{\text{high}}}}{1 + \frac{s}{\omega_{\text{low}}}}$$

Where:

- ω_{low} = SPD LEADLAG LOW FREQ (P.214)
- ω_{high} = SPD LEADLAG LOW FREQ (P.214) * SPD LEADLAG RATIO (P.213)

SPD LEADLAG LOW FREQ (P.214)

Specifies the low break frequency of the speed feedback lead/lag block.

Parameter Range:	0.01 to 69.81 RAD/S when: <ul style="list-style-type: none"> • FEEDBACK SELECT (P.200) = ARMATURE VOLT • SPD LOOP SCAN TIME (P.019) = 10 MS 0.01 to 139.62 RAD/S when: <ul style="list-style-type: none"> • FEEDBACK SELECT (P.200) ≠ ARMATURE VOLT • SPD LOOP SCAN TIME (P.019) = 5 MS
Default Setting:	1.00 RAD/S
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning

If SPD LEADLAG SELECT is set to:

- BYPASS: This parameter has no effect.
- LAG/LEAD: This parameter specifies the lead break frequency.
- LEAD/LAG: This parameter specifies the lag break frequency.

SPD LEADLAG RATIO (P.213)

Specifies the ratio between the low and high break frequencies of the speed feedback lead/lag block.

Parameter Range:	2 to 20
Default Setting:	2
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Tuning

For example, if this parameter is set to 10, the high break frequency is 10 times the low break frequency (set by SPD LEADLAG LOW FREQ).

If SPD LEADLAG SELECT is set to BYPASS, this parameter has no effect.

SPD LEADLAG SELECT (P.216)

Determines if and how the lead/lag block will act on the speed loop feedback signal.

Parameter Range:	LEAD/LAG BYPASS LAG/LEAD
Default Setting:	BYPASS
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning

If BYPASS is selected, the lead/lag block is bypassed and the feedback signal is used directly by the speed loop summing junction.

5.3 Reading the Speed Loop Error Signal

The speed loop error signal is determined by subtracting SPD LOOP FEEDBACK (P.296) from the SPD LOOP REFERENCE (P.295).

SPD LOOP ERROR (P.297)

The speed loop error signal, which is the difference between SPD LOOP REFERENCE (P.295) and SPD LOOP FEEDBACK (P.296).

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	SPD - Speed/Voltage Loop (SPD) Test Points

SPD LOOP FEEDBACK (P.296)

The final speed/voltage loop drive feedback value after scaling.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	SPD - Speed/Voltage Loop (SPD) Test Points

5.4 Configuring the Speed Loop Forward Path Lag Block

Lag adjustments compensate for noisy feedback or reference signals. The speed loop lag block serves as a low pass frequency compensation filter. A positive or negative step input to the lag block drives the output to increase or decrease its value in the direction of the input. A lower lag break frequency will exhibit a slower step response than a higher one.

The lag transfer function is: $\frac{1}{1 + \frac{s}{\omega_{lag}}}$, where ω_{lag} = SPD LOOP LAG FREQ (P.215).

SPD LOOP LAG BYPASS (P.217)

Determines if the speed loop forward path lag block will act upon the speed loop error signal.

Parameter Range:	ON OFF
Default Setting:	ON
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning

If ON, the lag block is bypassed and does not affect the speed loop forward path signal.

SPD LOOP LAG FREQ (P.215)

Specifies the lag break frequency for the speed loop forward path lag block.

If SPD LOOP LAG BYPASS is ON, this parameter has no effect.

Parameter Range:	0.01 to 139.62 RAD/S when <ul style="list-style-type: none"> • FEEDBACK SELECT (P.200) = ARMATURE VOLT • SPD LOOP SCAN TIME (P.019) = 10 MS 0.01 to 279.25 RAD/S when <ul style="list-style-type: none"> • FEEDBACK SELECT (P.200) ≠ ARMATURE VOLT • SPD LOOP SCAN TIME (P.019) = 5 MS
Default Setting:	1.00 RAD/S
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning

SPD LOOP LAG OUTPUT (P.298)

The value immediately after the speed loop forward path lag block.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	SPD - Speed/Voltage Loop (SPD) Test Points

5.5 Configuring the Speed Loop Current Limits

Armature current is typically limited through two parameters, POSITIVE CURRENT LIM (P.005) and NEGATIVE CURRENT LIM (P.006). Configure these parameters so they limit armature current to a range that is consistent with normal operation of the application.

The current limits can also come from:

- Analog inputs 1 and 2 on the I/O Expansion kit.
- Network input registers 1, 2, or 3 from a network.

When POS CURRENT LIM SEL (P.223) or NEG CURRENT LIM SEL (P.224) is set to REGISTER, the register values are automatically clamped to prevent a minimum (non-zero) current condition.

Normally, the negative current limit is input as a positive value, then converted to a negative value by an inverter. If needed, the inverter can be disabled by the NEG CUR LIM INV EN (P.226) parameter. For example, if the inverter is enabled and the negative current limit is 150.0%FLA, the actual negative current limit used is -150.0%FLA.



ATTENTION: When analog inputs or network registers are used to control current limits, bipolar values are permitted for the positive and negative current limits of the current and speed loops. Extreme care must be exercised when setting the current limit values in this case. If the negative current limit is set to a non-zero value, the current loop reference will be clamped to this minimum value, possibly causing unexpected motor or machine operation, including rapid acceleration or overspeed. Failure to observe this precaution could result in bodily injury.

If you change NEG CUR LIM INV EN (P.226), POS CURRENT LIM SEL (P.223) and NEG CURRENT LIM SEL (P.224) are automatically set to REGISTER. When this occurs, an alarm is generated to notify you of a possible change in the current limits. Make sure the settings of POS CURRENT LIM SEL (P.223), NEG CURRENT LIM SEL (P.224), POSITIVE CURRENT LIM (P.005), and NEGATIVE CURRENT LIM (P.006) are correct for your application before operating the drive.

NEG CURRENT LIM SEL (P.224)

Selects the source for the negative current limit.

If REGISTER is selected, NEGATIVE CURRENT LIM (P.006) is used as the limit.

Parameter Range:	REGISTER ANALOG IN 1 ANALOG IN 2 NETW IN REG 1 NETW IN REG 2 NETW IN REG 3
Default Setting:	REGISTER
Parameter Type:	Configurable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning Current Minor Loop (CML) - CML Tuning

The I/O Expansion kit must be installed to use ANALOG IN 1 (terminals 50 and 51 on the I/O Expansion board) or ANALOG IN 2 (terminals 52 and 53).

A network kit must be installed to select the network input registers (NETW IN REG 1, 2, or 3). Note that the network input registers are updated only when Control Source (P.000) is set to NETWORK and the network is active.

This parameter is affected by NEG CUR LIM INV EN (P.226).

NEG CUR LIM INV EN (P.226)

Enables or disables the negative current limit inverter to the speed loop PI block low limit input.

Parameter Range:	DISABLED ENABLED
Default Setting:	ENABLED
Parameter Type:	Configurable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

When this parameter is set to ENABLED, POSITIVE CURRENT LIM (P.005) and NEGATIVE CURRENT LIM (P.006) are restricted to positive values.

When this parameter is set to DISABLED, the range of NEGATIVE CURRENT LIM (P.006) is restricted to negative values.

When you change this parameter value:

- Alarm A00052 occurs.
- The parameters NEG CURRENT LIM SEL (P.224) and POS CURRENT LIM SEL (P.223) are automatically set to REGISTER.
- NEGATIVE CURRENT LIM (P.006) is inverted. For example, if NEG CUR LIM INV EN is set to ENABLE and NEGATIVE CURRENT LIM is set to 150% FLA, changing NEG CUR LIM INV EN to DISABLED changes the value of NEGATIVE CURRENT LIM to -150% FLA.

Carefully check your current limit scheme and the values of POSITIVE CURRENT LIM (P.005) and NEGATIVE CURRENT LIM (P.006) to avoid unintended drive operation.

NEGATIVE CURRENT LIM (P.006)

This parameter only needs to be set for regenerative drives.

Selects the highest amount of current (% full load amps) for the reverse bridge. Used as a low limit for the speed loop PI block when NEG CURRENT LIM SEL (P.224) is set to REGISTER.

Parameter Range:*	When NEG CUR LIM INV EN (P.226) = ENABLED: 0 to MAXIMUM CURRENT (%FLA) When NEG CUR LIM INV EN (P.226) = DISABLED: -MAXIMUM CURRENT to 0 (%FLA)
Default Setting:	± 150 %FLA
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning Current Minor Loop (CML) - CML Tuning Quick Start

*The range is clamped to zero:

- For non-regenerative drives.
- If FEEDBACK SELECT (P.200) is set to AC TACH.
- If FEEDBACK SELECT is PULSE TACH and PULSE TACH QUADRATURE (P.208) is OFF.

The range of NEGATIVE CURRENT LIM depends on the setting of NEG CUR LIM INV EN (P.226).

POS CURRENT LIM SEL (P.223)

Selects the source for the positive current limit.

If REGISTER is selected, POSITIVE CURRENT LIM (P.005) is used as the limit.

Parameter Range:	REGISTER ANALOG IN 1 ANALOG IN 2 NETW IN REG 1 NETW IN REG 2 NETW IN REG 3
Default Setting:	REGISTER
Parameter Type:	Configurable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning Current Minor Loop (CML) - CML Tuning

The I/O Expansion kit must be installed to use ANALOG IN 1 (terminals 50 and 51 on the I/O Expansion board) or ANALOG IN 2 (terminals 52 and 53).

A network option board must be installed to select the network input registers (NETW IN REG 1, 2, or 3). Note that the network input registers are updated only when Control Source (P.000) is set to NETWORK and the network is active.

This parameter is affected by NEG CUR LIM INV EN (P.226).

POSITIVE CURRENT LIM (P.005)

Sets the highest amount of current (% full load amps) for the forward bridge. Used as a high limit for the speed loop PI block when POS CURRENT LIM SEL (P.223) is set to REGISTER.

Parameter Range:	0 to MAXIMUM CURRENT (%FLA)
Default Setting:	150 %FLA
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning Current Minor Loop (CML) - CML Tuning Quick Start

5.6 Configuring the Speed Loop PI Block

The proportional-integral transfer function is:

$$K_p \left(\frac{s + \omega_{ld}}{s} \right)$$

where:

- K_p = SPD LOOP PI PROP GAIN (P.211)
- ω_{ld} = SPD LOOP PI LEAD FREQ (P.212)

When CONTROL SOURCE SELECT is set to NETWORK, you can reset and assign initial values to the speed loop PI block. This allows you to switch between current and speed regulation without stopping the drive.

The PI block is reset when SPD LOOP PI RESET is asserted. The PI block is also held in reset when the drive is stopped. While reset is asserted, the output of the PI block is the initial value.

The initial value is determined by SPD LOOP PI INIT SEL and SPD LOOP PI INIT VAL.

If CONTROL SOURCE SELECT is not set to NETWORK, the block uses an initial value of zero (SPD LOOP PI INIT SEL set to ZERO.)

When the PI block reset is used, the system must be set to minimize the error between the actual reference and the commanded reference when changing regulation schemes to minimize bumps in regulation. For example, when changing from speed to current regulation, the speed loop PI block's initial value should be updated with the actual armature current feedback just before the change is made. The speed reference should be set to speed feedback before changing from current to speed regulation.

You can pretorque the speed regulator by setting the speed loop PI block's initial value to the desired starting torque value and releasing the block from reset after starting the drive. The initial torque will be the initial value as the drive begins to ramp to the reference speed.

SPD LOOP OUTPUT (P.299)

Speed loop PI block output value.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	SPD - Speed/Voltage Loop (SPD) Test Points Current Minor Loop (CML) - CML Test Points

SPD LOOP PI INIT SEL

Selects the source for the initial value of the speed loop PI block when CONTROL SOURCE SELECT is set to NETWORK.

If CONTROL SOURCE SELECT is not set to NETWORK, SPD LOOP PI INIT SEL is forced to ZERO.

Parameter Range:	0 = ZERO 1 = SPD LOOP PI INIT VAL 2 = ANALOG MAN TRIM REF (P.194)
Default Setting:	0
Parameter Type:	Configurable
OIM Menu Path(s):	This parameter is available over the network, It cannot be viewed through the OIM.

Refer to the appropriate network communication manual for register map assignments.

SPD LOOP PI INIT VAL

The initial value of the speed loop PI block when CONTROL SOURCE SELECT is set to NETWORK and SPD LOOP PI INIT SEL is set to 1 (SPD LOOP PI INIT VAL).

Parameter Range:	-32768 to 32767
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	This parameter is only available over the network, It cannot be viewed through the OIM.

This parameter is forced to 0 if CONTROL SOURCE SELECT is not set to NETWORK.

Refer to the appropriate network communication manual for register map assignments.

SPD LOOP PI LEAD FREQ (P.212)

Speed loop PI block lead break frequency.

Parameter Range:	0.00 to 282.74 RAD/S when <ul style="list-style-type: none">• FEEDBACK SELECT (P.200) = ARMATURE VOLT• SPD LOOP SCAN TIME (P.019) = 10 MS 0.00 to 327.67 RAD/S when <ul style="list-style-type: none">• FEEDBACK SELECT (P.200) ≠ ARMATURE VOLT• SPD LOOP SCAN TIME (P.019) = 5 MS
Default Setting:	3.00 RAD/S
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning

A setting of 0.00 allows proportional-only speed loop control.

This parameter is set by the speed loop self-tuning procedure. You can also enter it directly. Self-tuning will overwrite values entered manually.

SPD LOOP PI PROP GAIN (P.211)

Speed loop PI block proportional gain.

Parameter Range:	0.10 to 128.00
Default Setting:	4.40
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) - Tuning

This parameter is set by the speed loop self-tuning procedure. You can also enter it directly. Self-tuning will overwrite values entered manually.

SPD LOOP PI RESET

While this is ON, the speed loop PI block is held in reset and the block's output is the initial value selected by SPD LOOP PI INIT VAL (Drop_1, register 39 of the alternate network register map).

Parameter Range:	0 = OFF 1 = ON
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	This parameter is only available over the network. It cannot be viewed through the OIM.

SPD LOOP PI RESET is forced OFF when CONTROL SOURCE SELECT is not NETWORK.

Refer to the appropriate network communication manual for register map assignments.

5.7 Configuring Parameters for Winding Applications

These options are only available when using the AutoMax Network Communication board (CONTROL SOURCE SELECT is set to NETWORK and NETW REGISTER MAP SEL (P.914) is set to 2 (ALTERNATE)) or when using the ControlNet Network Communication board.

For diameter-dependent loads, you can scale the feedback to the speed loop. The feedback is scaled through a multiplier block. The operation of the multiplier block is:

$$\frac{A \cdot B}{1000}$$

Where:

- A is a speed feedback multiplier (gain)
- B is the speed feedback from the lead/lag block output

When NETW REGISTER MAP SEL (P.914) is set to ALTERNATE, the source for A is the network register SPEED FEEDBACK GAIN (alternate map, Drop_1, register 38). Even if the multiplier block is not being used, you must write a value of 1000 to the SPEED FEEDBACK GAIN register whenever writing to Drop_1. This sets the multiplier block to unity gain.

If the web is underwound, set UNDERWIND ENABLE (alternate map, Drop_1, register 32, bit 5) to ENABLE. This enables two inverters, one in the speed loop feedback path immediately before the feedback summing junction, and one at the input to the CML limit block.

Refer to the appropriate network communication manual for register map assignments.

UNDERWIND ENABLE

Setting this bit to 1 enables two inverter blocks that permit underwind operation.

Setting this bit to 0 disables the two inverter blocks and permits overwind operation.

Parameter Range:	0 = DISABLED (overwind) 1 = ENABLED (underwind)
Default Setting:	0
Parameter Type:	Configurable
OIM Menu Path(s):	This parameter is only available over the network. It cannot be viewed through the OIM.

Refer to the appropriate network communication manual for register map assignments.

To use this register, CONTROL SOURCE SELECT must be set to NETWORK and NETW REGISTER MAP SEL (P.914) must be set to ALTERNATE.

The inverters are located in the speed loop feedback path (see figure 5.1) and the current minor loop reference path (see figure 6.1).

If CONTROL SOURCE SELECT is changed from NETWORK to any other control source, the UNDERWIND ENABLE bit is set to the default of DISABLED. If the setting was ENABLED, the motor can rotate in the opposite direction when the drive is restarted with a control source other than the network.



ATTENTION: When CONTROL SOURCE SELECT is changed from NETWORK to another value, UNDERWIND ENABLE is forced to DISABLED. This could cause the motor to rotate in the opposite direction than it did under network control. The active speed reference should be set to zero before starting the drive from the new control source. Slowly increase the speed reference until the proper rotation direction can be determined. If it is incorrect, change the setting of the FORWARD/REVERSE input. The active speed reference is based on the new control source and the auto or manual setting. Failure to observe this precaution could result in severe bodily injury or loss of life.

SPEED FEEDBACK GAIN

Controls the gain of the speed loop feedback path.

This is typically a value that is related to the diameter of the roll in a winder application.

Parameter Range:	1000 to 32000
Default Setting:	1000
Parameter Type:	Tunable
OIM Menu Path(s):	This parameter is only available over the network. It cannot be viewed through the OIM.

Refer to the appropriate network communication manual for register map assignments.

1000 corresponds to a gain of 1.000 and 32,000 to a gain of 32.000.

To access this register, CONTROL SOURCE SELECT must be set to NETWORK and NETW REGISTER MAP SEL (P.914) must be set to ALTERNATE.

To bypass the multiplier block, set this register to 1000 (1.000). This is the also the value SPEED FEEDBACK GAIN is forced to when NETW REGISTER MAP SEL (P.914) is set to ORIGINAL. The SPEED FEEDBACK GAIN block is bypassed when CONTROL SOURCE SELECT is not set to NETWORK.

If CONTROL SOURCE SELECT is changed from NETWORK to any other control source, the UNDERWIND ENABLE bit is set to the default of DISABLED. If the setting was ENABLED, the motor can rotate in the opposite direction when the drive is restarted with a control source other than the network.



ATTENTION: When CONTROL SOURCE SELECT is changed from NETWORK to another value, UNDERWIND ENABLE is forced to DISABLED. This could cause the motor to rotate in the opposite direction than it did under network control. The active speed reference should be set to zero before starting the drive from the new control source. Slowly increase the speed reference until the proper rotation direction can be determined. If it is incorrect, change the setting of the FORWARD/REVERSE input. The active speed reference is based on the new control source and the auto or manual setting. Failure to observe this precaution could result in severe bodily injury or loss of life.

Configuring the Current Minor Loop

In all FlexPak 3000 drive configurations, the central control loop is the current minor loop (CML). This is the control loop that regulates the amount of current flowing through the motor armature.

The CML is a simple control loop composed of a reference path, a feedback path, and a forward path that includes a proportional and integral (PI) block. See figure 6.2. The input to the PI block, known as the error, is the difference between the reference and feedback. The output of the PI block determines the level of current flowing through the motor armature. When a reference change occurs, the error becomes non-zero, causing the PI block output to change. This results in a higher or lower level of current flowing through the armature until the feedback again becomes equal to the reference.

Figure 6.1 shows the details of the CML reference path. Figure 6.2 shows the details of the CML regulator block diagram.

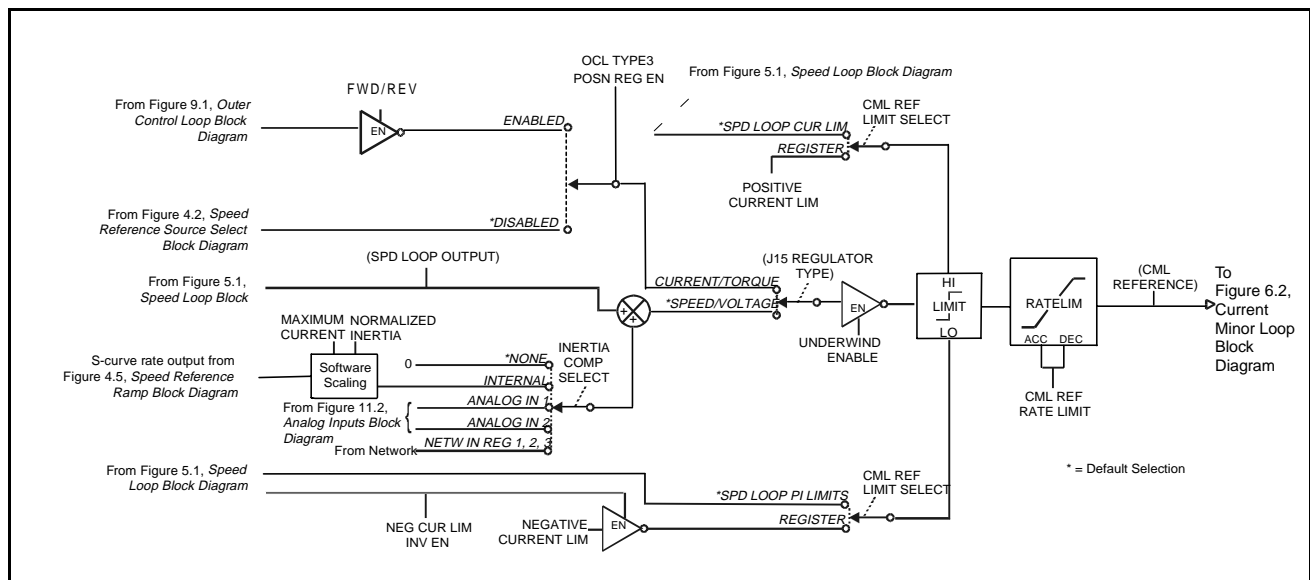


Figure 6.1 – Current Minor Loop Reference Path Block Diagram

6.1 Configuring Inertia Compensation

INERTIA COMP SELECT (P.221)

Selects the source of the inertia compensation signal.

The analog input choices are only available if the I/O Expansion kit is installed.

Parameter Range:	NONE INTERNAL ANALOG IN 1 ANALOG IN 2 NETW IN REG 1 NETW IN REG 2 NETW IN REG 3
Default Setting:	NONE
Parameter Type:	Configurable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning

When INTERNAL is selected, the inertia compensation signal is generated by scaling the rate output from the speed/voltage loop S-curve block based on the combined inertia of the motor and its connected load.

Inertia compensation circuit supports constant diameter, constant field current applications. The compensation signal is summed with the speed/voltage loop PI block output to form the reference to the CML.

When INTERNAL is selected, rate output from the speed/voltage loop S-curve block is scaled based on the combined inertia of the motor and its connected load, as set through the NORMALIZED INERTIA (P.222).

A network kit must be installed to select the network input registers (NETW IN REG 1, 2, or 3). Note that the network input registers are updated only when Control Source (P.000) is set to NETWORK and the network is active.

MAXIMUM CURRENT (P.007)

The highest amount of current (positive or negative) for a given application.

This input is the basis of armature current scaling.

Parameter Range:	25 to 200 %FLA
Default Setting:	150 %FLA
Parameter Type:	Configurable
OIM Menu Path(s):	Current Minor Loop (CML) - CML Feedback Scaling

MAXIMUM CURRENT is limited to 200% of MOTOR RATED ARM AMPS.

The setting of MAXIMUM CURRENT can affect the value of J18 ARM I FB RESISTOR (P.395). Check J18 ARM I FB RESISTOR (P.395) and the setting of the J18 jumper if you change MAXIMUM CURRENT.

NORMALIZED INERTIA (P.222)

The time required to accelerate the motor and load inertia from zero to motor base speed at MOTOR RATED ARM VOLTS (P.009) and MOTOR HOT FLD AMPS (P.510).

Parameter Range:	0.05 to 65.20 seconds
Default Setting:	1.00 second
Parameter Type:	Tunable
OIM Menu Path(s):	Speed/Voltage Loop (SPD) - Speed/Voltage Loop (SPD) Tuning

This parameter is set by the speed loop self-tuning procedure. You can also enter it directly. Self-tuning will overwrite values entered manually.

6.2 Selecting and Conditioning CML Reference Selection

A hardware jumper, J15, configures the drive as a current/torque or speed/voltage regulator. When J15 is set to CURRENT, the input signal TORQUE REFERENCE (P.189) is the CML reference. TORQUE REFERENCE can come from an analog input, frequency input, or a network master. When J15 is set to SPEED, the signal SPD LOOP OUTPUT (P.299) is the CML reference. The software reads the setting of hardware jumper J15 only at powerup. See the hardware manual for information on setting jumpers.

The selected CML reference passes through an amplitude limit block and a rate limit block. See figure 6.1 for the block diagram.

The amplitude limit block prevents the reference signal from becoming greater than or less than the limits selected by CML REF LIMIT SELECT (P.311). These limits can be either the values set by parameters NEGATIVE CURRENT LIM (P.006) and POSITIVE CURRENT LIM (P.005), or the limit values being used by the speed loop PI block.

The rate limit block limits the rate of change of the selected CML reference based on value you input for CML REF RATE LIMIT (P.303). CML REF RATE LIMIT (P.303) defines the minimum allowable time (in milliseconds) that the reference can change from zero to MAXIMUM CURRENT (P.007). When the drive is stopped, the output of the rate limit block is clamped to zero. The amplitude and rate-limited CML reference appears as the output parameter CML REFERENCE (P.396).

CML REF LIMIT SELECT (P.311)

Selects the source for the CML positive and negative current limits.

Parameter Range:	1 = SPD LOOP PI LIMITS 2 = REGISTER
Default Setting:	1
Parameter Type:	Configurable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

If you select REGISTER, the CML loop limits are POSITIVE CURRENT LIM (P.005) and NEGATIVE CURRENT LIM (P.006).

If you select SPD LOOP PI LIMITS, the CML loop reference limits are the same as those used by the speed loop PI block.

CML REF RATE LIMIT (P.303)

Minimum time for CML REFERENCE to change from zero to MAXIMUM CURRENT.

Parameter Range:	1 to 1000 msec
Default Setting:	40 msec
Parameter Type:	Tunable
OIM Menu Path(s):	Current Minor Loop (CML) - CML Tuning

This parameter is set by the CML self-tuning procedure. You can also enter it directly. Self-tuning will overwrite values entered manually.

CML REFERENCE (P.396)

The amplitude and rate limited value of the selected CML reference.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Current Minor Loop (CML) - CML Test Points

NEG CUR LIM INV EN (P.226)

Enables or disables the negative current limit inverter to the speed loop PI block low limit input.

Parameter Range:	DISABLED ENABLED
Default Setting:	ENABLED
Parameter Type:	Configurable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

When this parameter is set to ENABLED, POSITIVE CURRENT LIM (P.005) and NEGATIVE CURRENT LIM (P.006) are restricted to positive values.

When this parameter is set to DISABLED, the range of NEGATIVE CURRENT LIM (P.006) is restricted to negative values.

When you change this parameter value:

- Alarm A00052 occurs.
- The parameters NEG CURRENT LIM SEL (P.224) and POS CURRENT LIM SEL (P.223) are automatically set to REGISTER.
- The value of NEGATIVE CURRENT LIM (P.006) is inverted. For example, if NEG CUR LIM INV EN is set to ENABLE and NEGATIVE CURRENT LIM is set to 150% FLA, changing NEG CUR LIM INV EN to DISABLED causes the value of NEGATIVE CURRENT LIM to change to -150% FLA.

Carefully check your current limit scheme and the values of POSITIVE CURRENT LIM (P.005) and NEGATIVE CURRENT LIM (P.006) to avoid unintended drive operation.

TORQUE REFERENCE (P.189)

Torque (current) reference value.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Current Minor Loop (CML) - CML Test Points

Used as the CML reference when the drive is configured as a current/torque reference. See section 6.3.

UNDERWIND ENABLE

Setting this bit to 1 enables two inverter blocks that permit underwind operation.

Setting this bit to 0 disables the two inverter blocks and permits overwind operation.

Parameter Range:	0 = DISABLED (overwind) 1 = ENABLED (underwind)
Default Setting:	0
Parameter Type:	Configurable
OIM Menu Path(s):	This parameter is only available over the network. It cannot be viewed through the OIM.

Refer to the appropriate network communication manual for register map assignments.

To use this register, CONTROL SOURCE SELECT must be set to NETWORK and NETW REGISTER MAP SEL (P.914) must be set to ALTERNATE.

The inverters are located on the speed loop feedback path (figure 5.1) and the CML reference path (figure 6.1).

If CONTROL SOURCE SELECT is changed from NETWORK to any other control source, the UNDERWIND ENABLE bit is set to the default of DISABLED. If the setting was ENABLED, the motor can rotate in the opposite direction when the drive is restarted with a control source other than the network.



ATTENTION: When CONTROL SOURCE SELECT is changed from NETWORK to another value, UNDERWIND ENABLE is forced to DISABLED. This could cause the motor to rotate in the opposite direction than it did under network control. The active speed reference should be set to zero before starting the drive from the new control source. Slowly increase the speed reference until the proper rotation direction can be determined. If it is incorrect, change the setting of the FORWARD/REVERSE input. The active speed reference is based on the new control source and the auto or manual setting. Failure to observe this precaution could result in severe bodily injury or loss of life.

6.3 Configuring the Armature Current Feedback

Current transformers and a rectifier bridge are used to determine the armature current feedback signal that is scaled by a burden resistor (hardware scaling). Ideally, the selected burden resistor would scale the feedback signal so that 3 volts corresponds to MAXIMUM CURRENT (P.007). However, since burden resistor selection is limited to one of four values, it is likely that none of the available burden resistors will result in ideal scaling. Therefore, software scaling is used to adjust the output of the A/D converter to the appropriate level. The FlexPak 3000 drive automatically calculates and sets the software scale factor based on CT TURNS RATIO (P.010), MOTOR RATED ARM AMPS (P.008), and MAXIMUM CURRENT (P.007). After these parameters have been set appropriately, hardware jumper J18 must be set according to parameter J18 ARM I FB RESISTOR (P.395).

An additional gain block in the feedback path allows you to adjust the current feedback signal by a maximum of $\pm 10\%$ (gain range of 0.900 to 1.100). The CML FEEDBACK GAIN ADJ (P.300) is typically set for unity gain.

The FlexPak 3000 drive limits the combination of the two gains (software and user scale factors) to a range of 0.800 and 2.000. For example, suppose the FlexPak 3000 drive sets the software scale factor to 1.950. CML FEEDBACK GAIN ADJ (P.300) is limited to a maximum value of 1.025 ($2.000/1.950$) to prevent the combined gain from exceeding 2.000.

The scaled CML feedback value appears as CML FEEDBACK (P.397).

See figure 6.2 for block diagram.

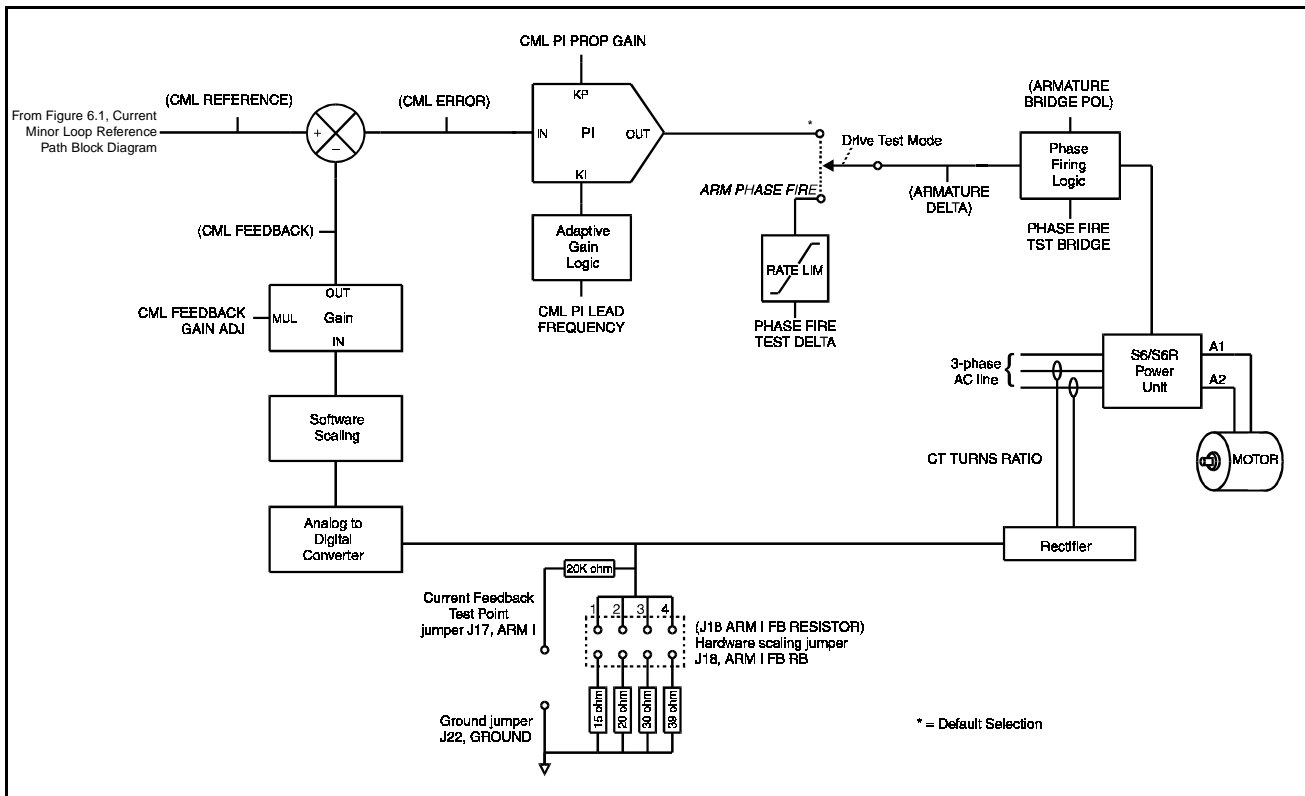


Figure 6.2 – Current Minor Loop Block Diagram

CML FEEDBACK (P.397)

The CML feedback signal after all hardware and software scaling.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Current Minor Loop (CML) - SCR Diagnostics - Armature Phase Fire Test Current Minor Loop (CML) - CML Feedback Scaling Current Minor Loop (CML) - CML Test Points

CML FEEDBACK GAIN ADJ (P.300)

The CML feedback gain adjustment. In most cases, this is set for unity gain. Typically, it will be set to 1.000.

Parameter Range:*	0.900 to 1.100
Default Setting:	1.000
Parameter Type:	Tunable
OIM Menu Path(s):	Current Minor Loop (CML) - CML Feedback Scaling

*The range might be affected by the software scaling factor calculated by the drive.

J18 ARM I FB RESISTOR (P.395)

Indicates the burden resistor position required to properly scale armature current feedback.

Parameter Range:	1 (15 Ω) 2 (20 Ω) 3 (30 Ω) 4 (39 Ω)
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Information – Correct Scaling Jumper Positions Current Minor Loop (CML) – CML Feedback Scaling Quick Start

The value of this parameter is based on the values of CT TURNS RATIO (P.010), MAXIMUM CURRENT (P.007), and MOTOR RATED ARM AMPS (P.008). If you change any one of these parameters, check the reading of J18 ARM I FB RESISTOR and make sure the setting of jumper J18 on the Regulator board matches.

MOTOR RATED ARM AMPS (P.008)

The rated armature current from the motor nameplate.

Parameter Range:	0 to 3000.0 amps
Default Setting:	8.0 amps
Parameter Type:	Configurable
OIM Menu Path(s):	Current Minor Loop (CML) - CML Feedback Scaling Quick Start

The setting of MOTOR RATED ARM AMPS can affect the value of J18 ARM I FB RESISTOR (P.395). Check J18 ARM I FB RESISTOR (P.395) and the setting of the J18 jumper if you change MOTOR RATED ARM AMPS.



ATTENTION: This parameter must be less than the motor rated armature amps or drive current rating listed on the motor nameplate. If this is configured incorrectly, overcurrent or excess heating of the motor could result. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

CT TURNS RATIO (P.010)

The drive current transformer turns ratio (T_p/T_n).

See Regulator board replacement instructions for information on determining the CT TURNS RATIO. This parameter is not restored if a Restore Defaults is done.

Parameter Range:	139 208 417 833 2000 5230 OTHER
Default Setting:	n/a (set at the factory based on the drive horsepower and AC line voltage.)
Parameter Type:	Configurable
OIM Menu Path(s):	Current Minor Loop (CML) - CML Feedback Scaling

The setting of CT TURNS RATIO can affect the value of J18 ARM I FB RESISTOR (P.395). Check J18 ARM I FB RESISTOR (P.395) and the setting of the J18 jumper if you change CT TURNS RATIO.



ATTENTION: The CT TURNS RATIO parameter is used in the calculation of the burden resistor value. Do not change this parameter from its factory default value unless you are replacing the Regulator board. Failure to observe this precaution could result in damage to, or destruction of, the equipment.

Drive Current Transformer Turns Ratio (Tp/Tn)	Value to Enter
1.5 HP @ 230 VAC / 3 HP @ 460 VAC	139
2 thru 7.5 HP @ 230 VAC / 5 thru 15 HP @ 460 VAC	208
10 thru 15 HP @ 230 VAC / 20 thru 30 HP @ 460 VAC	417
20 thru 30 HP @ 230 VAC / 40 thru 60 HP @ 460 VAC	833
40 thru 75 HP @ 230 VAC / 75 thru 150 HP @ 460 VAC	2000
100 thru 150 HP @ 230 VAC / 200 thru 300 HP @ 460 VAC	5230
400 to 600 HP @ 460 VAC	7770
7A	139
29A	208
55A	417
110A	833
265A	2000

6.4 Configuring the CML Forward Path

The proportional-integral (PI) controller adjusts the armature firing angle, ARMATURE DELTA (P.399), to compensate for any difference between the reference and the feedback signals. When the drive is stopped, this block's output is clamped to zero.

Proportional gain is set by CML PI PROP GAIN (P.301). The integral time constant can be changed by adjusting CML PI LEAD FREQUENCY (P.302)

ARMATURE BRIDGE POL (P.394)

Indicates which bridge is currently active. OFF indicates the forward bridge. ON indicates the reverse bridge.

Parameter Range:	OFF ON
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Current Minor Loop (CML) - CML Test Points

ARMATURE DELTA (P.399)

Indicates the armature firing angle in microseconds.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Current Minor Loop (CML) - CML Test Points Current Minor Loop (CML) - SCR Diagnostics - Armature Phase Fire Test

CML ERROR (P.398)

The CML error signal. It is the difference between CML REFERENCE (P.396) and CML FEEDBACK (P.397).

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Current Minor Loop (CML) - CML Test Points

CML PI LEAD FREQUENCY (P.302)

The lead break frequency for the CML proportional-integral (PI) block.

Parameter Range:	10 to 500 RAD/S
Default Setting:	100 RAD/S
Parameter Type:	Tunable
OIM Menu Path(s):	Current Minor Loop (CML) - CML Tuning

This parameter is set by the CML self-tuning procedure. You can also enter it directly. Self-tuning will overwrite values entered manually.

CML PI PROP GAIN (P.301)

Proportional gain for the CML proportional-integral (PI) block.

Parameter Range:	0.000 to 4.000
Default Setting:	0.250
Parameter Type:	Tunable
OIM Menu Path(s):	Current Minor Loop (CML) - CML Tuning

This parameter is set by the CML self-tuning procedure. You can also enter it directly. Self-tuning will overwrite values entered manually.

Configuring the Metering Outputs

The FlexPak 3000 drive offers two filtered outputs that can be used to source external meters. These outputs are at terminals 24 through 26 on the Regulator board. See the hardware manual for information on wiring these outputs.

These outputs can be modified by the parameters described in this chapter.

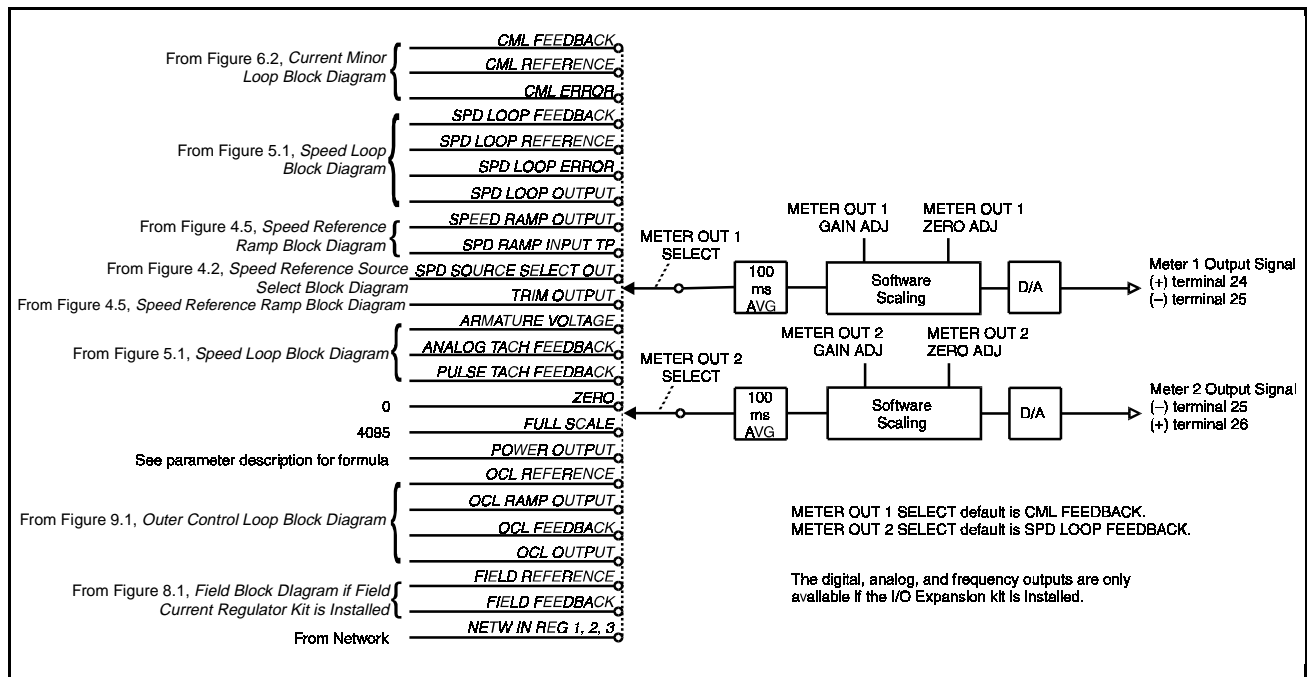


Figure 7.1 – Metering Outputs Block Diagram

METER OUT 1 GAIN ADJ (P.400)

Scales the meter output 1 signal at the Regulator board terminal strip.

Parameter Range:	1.100 to 1.900
Default Setting:	1.000
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Meter Outputs

METER OUT 1 SELECT (P.404) can be set to FULL SCALE for an accurate gain adjustment. See figure 7.1.

Adjust the zero point (METER OUT 1 ZERO ADJ (P.402)) before adjusting gain.

METER OUT 1 SELECT (P.404)

Selects the drive output that will source meter output 1 (terminals 24 and 25 on the Regulator board).

Parameter Range:	See table 7.1 for options
Default Setting:	CML FEEDBACK
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Meter Outputs

METER OUT 1 ZERO ADJ (P.402)

Removes any offset from the meter output 1 signal at the Regulator board terminal strip.

Parameter Range:	-200 to 200
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Meter Outputs

METER OUT 1 SELECT (P.404) can be set to ZERO for an accurate zero adjustment. See figure 7.1.

METER OUT 2 GAIN ADJ (P.401)

Scales the meter output 2 signal at the Regulator board terminal strip.

Parameter Range:	0.100 to 1.900
Default Setting:	1.000
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Meter Outputs

METER OUT 2 SELECT (P.405) can be set to FULL SCALE for an accurate gain adjustment. See figure 7.1.

Adjust the zero point (METER OUT 2 ZERO ADJ (P.403)) before adjusting gain.

METER OUT 2 SELECT (P.405)

Selects the drive output that will source meter output 2 (terminals 25 and 26 on the Regulator board).

Parameter Range:	See table 7.1 for options
Default Setting:	SPD LOOP FEEDBACK
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Meter Outputs

METER OUT 2 ZERO ADJ (P.403)

Removes any offset from the meter output 2 signal at the Regulator board terminal strip.

Parameter Range:	-200 to 200
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Meter Outputs

METER OUT 2 SELECT (P.405) can be set to ZERO for an accurate zero adjustment. See figure 7.1.

Table 7.1 – Options for Metering Parameters

Signal Selected	Full Scale Value
CML FEEDBACK (P.397) CML REFERENCE (P.396) CML ERROR (P.398) SPD LOOP OUTPUT (P.299)	$\text{MOTOR RATED ARM AMPS} \times \frac{\text{MAXIMUM CURRENT}}{100} \quad (\text{amps})$ <p style="text-align: center;">or</p> $\text{MAXIMUM CURRENT (\% full load amps)}$
SPD LOOP FEEDBACK (P.296) SPD LOOP REFERENCE (P.295) SPD LOOP ERROR (P.297) SPEED RAMP OUTPUT (P.199) SPEED RAMP INPUT TP (P.198) SPD SOURCE SELECT OUT (P.193) TRIM OUTPUT (P.197) ANALOG TACH FEEDBACK (P.291) PULSE TACH FEEDBACK (P.292) OCL OUTPUT (P.848)	TOP SPEED (RPM)
ARMATURE VOLTAGE (P.289)	$\text{MOTOR RATED ARM VOLTS (volts)}$
POWER OUTPUT	$\text{MOTOR RATED ARM VOLTS} \times \text{MOTOR RATED ARM AMPS} \times \frac{\text{MAXIMUM CURRENT}}{100} \quad \text{watts}$
FIELD REFERENCE (P.590) FIELD FEEDBACK (P.589)	$\text{MOTOR HOT FLD AMPS (amps)}$
OCL REFERENCE (P.845) OCL RAMP OUTPUT (P.846) OCL FEEDBACK (P.847) NETW IN REG 1 (P.905) NETW IN REG 2 (P.906) NETW IN REG 3 (P.907) FULL SCALE	4095 (counts)
ZERO	0

Configuring the Field Supply

The FlexPak 3000 drive can be used with one of three types of field supplies:

- **Standard Field Supply:** Provides field control for the standard drive. All configuration for the standard field supply is through hardware. There are no parameters related to the standard field supply. This supply generates a fixed field voltage and does not provide field economy.
- **Optional Enhanced Field Supply:** Provides electronic field trim, field economy, and higher voltage field supplies than the standard field supply. The Enhanced Field Supply kit must be installed to use this field supply.
- **Field Current Regulated Supply:** Replaces the standard or enhanced field excitation supply with a current regulated supply. It provides user-adjustable field economy, constant horsepower operation, and user-adjustable field loss. The Field Current Regulator kit must be installed to use this field supply.

The Field Current Regulator kit is standard for drives that are 150 to 600HP @ 460VAC or 75 to 300HP at 230VAC. It is optional for lower HP drives.

The parameters you will configure for the field supply depend on the supply that is installed in your drive. You can check FLD CURRENT REGULATOR (P.586) to determine if the Field Current Regulator kit is installed. If FLD CURRENT REGULATOR (P.586) reports NOT INSTALLED, you have either the standard field supply, an Enhanced Field Supply kit, or an incorrectly installed or failed Field Current Regulator kit. Check your drive and installation notes to verify the type of field supply.

FLD CURRENT REGULATOR (P.586)

Indicates whether or not the Field Current Regulator kit is installed. If it is installed, lists the rating of the kit that is installed.

Note that if “20 AMP” is displayed, a 15 amp Field Current Regulator kit is installed.

Parameter Range:	NOT INSTALLED 4 AMP 10 AMP 20 AMP
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Field - Field Current Regulator Field - Standard/enhanced Field Supply Drive Information

8.1 Configuring Field Economy

Field economy is available if the Enhanced Field Supply kit or Field Current Regulator kit is installed. It is not available if you are using the standard field supply.

Field economy reduces the field voltage when the motor is at rest, reducing standby power consumption and prolongs the insulation life of the motor field windings.

When the Field Current Regulator kit is installed, the drive enters field economy when the drive is first powered up. When the armature becomes active, the drive goes to full field. After the drive stops, field economy becomes active after the time specified by FIELD ECONOMY DELAY (P.501). The field economy level is adjustable through FIELD ECONOMY REF (P.511).

When the Enhanced Field Supply kit is installed, the drive powers up at full field. Field economy is fixed at 45% of AC line voltage. After the drive stops, field economy becomes active after the time specified by FIELD ECONOMY DELAY (P.501).

FIELD ECONOMY ACTIVE (P.599) indicates when field economy is active.

The field current reference for the field loop changes depending on whether or not field economy is active. If field economy is:

- Inactive: FIELD REF REGISTER (P.513) is limited and is the field current reference.
- Active: MOTOR HOT FLD AMPS (P.510) and FIELD ECONOMY REF (P.511) are multiplied and used as the field current reference.

You can check the value of the field current reference by looking at FIELD REFERENCE (P.590). This reference is summed with FIELD FEEDBACK and fed into the field PI block.

If the Field Current Regulator kit is installed, you can adjust the field economy current level using FIELD ECONOMY REF (P.511). FIELD ECONOMY REF and/or FIELD REF REGISTER (P.513) must be above FIELD LOSS THRESHOLD (P.512) to avoid field loss faults. The field loss logic is disabled while in field economy.



ATTENTION: The incorrect configuration of these parameters can cause a motor overvoltage condition. Configure MOTOR HOT FLD AMPS (P.510) to the motor's nameplate value. Failure to observe this precaution can result in bodily injury and damage to the equipment.

FIELD ECONOMY ACTIVE (P.599)

Indicates the present state of field economy.

This parameter has no effect if the standard field supply is installed.

Parameter Range:	ON OFF
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Field - Standard/enhanced Field Supply Field - Field Current Regulator - Field Loop Test Points

FIELD ECONOMY DELAY (P.501)

After the motor stops, the drive maintains full field for FIELD ECONOMY DELAY minutes before entering field economy.

Parameter Range:	0 to 27 minutes
Default Setting:	5 minutes
Parameter Type:	Tunable
OIM Menu Path(s):	Field - Standard/enhanced Field Supply Field - Field Current Regulator - Field Loop Configure

When the motor starts again, the drive immediately returns to full field. FIELD ECONOMY DELAY does not affect operation of the standard field supply. Field economy cannot be disabled.

This parameter has no effect when the Enhanced Field Supply kit or standard field supply is installed.

FIELD ECONOMY REF (P.511)

Only available if the Field Current Regulator kit is installed.

Parameter Range:	0 to 100%
Default Setting:	0%
Parameter Type:	Tunable
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Configure

The percentage of MOTOR HOT FLD AMPS (P.510) set as a reference for field economy mode. This parameter must be set above the FIELD LOSS THRESHOLD (P.512) value to avoid field loss faults.

This parameter has no effect when the Enhanced Field Supply kit or standard field supply is installed.

FIELD REF REGISTER (P.513)

Current reference for the field control loop. This is the field current reference when the drive is not in field economy.

Parameter Range:	0 to MOTOR HOT FLD AMPS
Default Setting:	MOTOR HOT FLD AMPS
Parameter Type:	Tunable
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Tuning

FIELD REF REGISTER should be set greater than FIELD LOSS THRESHOLD (P.512) to avoid FIELD LOSS faults.

Only available if the Field Current Regulator kit is installed.

8.2 Configuring the Enhanced Field Supply

These parameters are available only if the Enhanced Field Supply kit is installed.

ENHANCED FLD VOLT ADJ (P.500)

Adjusts the field output voltage.

ENHANCED FLD VOLT ADJ has no effect on the operation of the standard field supply or the Field Current Regulator kit.

Parameter Range:	0 to 180 (J21 set to B-C) 0 to 120 (J21 set to A-C)
Default Setting:	84 0 when the Field Current Regulator kit is installed
Parameter Type:	Tunable
OIM Menu Path(s):	Field - Standard/enhanced Field Supply

Increasing ENHANCED FLD VOLT ADJ increases the output voltage at the F1 and F2 terminals. Decreasing ENHANCED FLD VOLT ADJ decreases the output voltage.

ENHANCED FLD VOLT ADJ has no effect when the drive is in field economy (FIELD ECONOMY ACTIVE (P.599) reads ON).

See the Enhanced Field Supply kit manual for detail on setting this jumper.

J20 FIELD LOSS DETECT (P.597)

Indicates the position of jumper J20, FIELD LOSS DETECT, which enables or disables field current loss detection. This jumper is only read on powerup.

Parameter Range:	ENABLE DISABLE
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Information Field - Standard/enhanced Field Supply

J20 should only be set to the DISABLE position when an external field supply is used.

Important: Jumper J20 is ignored if the Field Current Regulator kit is installed. Therefore, placing J20 in the DISABLE position will not disable field loss detection. See manual D2-3336 for information on the Field Current Regulator kit.



ATTENTION: The user must provide external field current loss detection and inhibit drive operation using one of the drive interlocks when this jumper is positioned to DISABLE. Misapplication of this jumper can cause the motor to run at dangerously high speeds. Provide external field current loss detection and inhibit drive operation using one of the drive interlocks if this jumper is positioned to DISABLE. Failure to observe this precaution could result in bodily injury.

J21 FLD SUPPLY JUMPER (P.598)

Indicates the position of Regulator board jumper J21, FIELD SUPPLY. It does not indicate the position of the jumper on the Enhanced Field Supply kit.

Parameter Range:	A-C B-C
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Information Field - Standard/enhanced Field Supply

This jumper must be at the same setting as the jumper on the Enhanced Field Supply kit, positions A-C or B-C.

This jumper is only available if the Enhanced Field Supply kit is installed. This jumper is only read on powerup.

8.3 Configuring the Field Current Regulated Supply

These parameters are only available if the Field Current Regulator kit is installed.

The Field Current Regulator kit replaces the standard field excitation supply with a current regulated supply. It provides field economy and constant horsepower (above base speed) operation. See figure 8.1 for the block diagram. See the Field Current Regulator kit manual, D2-3336, for a full description of the field block.

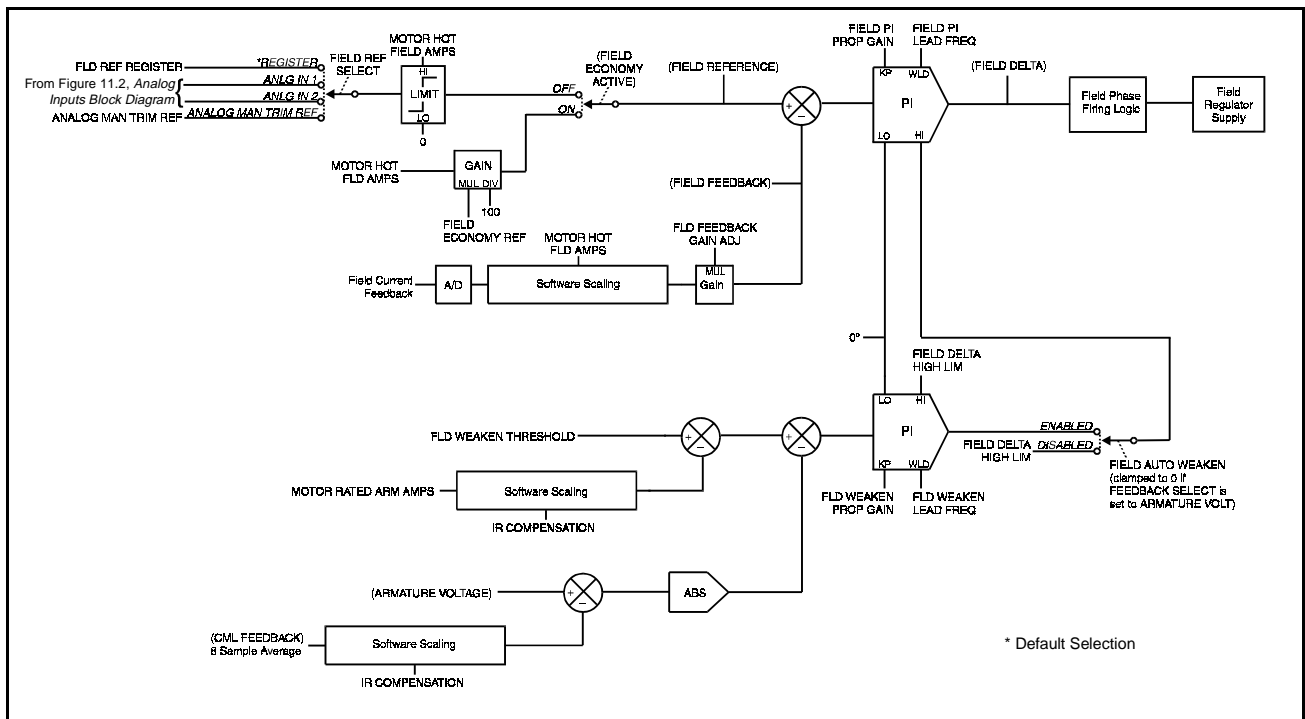


Figure 8.1 – Field Block Diagram if Field Current Regulator Kit is Installed

FIELD DELTA (P.588)

The field firing angle in degrees.

Parameter Range:	0 to 180 DEGREE
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Test Points

FIELD FEEDBACK (P.589)

Motor field current feedback signal after scaling and gain.

Parameter Range:	+/-MOTOR HOT FLD AMPS
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Feedback Scaling Field - Field Current Regulator - Field Loop Test Points

FIELD PI LEAD FREQ (P.515)

Lead frequency for the field current PI block.

Parameter Range:	0 to 282.70 RAD/S
Default Setting:	1.50 rad/s
Parameter Type:	Tunable
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Tuning

FIELD PI PROP GAIN (P.514)

Proportional gain setting for the field current PI block.

Parameter Range:	0.10 to 128.00
Default Setting:	0.50
Parameter Type:	Tunable
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Tuning

FIELD REF SELECT (P.521)

Selects the reference source for the field current regulator.

Parameter Range:	1 = REGISTER 2 = ANALOG MAN TRIM REF 3 = ANALOG IN 1 4 = ANALOG IN 2
Default Setting:	1
Parameter Type:	Configurable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

An I/O Expansion kit must be installed to select ANALOG IN 1 or ANALOG IN 2.

REGISTER is the FIELD REF REGISTER (P.513), which can also be modified through a network register (drop_1, register 37).

FIELD REFERENCE (P.590)

Field current reference.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Test Points

When FIELD ECONOMY ACTIVE (P.599) is OFF, it is the limited value of the selected field reference.

When FIELD ECONOMY ACTIVE (P.599) is ON, it is the field economy reference.

FLD FEEDBACK GAIN ADJ (P.516)

Gain adjustment for the field current feedback.

In most cases, this will be set for unity gain (1.000).

Parameter Range:	0.900 to 1.100
Default Setting:	1.000
Parameter Type:	Tunable
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Feedback Scaling

MOTOR HOT FLD AMPS (P.510)

Motor nameplate value of the rated hot field amps. This input is the basis of field current scaling.

Parameter Range:	0.11 to installed supply rating (4.00, 10.00, or 20.00 amps)
Default Setting:	0.01 amps
Parameter Type:	Configurable
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Feedback Scaling

If the factory defaults are restored, or if a valid value has not yet been entered for this parameter, the DC field voltage is fixed at 150V on a 230VAC line, or at 300V on a 460VAC line.



ATTENTION: The incorrect configuration of this parameter can cause a motor overvoltage condition. Configure MOTOR HOT FLD AMPS (P.510) to the motor nameplate value. Failure to observe this precaution can result in bodily injury and damage to the equipment.

8.3.1 Configuring Automatic Field Weakening

The Field Current Regulator kit can provide automatic field weakening. Field weakening can only be used with speed-regulated drives.

Important: Automatic field weakening cannot be used if FEEDBACK SELECT is set to ARMATURE VOLT.

When ARMATURE VOLTAGE (P.289) exceeds FLD WEAKEN THRESHOLD (P.518), the field begins to weaken and the field control loop begins regulating armature voltage. When field auto weakening is enabled, the drive uses the values of ARMATURE VOLTAGE (P.289) and FLD WEAKEN THRESHOLD (P.518) to try to maintain a zero input to the first PI block. If armature voltage increases, a negative value is input to the PI block, which decreases the high limit to the next PI block. This reduces field current, subsequently lowering the armature voltage, bringing the input to the first PI block closer to zero.

If IR compensation is used, the threshold where the field control loop begins regulating armature voltage is FLD WEAKEN THRESHOLD (P.518) less IR COMPENSATION (P.206) at rated armature current.

To use automatic field weakening, set FIELD AUTO WEAKEN (P.517) to ENABLE.

To turn off automatic field weakening, set FIELD AUTO WEAKEN (P.517) to DISABLE. If automatic field weakening is disabled, the field current PI block high limit is fixed at 180 degrees.

If needed, you can use FLD WEAKEN LEAD FREQ (P.520) and FLD WEAKEN PROP GAIN (P.519) to modify the lead frequency and gain of the field auto weaken PI block.



ATTENTION: The incorrect configuration of the parameters for this loop can cause a motor overvoltage condition. Configure MOTOR HOT FLD AMPS (P.510) to the motor's nameplate value. Failure to observe this precaution can result in bodily injury and damage to the equipment.

FIELD AUTO WEAKEN (P.517)

Enables or disables automatic field weakening by the field control loop. When it is disabled, the field current PI block high limit is fixed at 180 degrees.

Parameter Range:	DISABLED ENABLED
Default Setting:	DISABLED
Parameter Type:	Configurable
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Configure

If FEEDBACK SELECT is set to ARMATURE VOLT, this is automatically set to DISABLED and cannot be changed.

FIELD DELTA HIGH LIM (P.587)

High limit of the field current PI block.

Parameter Range:	0 to 180 DEGREE
Default Setting:	130 DEGREE
Parameter Type:	Configurable
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Configure

FIELD LOSS THRESHOLD (P.512)

The value that is compared to FIELD FEEDBACK (P.589) to check for field loss.

Parameter Range:	50 to 100% of MOTOR HOT FLD AMPS (P.510) when FEEDBACK SELECT (P.200) is set to ARMATURE VOLT 0 to 100% of MOTOR HOT FLD AMPS (P.510) when FEEDBACK SELECT (P.200) is set to DC TACH, PULSE TACH, or AC TACH
Default Setting:	60% of MOTOR HOT FLD AMPS (P.510)
Parameter Type:	Configurable
OIM Menu Path(s):	Field – Field Current Regulator – Field Loop Configure

FIELD LOSS THRESHOLD is set as a percentage of MOTOR HOT FLD AMPS. It is usually set to 85% of the motor nameplate field weaken current.

FLD WEAKEN LEAD FREQ (P.520)

PI block lead frequency of the field control loop's armature voltage regulator.

Parameter Range:	0.01 to 282.70 RAD/S
Default Setting:	0.50 RAD/S
Parameter Type:	Tunable
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Tuning

FLD WEAKEN PROP GAIN (P.519)

The proportional gain of the field control loop's armature voltage regulator.

Parameter Range:	0.01 to 128.00
Default Setting:	1.60
Parameter Type:	Tunable
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Tuning

FLD WEAKEN THRESHOLD (P.518)

Sets the point at which the field control loop begins regulating armature voltage and the field begins to weaken.

Parameter Range:	0 to 120% of MOTOR RATED ARM VOLTS (P.009)
Default Setting:	95% of MOTOR RATED ARM VOLTS (P.009)
Parameter Type:	Tunable
OIM Menu Path(s):	Field - Field Current Regulator - Field Loop Tuning

If IR compensation is used, the threshold is FLD WEAKEN THRESHOLD at rated armature current.

Configuring the Outer Control Loop

The outer control loop (OCL) is typically used to provide dancer position or tension control in a web processing system. The OCL trims the speed/voltage loop reference signal. The block diagram for the OCL is shown in figure 9.1.

The OCL can be configured as a:

- Type 1 position regulator, which uses proportional-only control in the forward path.
- Type 2 position regulator, which uses proportional-plus-integral control to reduce steady state error to zero.
- Type 3 position regulator, which inputs the OCL output directly into the current minor loop.
- Other OCL schemes.

To configure the OCL as a type 1 position regulator, set the lead break frequency (OCL PI LEAD FREQ (P.809)) equal to zero (this sets the PI block to proportional only).

To configure the OCL as a type 2 position regulator, set the lead break frequency (OCL PI LEAD FREQ (P.809)) to a non-zero value.

When enabled, the OCL executes every 20 msec.

Important: Scaling units of some OCL parameters are not predefined and must be set by you. See the OIM manual to create OCL user-defined units.

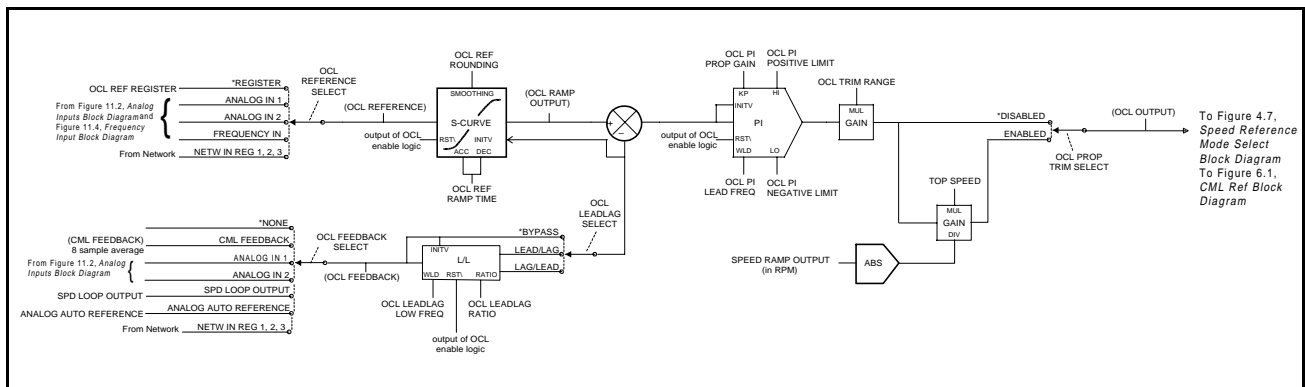


Figure 9.1 – Outer Control Loop Block Diagram

9.1 Enabling the Outer Control Loop



ATTENTION: An abrupt speed change could occur when the outer control loop is enabled. Make sure proper safeguards are in place before enabling the outer control loop. Failure to observe this precaution can result in severe bodily injury or loss of life.

To enable the OCL, either the I/O Expansion kit must be installed, CONTROL SOURCE SELECT must be set to NETWORK, or DIG IN 0 SELECT (P.428) must set to OCL ENABLE.

The OCL enable signal (OCL ENABLE (P.849)) must be ON to execute the OCL. If it is OFF or if the drive is not running, all OCL functions (S-curve, PI, and lead/lag) are held in reset and OCL OUTPUT (P.848) is zero.

Table 9.1 shows the source of the OCL enable signal for the various control sources.

Table 9.1 – OCL Enable Signal Source

Control Source	I/O Expansion Board Installed	OCL Enable Signal Source
NETWORK	n/a	Network OCL Enable
KEYPAD, TERMBLK, OR SERIAL	Yes	I/O Expansion kit Digital Input 5 (terminal 64)
	No	Regulator board Digital Input 0 (terminal 12) set to 0

To check the status of the OCL ENABLE, see parameter OCL ENABLE (P.849).

The OCL enable logic is shown in figure 9.2.

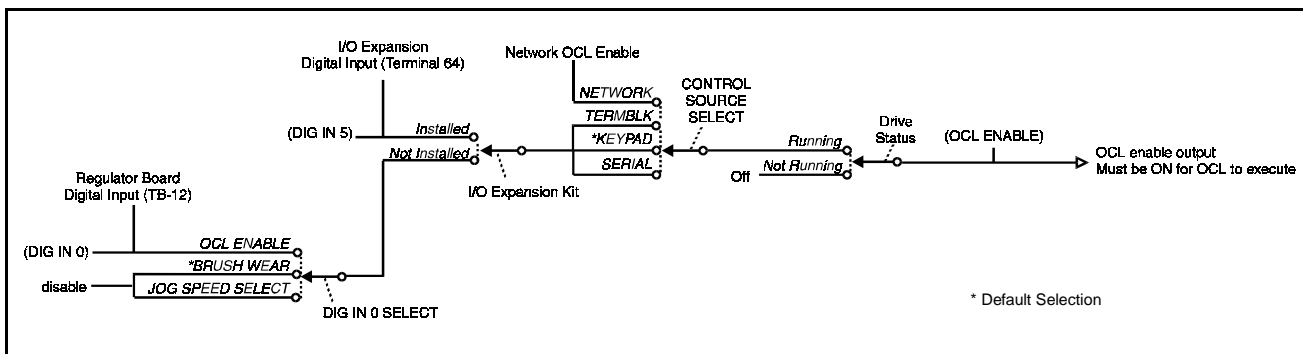


Figure 9.2 – Outer Control Loop Enable Logic

DIG IN 0 (P.490)

Indicates the state of digital input 0 (terminal 12 on the Regulator board).

Parameter Range:	ON OFF (see table 9.2 for detail)
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

DIG IN 0 is ON when +24VDC is applied for more than 10msec. It is OFF when 0VDC is applied.

Table 9.2 – Conditions Indicated by DIG IN 0 (P.490)

DIG IN 0 SELECT (P.428) Setting	Condition if DIG IN 0 (P.490) Reads:	
	ON	OFF
BRUSH WEAR INPUT	OK	Worn
JOG SPEED SELECT	Jog Speed 2 active	Jog Speed 1 active
OCL ENABLE	OCL enabled	OCL disabled

DIG IN 0 SELECT (P.428)

Determines which function is controlled by digital input 0 (terminal 12 on the Regulator board).

Parameter Range:	1 = BRUSH WEAR INPUT 2 = JOG SPEED SELECT 3 = OCL ENABLE
Default Setting:	1
Parameter Type:	Configurable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

The signal can be:

- OCL ENABLE: Enables the outer control loop if CONTROL SOURCE SELECT is not set to NETWORK and if the I/O Expansion kit is not installed.
- BRUSH WEAR: The input is from a brush wear indicator. If the input is OFF, the MOTOR BRUSH WEAR LOW alarm is generated. You must have the E.S.P. Brush Monitor Detector kit installed to use this option.
- JOG SPEED SELECT: The input determines whether JOG SPEED 1 (P.012) or JOG SPEED 2 (P.017) will be used when the drive is jogging.

DIG IN 5 (P.499)

State of the outer control loop enable input (terminal 64 on the I/O Expansion kit).

Parameter Range:	ON OFF
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Input/Output - Digital I/O

DIG IN 5 is ON when +24VDC is applied for more than 10msec. It is OFF when 0VDC is applied.

OCL ENABLE (P.849)

The status of the OCL enable signal. OFF indicates the OCL is disabled (held in reset). ON means it is operating.

Parameter Range:	ON OFF
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Test Points

9.2 Outer Control Loop Signal Processing

The OCL reference signal passes through a reference and a forward path.

9.2.1 Configuring the OCL Reference Path

You can configure the OCL to include an S-curve block. This prevents the speed/voltage loop from being “jerked” when the OCL is enabled. The S-curve block output ramps smoothly from the OCL FEEDBACK (P.847) value to the OCL reference setpoint to reduce mechanical wear.

The OCL reference signal is fed into the S-curve block, where it is modified by OCL REF RAMP TIME (P.802) and OCL REF ROUNDING (P.803). These parameters determine the amount of rounding and minimum amount of time of the OCL reference ramp when the OCL S-curve block output changes from 0 to full scale and vice versa. Rounding is performed at the beginning and end of an OCL reference change.

You can check the output of the block through OCL RAMP OUTPUT (P.846).

OCL RAMP OUTPUT (P.846)

The outer control loop reference S-curve block output in OCL user-defined units.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Test Points

OCL REFERENCE (P.845)

The reference value for the outer control loop. Displayed in OCL user-defined units.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Test Points

OCL REFERENCE SELECT (P.800)

Selects the reference for the outer control loop.

Parameter Range:	REGISTER ANALOG IN 1 ANALOG IN 2 FREQUENCY IN NETW IN REG 1 NETW IN REG 2 NETW IN REG 3
Default Setting:	REGISTER
Parameter Type:	Configurable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Configure

If REGISTER is selected, the reference is from OCL REF REGISTER (P.801).

The I/O Expansion kit must be installed to use ANALOG IN 1 (terminals 50 and 51 on the I/O expansion board), ANALOG IN 2 (terminals 52 and 53), or FREQUENCY IN (terminals 39, 40, and 41).

A communication kit must be installed to select the communication registers (NETW IN REG 1, 2, or 3). Note that the network input registers are updated only when Control Source (P.000) is set to NETWORK and the network is active.

OCL REF RAMP TIME (P.802)

The ramp time for the outer control loop reference.

Parameter Range:	0.0 to 300.0 seconds
Default Setting:	10.0 seconds
Parameter Type:	Tunable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Tuning

Sets the minimum amount of time for the OCL S-curve block output to change from 0 to full scale and vice versa. If set to 0.0, the S-curve block is bypassed.

Important: If the S-curve block is bypassed, rapid speed change can result.

OCL REF REGISTER (P.801)

The reference for the outer control loop that is used when OCL REFERENCE SELECT (P.800) is set to REGISTER.

Parameter Range:	-4095 to 4095
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Configure

Typically used in applications where a constant reference is needed.

OCL REF ROUNDING (P.803)

Specifies the amount of reference smoothing (rounding) for the outer control loop.

Parameter Range:	0 to 50%
Default Setting:	0%
Parameter Type:	Tunable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Tuning

It is set as a percentage of OCL REF RAMP TIME. Rounding is performed at the beginning and end of an OCL reference change.

If OCL REF ROUNDING is set to 0%, the OCL performs a linear ramp function. If it is set to 50%, the entire ramp time is smoothed: 50% at the beginning of the reference change and 50% at the end. If OCL REF RAMP TIME (P.802) is 0.0 (S-curve block bypassed), OCL REF ROUNDING has no effect on the OCL reference signal.

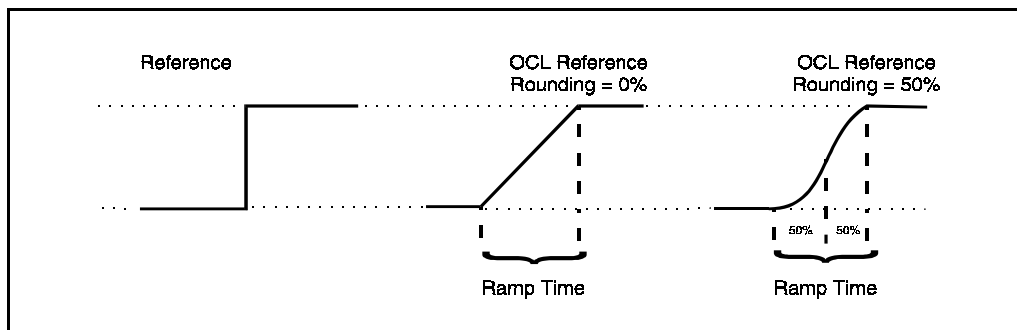


Figure 9.3 – OCL Reference Signal Rounding

9.2.2 Configuring the Outer Control Loop Forward Path

The difference between the OCL RAMP OUTPUT (P.846) and OCL feedback signal (after lead/lag has been applied, if selected) is summed with the OCL feedback and then fed into a PI block. In the PI block, gain (OCL PI PROP GAIN (P.808)) and lead frequency (OCL PI LEAD FREQ (P.809)) are applied. The output of the PI block is clamped within the values of OCL PI POSITIVE LIMIT (P.810) and OCL PI NEGATIVE LIMIT (P.811).

The signal from the PI block is fed into the OCL trim range block. Trim determines the amount of control the OCL signal has on the speed/voltage loop reference. The amount of trim is set through OCL TRIM RANGE (P.812).

If OCL PROP TRIM SELECT (P.813) is enabled, the signal from the trim range block is passed through another gain block. The gain of this block is proportional to the absolute value of the speed reference at the output of the speed loop S-curve block. The gain of this block ranges from 0 at zero speed to unity gain when the reference is equal to TOP SPEED (P.011).

You can check the final OCL value through OCL OUTPUT (P.848).

OCL OUTPUT (P.848)

The output of the outer control loop in speed units. This is the OCL trim that is applied to the speed/voltage control loop.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Test Points

OCL PI LEAD FREQ (P.809)

The lead break frequency of the proportional integral (PI) block of the outer control loop.

Parameter Range:	0.00 to 141.37 RAD/S
Default Setting:	1.00 RAD/S
Parameter Type:	Tunable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Tuning

If the OCL is configured as a type 1 position regulator, set this equal to 0.00 (proportional only).

OCL PI NEGATIVE LIMIT (P.811)

The negative limit of the outer control loop PI block.

Parameter Range:	0 to 100% of TOP SPEED (P.011)
Default Setting:	100%
Parameter Type:	Tunable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Tuning

OCL PI POSITIVE LIMIT (P.810)

The positive limit of the outer control loop PI block.

Parameter Range:	0 to 100% of TOP SPEED (P.011)
Default Setting:	100%
Parameter Type:	Tunable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Tuning

OCL PI PROP GAIN (P.808)

The proportional gain of the outer control loop PI block.

Parameter Range:	0.10 to 128.00
Default Setting:	2.00
Parameter Type:	Tunable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Tuning

OCL PROP TRIM SELECT (P.813)

When ENABLED is selected, the OCL output is proportional to the absolute value of the speed reference at the output of the speed loop S-curve block.

Parameter Range:	DISABLED ENABLED
Default Setting:	DISABLED
Parameter Type:	Configurable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

OCL TRIM RANGE (P.812)

The trim range for the outer control loop.

Parameter Range:	-100. to 100.0% of TOP SPEED (P.011)
Default Setting:	0.0%
Parameter Type:	Tunable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Tuning

This parameter specifies the amount of control the ocl output signal has on the speed/voltage loop reference or the CML reference when the drive is configured as a Type III position regulator.

9.3 Configuring the Outer Control Loop Feedback Path

The OCL lead and lag options allow you to limit ratio errors when the primary ratio variable changes quickly. Lead/lag adjustments compensate for backlash or coupling issues with the feedback device.



ATTENTION: Lead/lag parameters must be adjusted by a qualified control engineer. Failure to observe this precaution can result in severe bodily injury or loss of life.

To enable lead/lag or lag/lead, set OCL LEADLAG SELECT to LEAD/LAG or LAG/LEAD, respectively. To disable lead/lag or lag/lead, set OCL LEADLAG SELECT to BYPASS.

When lead/lag or lag/lead is selected, the OCL accepts a feedback signal from the source selected by OCL FEEDBACK SELECT (P.804). You can check the value of this signal through OCL FEEDBACK (P.847).

OCL FEEDBACK is fed into the lead/lag block. In this block, the OCL LEADLAG LOW FREQ (P.806) and OCL LEADLAG RATIO (P.807) values are applied to the signal and the drive calculates the high break frequency. OCL LEADLAG LOW FREQ sets where the signal will break. The OCL LEADLAG RATIO is the ratio maintained between the low break and high break frequency. The low frequency and ratio settings are multiplied to determine the high break frequency. For example, if the low break frequency is 0.50 rad/s and the ratio is 10, the high break frequency is 5.00 rad/s.

The transfer functions for lead/lag and lag/lead are:

Lead/Lag:

$$\frac{1 + \frac{s}{\omega_{low}}}{1 + \frac{s}{\omega_{high}}}$$

Lag/Lead:

$$\frac{1 + \frac{s}{\omega_{high}}}{1 + \frac{s}{\omega_{low}}}$$

Where:

- ω_{low} = OCL LEADLAG LOW FREQ (P.806)
- ω_{high} = OCL LEADLAG LOW FREQ (P.806) * OCL LEADLAG RATIO (P.807)

OCL FEEDBACK (P.847)

The feedback value of the outer control loop. It is displayed in OCL user-defined units.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Test Points

OCL FEEDBACK SELECT (P.804)

Selects the source of the OCL feedback signal.

Parameter Range:	NONE CML FEEDBACK ANALOG IN 1 ANALOG IN 2 5 = SPEED LOOP OUTPUT 6 = ANALOG AUTO REFERENCE 7 = NETWORK IN REG 1 8 = NETWORK IN REG 2 9 = NETWORK IN REG 3
Default Setting:	NONE
Parameter Type:	Configurable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Configure

The choices are:

- NONE: The OCL feedback signal is fixed at 0.
- CML FEEDBACK: Feedback is from an eight-sample average of the current minor loop (CML) feedback signal.
- ANALOG IN 1 or 2: Feedback is from an I/O Expansion kit analog input. These are only available if an I/O Expansion kit is installed.

The following options are available only if a network kit is installed:

- 5 (SPEED LOOP OUTPUT): Feedback is the SPD LOOP OUTPUT (P.299) value.
- 6 (ANALOG AUTO REFERENCE): Feedback is the ANALOG AUTO REFERENCE (P.188) value.
- 7, 8, and 9 (NETWORK IN REG 1, 2, and 3): Feedback is the associated network input register.

OCL LEADLAG LOW FREQ (P.806)

Lead/lag block low break frequency of the outer control loop.

Parameter Range:	0.01 to 34.90 RAD/S
Default Setting:	1.00 RAD/S
Parameter Type:	Tunable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Tuning

Sets the lead break frequency if OCL LEADLAG SELECT (P.805) is set to LEAD/LAG.
Sets the lag break frequency if OCL LEADLAG SELECT is set to LAG/LEAD.

OCL LEADLAG RATIO (P.807)

The ratio between the low break frequency and high break frequency of outer control loop lead/lag block.

Parameter Range:	2 to 20
Default Setting:	10
Parameter Type:	Tunable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Tuning

The settings of this parameter and the OCL LEADLAG LOW FREQ determine the high break frequency.

Increasing this value increases the ratio between the low and high frequencies. If OCL LEADLAG SELECT (P.805) is set to LEAD/LAG, OCL LEADLAG RATIO sets the break frequency for lag. If OCL LEADLAG SELECT (P.805) is set to LAG/LEAD, this sets the break frequency for lead.

OCL LEADLAG SELECT (P.805)

Selects the outer control loop as lead/lag, lag/lead, or bypassed.

Parameter Range:	LEAD/LAG BYPASS LAG/LEAD
Default Setting:	BYPASS
Parameter Type:	Tunable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Configure

OCL TYPE3 POSN REG EN (P.814)

Selects the source of the Current Minor Loop reference when the drive is configured as a current regulator (i.e., when hardware jumper J15 is set to CURRENT).

Parameter Range:	DISABLED ENABLED
Default Setting:	DISABLED
Parameter Type:	Configurable
OIM Menu Path(s):	Outer Control Loop (OCL) - OCL Configure

When set to DISABLED, TORQUE REFERENCE (P.189) is used as the CML reference. When set to ENABLED, OCL OUTPUT (P.848) is used as the CML reference.

CHAPTER 10

Configuring a Network

You can have a DeviceNet Interface board, AutoMax Network Communication board, or ControlNet Network Communication board installed in the drive. This chapter describes the parameters that you can configure for these networks. For information on the networks, see the appropriate network manual.

Some parameters are only accessible over the network using the alternate register map (NETW REGISTER MAP SEL (P.914) set to ALTERNATE).

Refer to the appropriate option board instruction manual for more information.

10.1 Configuration for All Networks

NETW COMM LOSS SELECT (P.901)

Selects how the drive will respond to network communication loss when CONTROL SOURCE SELECT is set to NETWORK.

Parameter Range:	FAULT USE LAST REF USE TRMBLK REF 4 = USE TRMBLK CNTL
Default Setting:	FAULT
Parameter Type:	Tunable
OIM Menu Path(s):	Network Communications

The choices are:

- **FAULT:** A fault is generated when network communication is lost, causing the drive to coast/DB stop.
- **USE LAST REF:** The drive continues to run if network communication is lost, using the last reference value received over the network. The alarm A00004, NETWORK COMMUNICATION TIMEOUT, is generated if network communication is lost.
- **USE TRMBLK REF:** The drive continues to run if network communication is lost, using the selected auto reference value from the Regulator board terminal strip (terminals 19 and 20). The drive automatically switches back to the network reference when network communication is re-established. The alarm A00004, NETWORK COMMUNICATION TIMEOUT, is generated if network communication is lost.
- **4 (USE TRMBLK CNTL):** The drive continues to run if network communication is lost. The Regulator board terminal strip will become the source for all control (Run, Jog, Stop, Fault Reset, Direction, and OCL Enable) and speed (auto) reference signals. The Speed Loop PI Reset and Underwind/Overwind bits cannot be changed while operating in this mode. They will remain at the last values received from the network. The drive automatically switches back to the network reference and control when network communication is re-established. Alarm A00004, NETWORK COMMUNICATION TIMEOUT, is generated if network communication is lost. This selection is available only when the ControlNet Network Communication board is installed in the drive.



ATTENTION: When USE TRMBLK REF or USE TRMBLK CNTL are selected, motor speed and direction changes can occur when network communication is lost and restored. All terminal block reference and control signals must be set to correct values for your application. Failure to observe this precaution could result in damage to, or destruction of, equipment.

Alarms do not cause the drive to stop. Therefore, some form of hardwired stop must be available in case of network communication loss, since stopping the drive through the network might not be possible. Once the drive is stopped, it cannot be restarted until network communication is re-established or CONTROL SOURCE SELECT is changed to something other than NETWORK.

If CONTROL SOURCE SELECT is not set to NETWORK, the loss of network communication does not affect operation of the drive.

Important: The stop button on the OIM is always functional, regardless of the value of this parameter.



ATTENTION: The user must provide an external operator-accessible coast/stop pushbutton at terminals 7 and 8 on the Regulator board to disable the machine in case of improper operation or network loss. Uncontrolled machine operation might result if this is not done. See the hardware manual for wiring information. Failure to observe this precaution could result in severe bodily injury or loss of life.

NETW COMM STATUS (P.908)

Indicates the status of network communication.

Parameter Range:	NOT ACTIVE ACTIVE
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Network Communications

NOT ACTIVE: The network board is not communicating with the network master.

ACTIVE: The network board is communicating with the network master.

NETW CONNECT TYPE (P.910)

Connection type of the AutoMax Network Communication kit or DeviceNet Interface kit.

This parameter has no effect on the operation of the ControlNet Network Communication kit.

Parameter Range:	BASIC FULL
Default Setting:	BASIC
Parameter Type:	Configurable
OIM Menu Path(s):	Network Communications

When set to BASIC, only essential drive data (reference, sequencing, basic tuning, and feedback data) are transferred over the network. This allows a higher density network with moderate functionality.

When NETW CONNECT TYPE is set to FULL, the entire set of drive data that has been assigned a network register is transferred over the network.

AutoMax Only: The large amount of data transferred in the full connection type requires that the drive occupy multiple network drops, thus decreasing the potential number of devices on the network. The drop depth is 4 when NETW CONNECT TYPE is set to FULL. The drop depth is 1 when it is set to BASIC.

NETW DROP NUMBER (P.900)

Network Drop Number. Selects the base drop number the network option board will respond to on the network.

NETW DROP NUMBER cannot be changed through the network.

Parameter Range:	For AutoMax Network Communication kit: 1 to 55 if NETW CONNECT TYPE = BASIC; 1 to 52 if NETW CONNECT TYPE = FULL For DeviceNet Interface kit: 0 to 63 (NETW CONNECT TYPE value does not affect) For ControlNet Network Communication kit: 1 to 99 (NETW CONNECT TYPE value does not affect)
Default Setting:	1
Parameter Type:	Configurable
OIM Menu Path(s):	Network Communications

When NETW CONNECT TYPE (P.910) is set to FULL, the AutoMax Network Communication kit occupies multiple network drops beginning at NETW DROP NUMBER. The number of drops occupied (drop depth) affects the upper limit of NETW DROP NUMBER. See NETW CONNECT TYPE (P.910), to determine drop depth.

NETW OUT REG 1 SELECT (P.902)

Selects the parameter to be monitored.

Parameter Range:	-32768 to 32767
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	Network Communications

Select the parameter to monitor by configuring the parameter number. For example, setting this parameter equal to 588 will write the value of parameter FIELD DELTA (P.588) to the installed network register.

NETW OUT REG 2 SELECT (P.903)

Selects the parameter to be monitored.

Parameter Range:	-32768 to 32767
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	Network Communications

Select the parameter to monitor by configuring the parameter number. For example, setting this parameter equal to 588 will write the value of parameter FIELD DELTA (P.588) to the installed network register.

NETW OUT REG 3 SELECT (P.904)

Selects the parameter to be monitored.

Parameter Range:	–32768 to 32767
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	Network Communications

Select the parameter to monitor by configuring the parameter number. For example, setting this parameter equal to 588 will write the value of parameter FIELD DELTA (P.588) to the installed network register.

NETW IN REG 1 (P.905)

Indicates the value being written by the network master.

Parameter Range:	–32768 to 32767
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Network Communications

For the AutoMax network, this parameter writes to Drop_1, register 34. For the ControlNet network, this parameter writes to file address N11:10.

NETW IN REG 2 (P.906)

Indicates the value being written by the network master.

Parameter Range:	–32768 to 32767
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Network Communications

For the AutoMax network, this parameter writes to Drop_1, register 35. For the ControlNet network, this parameter writes to files address N11:11.

NETW IN REG 3 (P.907)

Indicates the value being written by the network master.

Parameter Range:	–32768 to 32767
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Network Communications

For the AutoMax network, this parameter writes to Drop_1, register 36. For the ControlNet network, this parameter writes to file address N11:12.

NETW TYPE & VERSION (P.909)

Indicates the type of network card installed and its software version.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Network Communications

Format is TV.VV where:

- T = Network Card type. 1 or 2 = AutoMax network. 4 = DeviceNet network. 5 = ControlNet network.
- V.VV = network board software version number.

NETWORK KIT (P.796)

Indicates whether or not a network kit is installed in the drive and if it has passed diagnostics. If the network kit has failed diagnostics, the drive is not operable (the armature cannot become active).

Parameter Range:	INSTALLED NOT INSTALLED FAILED DIAGS
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Network Communications Drive Information

10.2 Configuring Parameters for DeviceNet

These parameters are specific to the DeviceNet network. For more information, see the DeviceNet Network Communication manual (HE-FP3).

DEVNET POLL MSG TYPE (P.913)

Selects which predefined set of data will be part of the DeviceNet poll connection command/response messages.

Parameter Range:	CONTROL ONLY CONTROL+CONFIG
Default Setting:	CONTROL ONLY
Parameter Type:	Configurable
OIM Menu Path(s):	Network Communications

If the AutoMax network is being used, this parameter has no effect.

CONTROL ONLY: The smaller amount of data transmitted in the CONTROL ONLY poll message type allows greater network density and performance.

CONTROL+CONFIG: The larger amount of data transmitted in the CONTROL+CONFIG poll message type allows some degree of drive configuration but decreases the network scan rate.

NETWORK BAUD RATE (P.912)

Sets the baud rate for the DeviceNet Interface kit. Entering a value of 0.0 Kbaud disables DeviceNet network communication.

Parameter Range:	0.0 Kbaud 125.0 Kbaud 250.0 Kbaud 500.0 Kbaud
Default Setting:	0.0 Kbaud
Parameter Type:	Configurable
OIM Menu Path(s):	Network Communications

The baud rate for the AutoMax network is not adjustable. If AutoMax network is being used, this parameter has no effect.

10.3 Configuring Parameters for the AutoMax Network

These parameters are only available if the AutoMax Network Communication board is installed. For more information on the board and parameters, see the AutoMax Network Communication board manual (D2-3318).

AMX NETW REF SELECT (P.911)

AutoMax Network reference selection.

Parameter Range:	DIRECT BROADCAST n where n = 1 to 8
Default Setting:	DIRECT
Parameter Type:	Configurable
OIM Menu Path(s):	Network Communications

Selects whether the drive reference is from the designated register in the drop register image or from one of the eight network broadcast registers when CONTROL SOURCE SELECT is set to NETWORK.

NETW REGISTER MAP SEL (P.914)

Indicates which register map configuration will be used for the AutoMax Network Communication kit.

Parameter Range:	1 = ORIGINAL 2 = ALTERNATE
Default Setting:	1
Parameter Type:	Configurable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

ALTERNATE selects the new register map, which permits use of additional functions.

ORIGINAL should be used if you need to maintain compatibility with older FlexPak drives that do not have a selectable register map (V3.12 and earlier).

10.4 Configuring Parameters for the ControlNet Network

These parameters are available only if the ControlNet Network Communication board is installed. For more information on this board and parameters, see the ControlNet Network Communication board manual (D2-3425).

CNI PROGRAM RUN MODE (P.915)

Selects how the drive responds when communicating with a PLC and the PLC is switched from run to program mode.

Parameter Range:	1 = STOP 2 = USE LAST REF 3 = USE TRMBLK CNTL
Default Setting:	1 = STOP
Parameter Type:	Configurable
OIM Menu Path(s):	Network Communications

When the PLC is put into Program mode, alarm A00006, CONTROLNET PROGRAM MODE, is generated to indicate the change in operation of the drive. An alarm is not generated when the PLC is returned to Run mode, since that is considered normal operation.

1 (STOP): The drive will coast/DB stop (if running) when the PLC is put into Program mode. When the PLC is in Program mode, the drive cannot be started while under Network control.

2 (USE LAST REF): The drive will not stop (if running) or start (if stopped) when the PLC is put into Program mode (or returned to Run mode). The drive will continue to use the last network reference received as its speed reference. This will continue until the PLC is returned to Run mode and a new reference value is received.

3 (USE TRMBLK CNTL): The drive will not stop (if running) or start (if stopped) when the PLC is put into Program mode (or returned to Run mode). The drive's Terminal Block will become the source for all control (Run, Jog, Stop, Fault Reset, Direction, and OCL Enable) and speed (auto) reference signals. The Speed Loop PI Reset and Underwind/Overwind bits cannot be changed while operating in this mode. They will remain at the last values received from the network. This will continue until the PLC is returned to Run mode when control/reference will come from the network, again.



ATTENTION: When USE TRMBLK CNTL is selected, motor speed and direction changes can occur when the PLC is changed between Program and Run modes. All terminal block reference and control signals must be set to correct values for your application. Failure to observe this precaution could result in damage to, or destruction of, equipment.

Configuring Parameters for the I/O Expansion Kit

This section provides descriptions for parameters that are available when the I/O Expansion kit is installed. For a kit description, see the I/O Expansion kit manual (D2-3301).

For information on the MOP options available through the I/O Expansion kit, see section 4.1.6, Configuring the Motor-Operated Potentiometer (MOP) Reference.

For information on the outer control loop options available through the I/O Expansion kit, see chapter 9, Configuring the Outer Control Loop.

These parameters are only available if the I/O Expansion kit is installed.

I/O EXPANSION KIT (P.797)

Indicates whether or not the I/O Expansion kit is installed in the drive and if it has passed diagnostics. If the I/O Expansion kit has failed diagnostics, the drive is not operable (the armature cannot become active).

Parameter Range:	NOT INSTALLED INSTALLED FAILED DIAGS
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Input/Output - Frequency I/O Input/Output - Analog I/O Input/Output - Digital I/O Drive Information

11.1 Configuring the Digital Outputs

The I/O Expansion kit includes two digital outputs.



ATTENTION: These outputs are intended for use as an indication. Failure to observe this precaution can result in severe bodily injury or loss of life.

If you use these outputs, you need to set parameters that select the source that drives the output and whether the output is normally open or normally closed.

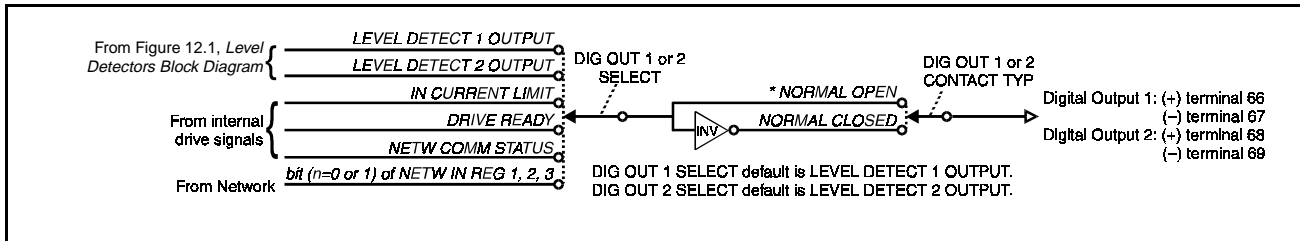


Figure 11.1 – Digital Outputs Block Diagram

DIG OUT 1 CONTACT TYP (P.410)

Selects whether digital output 1 (terminals 66 and 67 on I/O Expansion kit) is normally open or normally closed.

Parameter Range:	NORMAL OPEN NORMAL CLOSED
Default Setting:	NORMAL OPEN
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Digital I/O

If NORMAL OPEN is selected, digital output 1 is open when the signal selected by DIG OUT 1 SELECT (P.409) is off and closed when it is on.

If NORMAL CLOSED is selected, digital output 1 is closed when the signal selected by DIG OUT 1 SELECT (P.409) is off and open when it is on.



ATTENTION: On a power cycle or reset, the contact is held open until the drive software powerup diagnostics is complete. Make sure that this condition does not result in a dangerous situation for your application. Failure to observe this precaution can result in severe bodily injury or loss of life.

DIG OUT 1 SELECT (P.409)

Selects the signal that drives digital output 1 (terminals 66 and 67 on the I/O Expansion kit).

Parameter Range:	LEVEL DETECT 1 OUTPUT LEVEL DETECT 2 OUTPUT IN CURRENT LIMIT DRIVE READY NETW COMM STATUS NETW IN REG 1 (bit 0) NETW IN REG 2 (bit 0) NETW IN REG 3 (bit 0)
Default Setting:	LEVEL DETECT 1 OUTPUT
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Digital I/O

- **LEVEL DETECT 1 or 2 OUTPUT:** The state of the selected level detector output is used to drive digital output 1. The signal is from the I/O Expansion kit digital output 1 or 2. See chapter 12, Configuring the Drive to Use Level Detectors.
- **IN CURRENT LIMIT:** The armature in-current-limit signal is used to drive digital output 1. The in-current-limit signal indicates whether or not the drive is operating at the maximum allowable current. See CML REF LIMIT SELECT (P.311).
- **DRIVE READY:** The drive-is-ready signal is used to drive digital output 1. The drive-is-ready signal indicates that the drive will start when the next run or jog command is received.
- **NETW COMM STATUS:** The state of NETW COMM STATUS (P.908) is used to drive digital output 1. See chapter 10 for description.
- **NETW IN REG 1, 2, or 3:** Bit 0 of NETW IN REG 1 (P.905), 2 (P.906), or 3 (P.907) is used to drive digital output 1. A network kit must be installed to select the network input registers. Note that the network input registers are updated only when Control Source (P.000) is set to NETWORK and the network is active. See chapter 10 for description.

DIG OUT 2 CONTACT TYP (P.412)

Selects whether digital output 2 (terminals 68 and 69 on the I/O Expansion kit) is normally open or normally closed.

Parameter Range:	NORMAL OPEN NORMAL CLOSED
Default Setting:	NORMAL OPEN
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Digital I/O

If NORMAL OPEN is selected, digital output 2 is open when the signal selected by DIG OUT 2 SELECT (P.411) is off and closed when it is on.

If NORMAL CLOSED is selected, digital output 2 is closed when the signal selected by DIG OUT 2 SELECT (P.411) is off and open when it is on.



ATTENTION: On a power cycle or reset, the contact is held open until the drive software powerup diagnostics are complete. Make sure this condition does not result in a dangerous situation for your application. Failure to observe this precaution can result in severe bodily injury or loss of life.

DIG OUT 2 SELECT (P.411)

Selects the signal used to drive digital output 2 (terminals 68 and 69 on the I/O Expansion kit).

Parameter Range:	LEVEL DETECT 1 OUTPUT LEVEL DETECT 2 OUTPUT IN CURRENT LIMIT DRIVE READY NETW COMM STATUS NETW IN REG 1 (bit 1) NETW IN REG 2 (bit 1) NETW IN REG 3 (bit 1)
Default Setting:	LEVEL DETECT 2 OUTPUT
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Digital I/O

- LEVEL DETECT 1 or 2 OUTPUT: The state of the selected level detector output drives digital output 2. The signal is from the I/O Expansion kit digital output 1 or 2. See chapter 12, Configuring the Drive to Use Level Detectors for information.
- IN CURRENT LIMIT: The armature in-current-limit signal, which indicates whether or not the drive is operating at the maximum allowable current, drives digital output 2. See CML REF LIMIT SELECT (P.311), for information.
- DRIVE READY: The drive-is-ready signal drives digital output 2. This signal indicates that the drive will start when the next run or jog command is received.
- NETW COMM STATUS: The state of NETW COMM STATUS (P.908) drives digital output 2. See chapter 10 for description.

NETW IN REG 1, 2, or 3: Bit 0 of NETW IN REG 1 (P.905), 2 (P.906), or 3 (P.907) drives digital output 2. A network kit must be installed to select the network input registers. Note that the network input registers are updated only when Control Source (P.000) is set to NETWORK and the network is active. See chapter 10 for description.

11.2 Configuring the Analog Inputs

Important: Analog input 2 (terminals 52 and 53 on the I/O Expansion kit) only accepts a ± 10 VDC input signal.

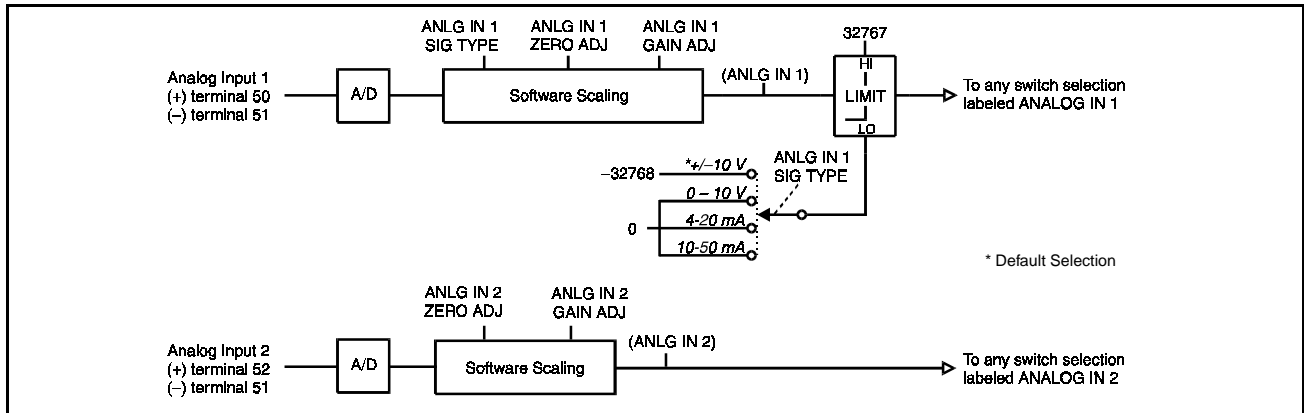


Figure 11.2 – Analog Inputs Block Diagram

If you use the analog input 1 input, you need to set hardware jumpers and a parameter that tells the drive what type of signal to expect at the input. For both analog inputs, you can also set the gain and zero.

Analog inputs are read every 5msec when FEEDBACK SELECT (P.200) is set to DC TACH, PULSE TACH, or AC TACH. They are read every 10msec when FEEDBACK SELECT (P.200) is set to ARMATURE VOLT.

To check the scaled signal, use parameters ANLG IN 1 (P.492) or ANLG IN 2 (P.493).

ANLG IN 1 (P.492)

The digital value of analog input 1 (terminals 50 and 51 on the I/O Expansion kit) after gain and zero have been applied.

Parameter Range:	n/a
Default Setting:	
Parameter Type:	Output
OIM Menu Path(s):	Input/Output - Analog I/O

ANLG IN 1 GAIN ADJ (P.415)

Gain adjustment for analog input 1 (terminals 50 and 51 on the I/O Expansion kit).

Parameter Range:	0.750 to 2.250
Default Setting:	1.000
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Analog I/O

Adjust the gain to get full scale values from the A/D converter when the maximum level of the applied input signal is different than that of the drive.

For example, if ANLG IN 1 SIG TYPE is set to 0-10 V, a 0-8 VDC signal produces 80% of the drive's full scale value. To produce the drive's full scale value using the 0-8VDC signal, change ANLG IN 1 GAIN ADJ to 1.250 ($8.0V \times 1.25 = 10.0V$). Gain values less than 1.000 decrease the resolution of the analog input.

Adjust the zero point (ANLG IN 1 ZERO ADJ (P.414)) before setting gain.

ANLG IN 1 SIG TYPE (P.413)

Selects the type of signal that the drive will expect to be connected to analog input 1 (terminals 50 and 51 on the I/O Expansion kit).

Parameter Range:	0–10 V +/-10 V 4-20 mA 10-50 mA
Default Setting:	+/-10 V
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Analog I/O

This setting must match the setting of I/O Expansion kit jumpers J11 and J12.

If the input drops below the selected value, the drive uses the low point of the range (for example, 0 V or 4mA).

ANLG IN 1 ZERO ADJ (P.414)

Adjusts the zero point of analog input 1 (terminals 50 and 51 on the I/O Expansion kit) to remove any offset that might exist on the input.

Parameter Range:	-200 to 200
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Analog I/O

To adjust the zero point, make small changes to this parameter until ANLG IN 1 is zero when the signal at terminals 50 and 51 is at its zero (0V, 4mA, or 10mA).

ANLG IN 2 (P.493)

The digital value of analog input 2 (terminals 52 and 53 on the I/O Expansion kit) after gain and zero are applied.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Input/Output - Analog I/O

ANLG IN 2 GAIN ADJ (P.417)

Gain adjustment for analog input 2 (terminals 52 and 53 on the I/O Expansion kit).

Parameter Range:	0.750 to 2.250
Default Setting:	1.000
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Analog I/O

Adjust the gain to get full scale values from the A/D converter when the maximum level of the applied input signal is different than that of the drive.

For example, a –8 to +8 VDC signal produces 80% of the drive's full scale value. To produce the drive's full scale value using the –8 to +8VDC signal, change ANLG IN 2 GAIN ADJ to 1.250 ($8\text{ V} \times 1.25 = 10\text{ V}$). Note that gain values less than 1.000 decrease the resolution of the analog input.

Adjust the zero point (ANLG IN 2 ZERO ADJ (P.416)) before setting gain.

ANLG IN 2 ZERO ADJ (P.416)

Adjusts the zero point of analog input 2 (terminals 52 and 53 on the I/O Expansion kit) to remove any offset that might exist on the input.

Parameter Range:	–200 to 200
Default Setting:	0
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Analog I/O

To adjust the zero point, make small changes to this parameter until ANLG IN 2 equals zero when the signal at terminals 52 and 53 is at 0V.

11.3 Configuring the Analog Outputs

The I/O Expansion kit has two unfiltered analog outputs. One can generate a bipolar DC voltage only. The other can be configured to generate a DC voltage from a 0 to ± 10 VDC, 4-20 mA, or 10-50 mA signal. These outputs can be scaled to generate DC voltage signals as low as 5 V, but maximum resolution (0.025%) is obtained when the full scale output signal is used. The full scale value (FSV) is determined based on the selected parameter group; load, speed, voltage, power, field or other.

Analog outputs are read every 5msec when FEEDBACK SELECT (P.200) is set to DC TACH, PULSE TACH, or AC TACH. They are read every 10msec when FEEDBACK SELECT (P.200) is set to ARMATURE VOLT.

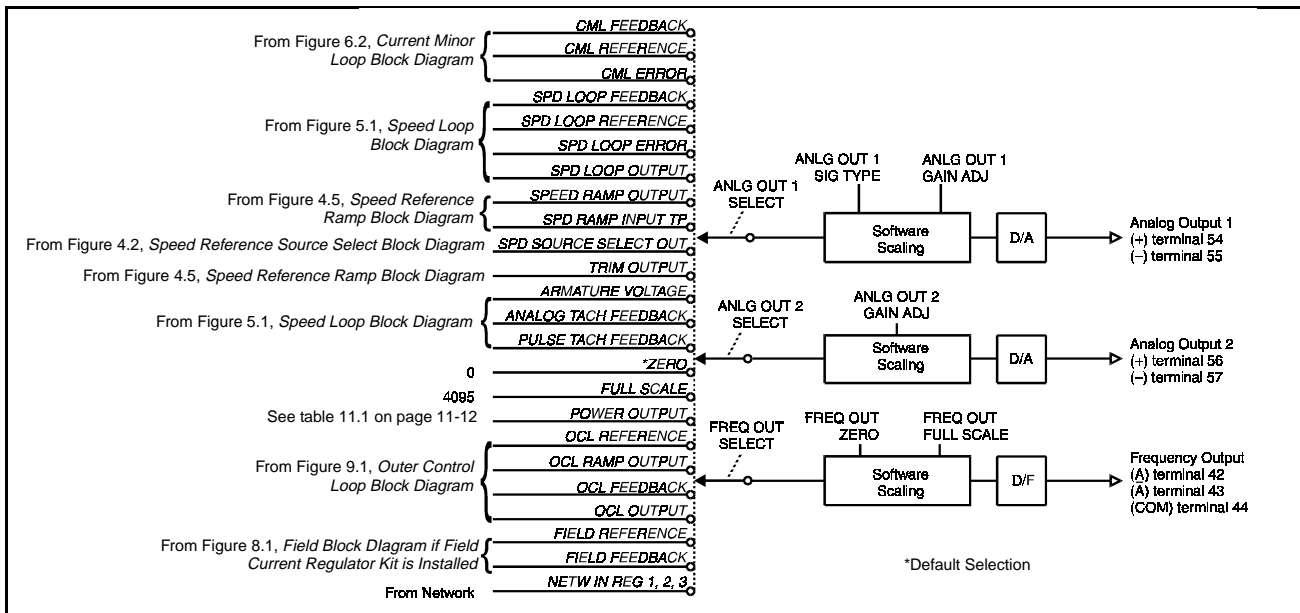


Figure 11.3 – Analog and Frequency Outputs Block Diagram

ANLNG OUT 1 GAIN ADJ (P.420)

Adjusts the gain of analog output 1 (terminals 54 and 55 of the I/O Expansion kit) to allow it to produce a signal from 5.0 to approximately 13.0VDC.

Parameter Range:	0.500 to 1.300
Default Setting:	1.000
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Analog I/O

The full scale value is determined by ANLNG OUT 1 SELECT. See table 11.1.

This parameter is typically used to adjust the 10 V full scale output to match the input voltage requirement of attached equipment. For example, you would set this parameter to 0.800 for equipment that accepts a 0 to 8 VDC signal.

Analog output 1 and 2 are only rated to 10 VDC, so gain adjustment values greater than 1.000 might cause the analog output circuit to saturate.

ANLG OUT 1 SELECT (P.418)

Selects the signal used to drive analog output 1 (terminals 54 and 55 on the I/O Expansion kit).

Parameter Range:	See table 11.1 for options
Default Setting:	ZERO
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Analog I/O

When the analog output is at its maximum value, the selected signal is at its full scale value.

ANLG OUT 1 SIG TYPE (P.419)

Selects the type of signal to be generated by analog output 1 (terminals 54 and 55 on the I/O Expansion kit).

Parameter Range:	0–10 V +/- 10 V 4-20 mA
Default Setting:	+/- 10 V
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Analog I/O

This setting must match the I/O Expansion kit J14 and J15 settings.

ANLG OUT 2 GAIN ADJ (P.422)

Adjusts the gain of analog output 2 (terminals 56 and 57 on the I/O Expansion kit) to allow it to produce a signal from 5.0 to the full scale value of approximately 13.0 VDC.

Parameter Range:	0.500 to 1.300
Default Setting:	1.000
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Analog I/O

The full scale value is determined by ANLG OUT 2 SELECT. See table 11.1.

This is typically used to adjust the 10 V full scale output to match the input voltage requirements of attached equipment. For example, set this parameter to 0.800 for equipment that accepts a ± 8 VDC signal.

The outputs are rated to 10 VDC, so gain adjust values greater than 1.000 might cause the analog output circuit to saturate.

Analog output 2 only generates a ± 10 VDC input signal and cannot be changed.

Analog output 1 and 2 are only rated to 10 VDC, so gain adjustment values greater than 1.000 might cause the analog output circuit to saturate.

ANLG OUT 2 SELECT (P.421)

Selects the signal used to drive analog output 2 (terminals 56 and 57 on the I/O Expansion kit).

Parameter Range:	See table 11.1 for options.
Default Setting:	ZERO
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Analog I/O

When the analog output is at its maximum value, the selected signal is at its full scale value.

11.4 Configuring the Frequency Input

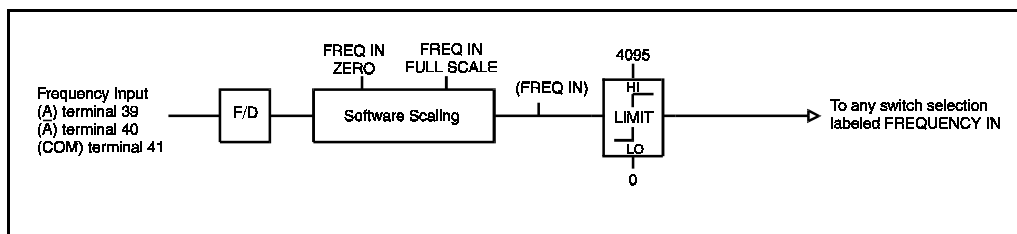


Figure 11.4 – Frequency Input Block Diagram

FREQ IN (P.491)

The digital value of the frequency input (terminals 39, 40, and 41 on the I/O Expansion kit).

Parameter Range:	0 to 4095
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Input/Output - Frequency I/O

FREQ IN is scaled between FREQ IN ZERO and FREQ IN FULL SCALE.

FREQ IN is zero when the frequency at the input is less than or equal to FREQ IN ZERO. It is 4095 when the frequency equals FREQ IN FULL SCALE.

FREQ IN FULL SCALE (P.424)

Specifies the maximum input frequency. This is the frequency that corresponds to full scale value.

Parameter Range:	2.0 to 250.0 kHz
Default Setting:	250.0 kHz
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Frequency I/O

For example, if the frequency input will be used as the speed loop reference (selected by AUTO REFERENCE SELECT (P.103)), this input frequency will correspond to TOP SPEED (P.011), because TOP SPEED is the basis for speed loop scaling.

FREQ IN ZERO (P.423)

Specifies the minimum input frequency. This is the frequency that corresponds to zero.

Parameter Range:	2.0 to FREQ IN FULL SCALE kHz
Default Setting:	2.0 kHz
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Frequency I/O

If the input frequency drops below the frequency specified by this parameter, the resulting digital value remains zero (it will not go negative).

11.5 Configuring the Frequency Output

The I/O Expansion kit has one unipolar frequency output. The output is unfiltered. The full scale value (FSV) is based on the selected parameter group: load, speed, voltage, power, field, or other.

The frequency output is read every 5msec when FEEDBACK SELECT (P.200) is set to DC TACH, PULSE TACH, or AC TACH. It is read every 10msec when FEEDBACK SELECT (P.200) is set to ARMATURE VOLT.

FREQ OUT FULL SCALE (P.427)

The frequency generated when the signal driving the frequency output is at full scale, as detailed in table 11.1.

Parameter Range:	2.0 to 250.0 kHz
Default Setting:	250.0 kHz
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Frequency I/O

For example, if FREQ OUT SELECT (P.425) is set to CML FEEDBACK, the FREQ OUT FULL SCALE frequency value is output when armature current is at MAXIMUM CURRENT (P.007). (MAXIMUM CURRENT is used as the basis for current minor loop scaling.)

FREQ OUT SELECT (P.425)

Selects the signal used to drive the frequency output (terminals 42,43, and 44 on the I/O Expansion kit).

Parameter Range:	See table 11.1 for options.
Default Setting:	ZERO
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Frequency I/O

FREQ OUT ZERO (P.426)

The frequency generated when the signal driving the frequency output is zero.

Parameter Range:	2.0 to FREQ OUT FULL SCALE kHz
Default Setting:	2.0 kHz
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Frequency I/O

If the signal goes negative, the frequency output maintains the frequency set by this parameter.

Table 11.1 – Options for Metering Parameters

Signal Selected	Full Scale Value
CML FEEDBACK (P.397) CML REFERENCE (P.396) CML ERROR (P.398) SPD LOOP OUTPUT (P.299)	MOTOR RATED ARM AMPS \times $\frac{\text{MAXIMUM CURRENT}}{100}$ (amps) or MAXIMUM CURRENT (% full load amps)
SPD LOOP FEEDBACK (P.296) SPD LOOP REFERENCE (P.295) SPD LOOP ERROR (P.297) SPEED RAMP OUTPUT (P.199) SPEED RAMP INPUT TP (P.198) SPD SOURCE SELECT OUT (P.193) TRIM OUTPUT (P.197) ANALOG TACH FEEDBACK (P.291) PULSE TACH FEEDBACK (P.292) OCL OUTPUT (P.848)	TOP SPEED (RPM)
ARMATURE VOLTAGE (P.289)	MOTOR RATED ARM VOLTS (volts)
POWER OUTPUT	MOTOR RATED ARM VOLTS \times MOTOR RATED ARM AMPS \times $\frac{\text{MAXIMUM CURRENT}}{100}$ watts
FIELD REFERENCE (P.590) FIELD FEEDBACK (P.589)	MOTOR HOT FLD AMPS (amps)
OCL REFERENCE (P.845) OCL RAMP OUTPUT (P.846) OCL FEEDBACK (P.847) NETW IN REG 1 (P.905) NETW IN REG 2 (P.906) NETW IN REG 3 (P.907) FULL SCALE	4095 (counts)
ZERO	0

Configuring the Drive to Use Level Detectors

The level detectors detect when the absolute value of a signal becomes greater than or equal to a specified threshold for longer than a specified period. They can be used as zero-speed detectors, at-speed detectors, or limit switches. They are used to drive I/O Expansion kit digital output 1 or 2. To use the level detectors, DIG OUT 1 SELECT (P.409) or DIG OUT 2 SELECT (P.411) must be set to LEVEL DETECT 1 OUTPUT or LEVEL DETECT 2 OUTPUT. Level detector outputs can also be monitored over the AutoMax network.

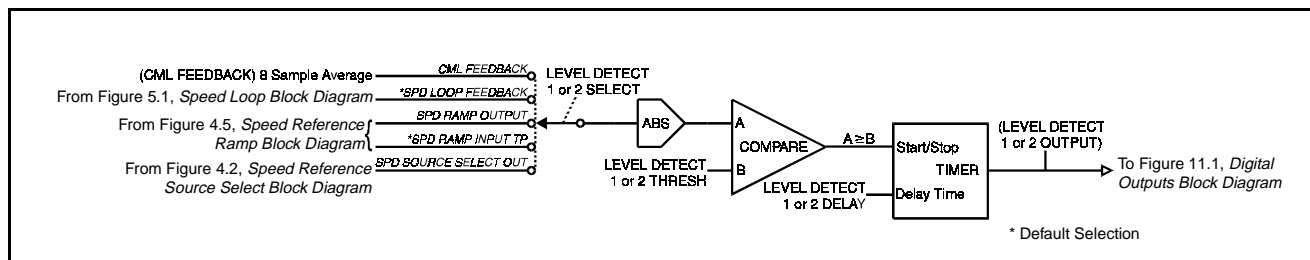


Figure 12.1 – Level Detectors Block Diagram

LEVEL DETECT 1 DELAY (P.604)

The delay time in seconds for the level detector 1 circuit.

Parameter Range:	0.0 to 300.0 seconds
Default Setting:	10.0 seconds
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Level Detectors

Sets the amount of time between when the level detector timer is triggered and when the output is set ON. If the input source signal goes below the detector's threshold value, the timer is immediately reset.

LEVEL DETECT 1 OUTPUT (P.648)

The output of level detector 1. This signal drives digital output 1 (terminals 66 and 67 on the I/O Expansion kit) if DIG OUT 1 SELECT is set to LEVEL DETECT 1 OUTPUT.

Parameter Range:	ON OFF
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Input/Output - Level Detectors

ON when the input signal selected by LEVEL DETECT 1 SELECT (P.602) is greater than or equal to LEVEL DETECT 1 THRESH (P.603) for longer than LEVEL DETECT 1 DELAY (P.604).

OFF whenever the input signal is less than LEVEL DETECT 1 THRESH.

LEVEL DETECT 1 SELECT (P.602)

Selects the signal that drives level detector 1.

Parameter Range:	CML FEEDBACK SPD LOOP FEEDBACK SPD RAMP INPUT TP SPEED RAMP OUTPUT SPD SOURCE SELECT OUT
Default Setting:	SPD LOOP FEEDBACK
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Level Detectors

LEVEL DETECT 1 THRESH (P.603)

The threshold for level detector 1.

Parameter Range:*	0.1 to 100.0% or MAXIMUM CURRENT
Default Setting:	10.0%
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Level Detectors

When the absolute value of the signal driving level detector 1 is greater than or equal to this threshold, the associated timer starts. If the input signal is less than this threshold, the timer is immediately reset. The level detector output is set to OFF.

*The parameter range for the level detector is automatically rescaled for speed or current based on the input selected by LEVEL DETECT 1 SELECT (P.602). If CML FEEDBACK is selected for LEVEL DETECT 1 SELECT, the parameter range is 0.1 to MAXIMUM CURRENT. For any other LEVEL DETECT 1 SELECT settings, the parameter range is 0.1 to 100.0%.

LEVEL DETECT 2 DELAY (P.607)

The delay time in seconds for the level detector 2 circuit.

Parameter Range:	0.0 to 300.0 seconds
Default Setting:	10.0 seconds
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Level Detectors

Sets the amount of time between when the level detector timer is triggered and when the output is set ON. If the input source signal goes below the detector's threshold value, the timer is immediately reset.

LEVEL DETECT 2 OUTPUT (P.649)

The output of level detector 2. This signal drives digital output 2 (terminals 68 and 69 on the I/O Expansion kit) if DIG OUT 2 SELECT is set to LEVEL DETECT 2 OUTPUT.

Parameter Range:	ON OFF
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Input/Output - Level Detectors

ON when the input signal selected by LEVEL DETECT 2 SELECT (P.605) is greater than or equal to LEVEL DETECT 2 THRESH (P.606) for longer than LEVEL DETECT 2 DELAY (P.607).

OFF whenever the input signal is less than LEVEL DETECT 2 THRESH.

LEVEL DETECT 2 SELECT (P.605)

Selects the signal that drives level detector 2.

Parameter Range:	CML FEEDBACK SPD LOOP FEEDBACK SPD RAMP INPUT TP SPEED RAMP OUTPUT SPD SOURCE SELECT OUT
Default Setting:	SPD RAMP INPUT TP
Parameter Type:	Configurable
OIM Menu Path(s):	Input/Output - Level Detectors

LEVEL DETECT 2 THRESH (P.606)

The threshold for level detector 2.

Parameter Range:*	0.1 to 100.0% or MAXIMUM CURRENT
Default Setting:	10.0%
Parameter Type:	Tunable
OIM Menu Path(s):	Input/Output - Level Detectors

When the absolute value of the signal driving level detector 2 is greater than or equal to this threshold, the associated timer starts. If the input signal is less than this threshold, the timer is immediately reset and the level detector output is set to OFF.

*The parameter range for the level detector is automatically rescaled for speed or current based on the input selected by LEVEL DETECT 2 SELECT (P.605). If CML FEEDBACK is selected for LEVEL DETECT 2 SELECT, the parameter range is 0.1 to MAXIMUM CURRENT. For any other LEVEL DETECT 2 SELECT settings, the parameter range is 0.1 to 100.0%.

Troubleshooting the FlexPak 3000 Drive



ATTENTION: Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should install, operate, or service this equipment. Read and understand this section in its entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

This section provides lists of faults and alarms that can occur and the possible causes. It also lists parameters that can be helpful when troubleshooting.

For instruction on how to clear faults and alarms, see the FlexPak 3000 Drive Operator Interface Module (OIM) User Guide (D2-3344).

13.1 Fault and Alarm Messages, Descriptions, and Code Numbers

Table 13.1 lists fault codes and table 13.2 lists alarm codes. The codes are in numeric order by the number you see on the OIM display when an alarm or fault occurs.

Table 13.1 – Fault Codes

Code	OIM Display	Description
F00001	IET (OVERCURRENT)	<p>Armature current instantaneously exceeded 180% of MAXIMUM CURRENT.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Incorrect armature current feedback scaling (MOTOR RATED ARM AMPS, MAXIMUM CURRENT, CT TURNS RATIO, or J18 not set properly). • One or more thyristors not operating. • Improper current minor loop tuning. • Motor armature winding damaged.

Table 13.1 – Fault Codes (Continued)

Code	OIM Display	Description
F00002	TACHOMETER LOSS	<p>Tachometer or encoder feedback signal missing.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Tachometer or encoder coupling failure. • Disconnected, loosely connected, or damaged tachometer or encoder wires. • Pulse encoder supply voltage low. • Incorrect analog tachometer scaling. • Incorrect pulse encoder configuration. • Motor armature winding not connected or open circuit. • Blown inverting fault (DC) fuse. • Inverting fault breaker tripped. • High inertia loads and high inductance armature circuits. To reduce nuisance faults, increase the firing angle threshold (see section 13.2). • Tachometer or encoder failure.
F00003	OVERSPEED	<p>Motor speed exceeded the 110% of TOP SPEED.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Incorrect tachometer or encoder scaling. • Blown field supply fuse(s). • Improper speed loop tuning. • PULSE TACH QUADRATURE set to ON for a non-regenerative drive. • Incorrect pulse encoder wiring.
F00004	FIELD CURRENT LOSS	<p>Standard or enhanced field supplies: The field loss detection circuit does not sense any field current flowing in the motor shunt field.</p> <p>Field Current Regulator kit field supply: FIELD FEEDBACK (P.589) fell below the FIELD LOSS THRESHOLD (P.512).</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Motor field winding not connected or open circuit. • Blown field supply fuse(s). • Blown AC line fuse(s). • Field supply failure. • Disconnected, loosely connected, or damaged wiring harness. • Field Current Regulator kit only: Improper field loop tuning.

Table 13.1 – Fault Codes (Continued)

Code	OIM Display	Description
F00005	SUSTAINED OVERLOAD	<p>Inverse time overload circuit trip.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Incorrect armature current feedback scaling (MOTOR RATED ARM AMPS, MAXIMUM CURRENT, CT TURNS RATIO, and/or J18 not set properly). • Blown field supply fuse(s). • Mechanical binding preventing the motor shaft from rotating freely.
F00006	BLOWER MOTOR STARTER OPEN	<p>The blower motor starter is open. If a blower motor starter kit is not installed, connector P8 must be fitted with the proper substitute connector to inhibit this fault.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Blown blower motor starter fuse(s). • Disconnected, loosely connected, or damaged blower motor starter wiring. • Blower motor overload.
F00007	OPEN ARMATURE	<p>The motor armature circuit is open.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Motor armature winding not connected or open circuit. • Blown inverting fault (DC) fuse. • Inverting fault breaker tripped.
F00008	MOTOR THERMOSTAT TRIP	<p>Motor thermostat indicates high temperature. If a motor thermostat is not used, customer terminal board pins 13 and 14 must be jumpered to inhibit this fault.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Damaged or disconnected motor thermostat wiring. • Inadequate ventilation. • Blower motor failure. • Incorrect blower rotation. • Blocked ventilation slots. • Clogged filters. • Excessive armature current. • One or more thyristors not operating.

Table 13.1 – Fault Codes (Continued)

Code	OIM Display	Description
F00009	CONTROLLER THERMOSTAT TRIP	<p>Drive thermostat indicates high temperature (>50°C)</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Inadequate heat sink ventilation. • Inadequate cabinet ventilation. • Heat sink fan failure. • Damaged or disconnected drive thermostat wiring.
F00010	AC LINE SYNCHRONIZATION FAULT	<p>Three-phase AC line synchronization circuit failure.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Blown AC line fuse(s). • AC line frequency not within required range of 48 to 62Hz. • Excessive AC line noise or distortion. • Unstable AC line frequency. See PLL MAXIMUM ERROR (P.308). • Disconnected, loosely connected or damaged J6 ribbon cable.
F00011	OIM COMMUNICATIONS TIMEOUT	<p>The Regulator board was unable to communicate with the interface module (OIM or DCM). (See the hardware manual for a description of regulator status LEDs that can pinpoint whether or not the interface module is communicating.)</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Disconnected, loosely connected, or damaged interface module/serial cable. • Regulator board failure.
F00012	ARMATURE OVER VOLTAGE	<p>Armature voltage exceeded 125% of MOTOR RATED ARM VOLTS (P.009).</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • MOTOR RATED ARM VOLTS not set properly. • Improper voltage loop tuning. • ENHANCED FLD VOLT ADJ (P.500) set too high (Enhanced Field Supply kit only).
F00013	NETWORK COMMUNICATION TIMEOUT	<p>Network communications is missing or failed to communicate with master (CONTROL SOURCE SELECT set to NETWORK).</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • NETW CONNECT TYPE (P.910) was changed from BASIC to FULL. • NETW DROP NUMBER (P.900) was changed. • Network option cable connections are loose or not connected. • Network option board failed or master communications failed.

Table 13.1 – Fault Codes (Continued)

Code	OIM Display	Description
F00014	REVERSED TACH LEADS	<p>The difference between the speed reference and speed feedback was greater than TACH LEAD FLT THRESH (P.227) for the time specified in TACH LEAD FLT DELAY (P.228).</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Tachometer or encoder leads are reversed. • The motor armature leads are reversed. • The motor field leads are reversed. • There is an overhauling load. • The drive was not tuned properly.
F00015	INVERTING FAULT AVOIDED	<p>The inverting fault avoidance logic has detected conditions that could have caused an inverting fault. The drive took action to avoid an actual inverting fault. See section 13.7, Setting Up Inverting Fault Avoidance, for more information on this fault.</p>
F00016	PHASE LOSS	<p>The measured AC line voltage fell below 75% of the value specified by NOMINAL AC LINE VOLTS (P.307).</p>
F00030 to F00041	SCR #n NOT OPERATING	<p>“n” is the number of the SCR that is not operating. n = 1-6, 11-16.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Disconnected, loosely connected or damaged thyristor gating circuit. • Improper current minor loop tuning. • Improper speed/voltage loop tuning. • Failed thyristor.
F00042	MULTIPLE SCRS NOT OPERATING	<p>One or more thyristor (SCR) is not carrying an equal load.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Disconnected, loosely connected or damaged thyristor gating circuit. • Blown AC line fuse(s). • Improper current minor loop tuning. • Improper speed/voltage loop tuning. • Failed thyristor.

Table 13.1 – Fault Codes (Continued)

Code	OIM Display	Description
F00060	SELF TUNING FAULT	<p>Self tune aborted by external input.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Operator stop asserted. • Drive interlock(s) open. • Drive fault became active.
F00061	SELF TUNING FAULT	<p>Non-zero speed feedback at self-tune start.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Analog tachometer only: ANALOG TACH ZERO ADJ (P.202) not set properly. • Incorrect speed feedback scaling or offset. • Overhauling load causing motor shaft rotation.
F00062	SELF TUNING FAULT	<p>Calculated armature inductance is out of range.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Motor armature winding not connected or open circuit. • Blown inverting fault (DC) fuse. • Inverting fault breaker tripped. • Armature inductance too high. Tune current minor loop manually.
F00063	SELF TUNING FAULT	<p>Maximum current with minimum rotation.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Motor cannot rotate freely. • Motor load is too high. • Motor field not at normal operating temperature.
F00064	SELF TUNING FAULT	<p>Attached inertia is out of range.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Maximum self-tune speed reached. • Overhauling load present. • High mechanical friction present. • The speed loop cannot be self-tuned. Tune speed loop manually.

Table 13.1 – Fault Codes (Continued)

Code	OIM Display	Description
F00065	SELF TUNING FAULT	<p>Speed unstable.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • CML not properly tuned before speed loop. • Tachometer or encoder feedback device connected incorrectly.
F00066	SELF TUNING FAULT	<p>SELF TUNE STABILITY (P.219) is too low.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Specified stability is less than that calculated by CML self-tuning. Use 50 or more.
F00067	SELF TUNING FAULT	<p>SELF TUNE STABILITY (P.219) is too low.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Specified stability is less than that calculated by CML self-tuning. Use 75 or more.
F00089 to F00099	SELF TUNING FAULT	<p>Fatal self-tuning fault occurred.</p> <p>Possible cause:</p> <ul style="list-style-type: none"> • Self-tuning was unable to complete. Tune manually.
F00100	MAIN CONTACTOR DID NOT OPEN	<p>The main (FN) contactor did not open following a run or jog request. If a dynamic braking kit is used, the dynamic braking auxiliary contact is wired in series with the FN auxiliary contact.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Disconnected, loosely connected, or damaged FN, FN auxiliary, dynamic braking, or dynamic braking auxiliary wiring. • FN, FN auxiliary, dynamic braking, or dynamic braking auxiliary contactor failure. • Disconnected, loosely connected, or damaged main contactor or dynamic braking control wiring (MCR or DBCR).
F00200	POWER FAILURE	<p>The power supply input voltage momentarily went below tolerance.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • AC line voltage dip. • Disconnected, loosely connected, or damaged J7 ribbon cable or power supply input wiring

Table 13.1 – Fault Codes (Continued)

Code	OIM Display	Description
F00700	FACTORY DEFAULTS RESTORED	<p>The stored parameter values were determined to be invalid. Factory default values have been restored. All parameter values (including any factory set parameters) must be re-adjusted based on your application before operating the drive. After all parameters have been set properly, a memory save must be performed followed by a fault reset.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Power loss during a prior memory save. • New Regulator board. • Defective Regulator board.
F00701	FAULT LOG RESTORE FAILURE	<p>The fault log information stored in retentive memory was determined to be invalid. The fault log has been cleared.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Power loss during a prior fault log save. • Defective Regulator board.
F00702	KEYPAD REF RESTORE FAILURE	<p>The keypad reference value stored in retentive memory was determined to be invalid. The keypad reference has been set to the MINIMUM SPEED (P.003) value.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Power loss during a previous keypad reference save. • Defective Regulator board.
F00703	OIM KEY RESTORE FAILURE	<p>The OIM key states stored in retentive memory are invalid. The FORWARD/REVERSE key has been set to FORWARD and the AUTO/MANUAL key has been set to MANUAL.</p> <p>It is possible to get this fault on a drive equipped with a DCM. If so, replace the Regulator board.</p> <p>Possible cause: Defective Regulator board.</p>
F00800	INVALID FIELD INSTALLED	<p>Installed field supply is not supported by the regulator.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Disconnected, loosely connected, or damaged field supply wires. • Regulated field supply failure. • Regulator board failure.
F00801	FIELD FEEDBACK OFFSET TOO HIGH	<p>Regulated field supply feedback offset is too high.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Disconnected, loosely connected, or damaged field supply wires. • Regulated field supply failure. • Regulator board failure.

Table 13.1 – Fault Codes (Continued)

Code	OIM Display	Description
F01000 to F01999	MICROBUS FAULT	<p>An error occurred on the Microbus.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Electrical noise due to improper wiring practices or unsuppressed brake coils, relays, or contactors. • Disconnected, loosely connected or damaged Microbus ribbon cable. • Defective Regulator board. • F01000-F01799: Defective Microbus peripheral or Regulator board. • F01810-F01816: A Microbus peripheral was found that is not supported by the regulator software.
F00999 and F02000 to F03999	MICROPROCESSOR HW/SW FAULT	<p>A microprocessor hardware or software fault occurred.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Electrical noise due to improper wiring practices or unsuppressed break coils, relays, contactors. • Defective Regulator board.

Table 13.2 – Alarm Codes

Code	Display	Description
A00001	MOTOR BRUSH WEAR LOW	<p>The motor brush wear detector indicates that the brushes are worn and require replacement. If a motor brush wear detector is not used, customer terminal strip terminals 12 and 14 must be jumpered to inhibit this alarm when DIG IN 0 SELECT (P.428) is set to BRUSH WEAR.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Worn motor brushes. • Disconnected, loosely connected, or damaged motor brush wear indicator wiring. • Motor brush wear indicator failure.
A00002	AC LINE VOLTAGE LOW	<p>The AC line voltage fell below 90% of NOMINAL AC LINE VOLTS (P.307).</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Low AC line voltage. • Incorrect value entered for NOMINAL AC LINE VOLTS (P.307). • Blown AC line fuse(s).
A00003	AC LINE VOLTAGE HIGH	<p>The AC line voltage rose above 115% of NOMINAL AC LINE VOLTS (P.307).</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • High AC line voltage. • Incorrect value entered for NOMINAL AC LINE VOLTS (P.307).

Table 13.2 – Alarm Codes (Continued)

Code	Display	Description
A00004	NETWORK COMMUNICATION TIMEOUT	<p>Network communications is missing or failed to communicate with master (CONTROL SOURCE SELECT set to NETWORK).</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • NETW CONNECT TYPE (P.910) was changed from BASIC to FULL. • NETW DROP NUMBER (P.900) was changed. • Network option cable connections are loose or not connected. • Network option device failed or master communications failed.
A00005	INVERTING FAULT AVOIDED	<p>The inverting fault avoidance logic has detected conditions that could have caused an inverting fault. The drive took action to avoid an actual inverting fault. See section 13.7, Setting Up Inverting Fault Avoidance, for more information on this alarm.</p>
A00006	CONTROL NET PROGRAM MODE	<p>The PLC communicating with the drive from ControlNet has entered Program mode; drive operation is determined by CNI PROG/RUN MODE (P.915).</p>
A00030	MAIN CONTACTOR DID NOT OPEN	<p>The main (FN) contactor did not open following a stop. If a dynamic braking kit is used, the dynamic braking auxiliary contact is wired in series with the FN auxiliary contact.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Disconnected, loosely connected, or damaged FN, FN auxiliary, dynamic braking, or dynamic braking auxiliary wiring. • FN, FN auxiliary, dynamic braking or dynamic braking auxiliary contactor failure. • Disconnected, loosely connected, or damaged main contactor or dynamic brake control wiring (MCR or DBCR).
A00031	MAIN CONTACTOR DID NOT CLOSE	<p>The main (FN) contactor did not close following a run or jog command. If a dynamic braking kit is used, the dynamic braking auxiliary contact is wired in series with the FN auxiliary contact.</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • Disconnected, loosely connected, or damaged FN, FN auxiliary, dynamic braking or dynamic braking auxiliary wiring. • FN, FN auxiliary, dynamic braking, or dynamic braking auxiliary contactor failure. • Disconnected, loosely connected or damaged main contactor or dynamic brake control wiring (MCR or DBCR). • If Dynamic Braking kit is not installed, missing jumper wire at terminals 3 and 4 on the field/DB terminal strip.

Table 13.2 – Alarm Codes (Continued)

Code	Display	Description
A00032	SUSTAINED SPEED	<p>Motor speed did not fall below STOP SPEED THRESHOLD (P.113) in the required amount of time during a stop (this time is automatically set to two times the DECELERATION TIME (P.002)).</p> <p>Possible causes:</p> <ul style="list-style-type: none"> • DECELERATION TIME (P.002) not set properly. • STOP SPEED THRESHOLD (P.113) not set properly. • Overhauling load maintaining motor speed higher than the STOP SPEED THRESHOLD (P.113). • Incorrect speed/voltage feedback scaling.
A00033	SUSTAINED ARMATURE CURRENT	<p>Armature current was unable to reach discontinuous conduction while stopping the drive.</p> <p>Possible cause:</p> <ul style="list-style-type: none"> • Motor CEMF too high or line voltage too low for proper commutation.
A00050	CML FEEDBACK SCALING ERROR	<p>Armature current feedback could not be scaled properly based on the values entered for MOTOR RATED ARM AMPS and MAXIMUM CURRENT. Verify that these parameter values are correct for your application. Verify that CT TURNS RATIO has been set to the correct value for your drive.</p>
A00051	LOW MINIMUM SPEED	<p>The MINIMUM SPEED value is less than 10% of the MAXIMUM SPEED value. This alarm will not be triggered on powerup. It only occurs when maximum or minimum speed has changed.</p> <p>Verify that these parameter values are correct for your application.</p>
A00052	(no message)	<p>NEG CUR LIM INV EN (P.226) has changed state, either enabling or disabling the negative current limit inverters. The parameters POS CURRENT LIM SEL (P.223) and NEG CURRENT LIM SEL (P.224) have been set to REGISTER. Carefully check your current limit scheme and the values of POSITIVE CURRENT LIM (P.005) and NEGATIVE CURRENT LIM (P.006) to avoid unintended drive operation. Also see section 5.4, Configuring the Speed Loop Current Limits.</p>
A00700	RETENTIVE MEMORY SAVE FAILURE	<p>An attempt to save information (parameter values, fault log data or the keypad reference value) to retentive memory failed. The drive may continue to be operated.</p> <p>Possible cause:</p> <ul style="list-style-type: none"> • Regulator board failure.

13.2 Adjusting the Tachometer or Encoder Loss Sensitivity

Normally, tachometer or encoder loss is reported when the SCR firing angle reaches 109° when armature current is present and the speed feedback is less than 5% of TOP SPEED (P.011). If you are getting nuisance trips associated with high inertia loads, you can adjust the SCR angle at which tachometer or encoder loss is reported.



ATTENTION: This equipment is at line voltage when AC power is connected to the drive. Disconnect and lock out incoming power to the drive before proceeding. After power is removed, verify that no voltage exists at power terminals 181, 182, and 183 before touching any internal parts of the drive. Failure to observe this precaution could result in severe bodily injury or loss of life.

If you are getting nuisance tachometer or encoder loss trips:

- Step 1. Lockout and tag power as necessary.
- Step 2. Turn off power to the drive.
- Step 3. Check all tachometer or encoder lead connections, including polarity.
- Step 4. If there is no problem with the connections, increase TACH LOSS SCR ANGLE by 1 degree.
- Step 5. Restart the drive.
- Step 6. If a tachometer or encoder loss is reported and the angle is less than 127°, repeat this procedure.

TACH LOSS SCR ANGLE (P.608)

The SCR firing angle at which tachometer or encoder loss is determined when current is present and motor speed is less than 5% of TOP SPEED (P.011).

Parameter Range:	0 to 127 DEGREE
Default Setting:	109 DEGREE
Parameter Type:	Tunable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

This parameter is also used to determine an open armature. An open armature is detected when the:

- armature current is zero
- motor speed feedback is less than 5% of TOP SPEED (P.011)
- SCR firing angle is equal to TACH LOSS SCR ANGLE



ATTENTION: The incorrect setting of this parameter can cause an overspeed condition. Set the value of this parameter only as high as necessary to stop tachometer or encoder loss. Failure to observe this precaution could result in bodily injury.

13.3 Phase Locked Loop (PLL) Maximum Error

If your drive power is supplied by a source that cannot maintain a suitable fixed frequency output (such as an alternator), you can adjust this parameter to prevent faults related to line synchronization.

PLL MAXIMUM ERROR (P.308)

Maximum allowable change in line period per AC line cycle.

Parameter Range:	2 to 1000 μ sec
Default Setting:	2 μ sec
Parameter Type:	Tunable
OIM Menu Path(s):	Current Minor Loop (CML) - Three Phase AC Line

This parameter should only be increased when drive power is supplied by a source that cannot maintain a suitable fixed frequency output (such as an alternator) to prevent faults related to line synchronization.

13.4 SCR Diagnostics and Adjusting Open SCR Sensitivity

Under normal drive operation, the load carried by each SCR is relatively equal, as shown in figure 13.1.

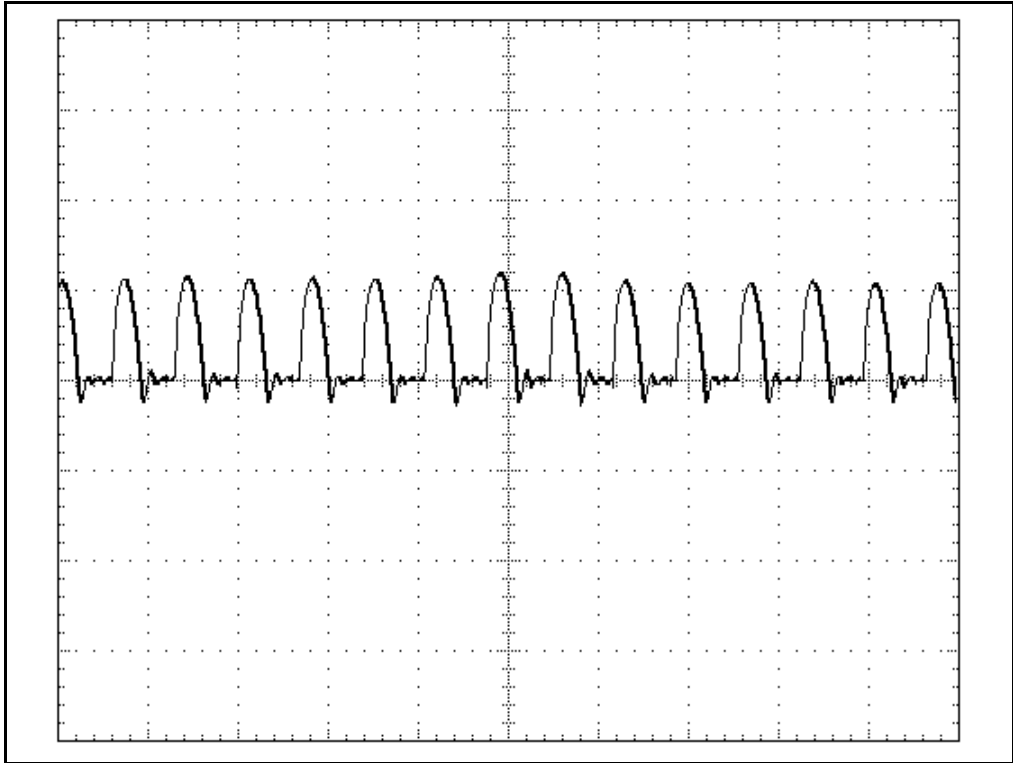


Figure 13.1 – SCR Armature Current During Normal Operation

If one or more SCRs fail to turn to on, a unique pattern of insufficient or missing current pulses results, as shown in figure 13.2.

Open SCR diagnostics detects SCRs that are not conducting by analyzing the level of current produced by each SCR pair firing. If one or more SCR consistently fails to produce current at a level approximately equal to other SCRs that fired, the drive concludes that an open SCR has occurred.

The open SCR diagnostic calculates the percentage deviation of current feedback for each pair of SCRs from the average current feedback. The percent deviation must exceed the value set for OPEN SCR SENSITIVITY (P.600) before the diagnostic proceeds to the next part of the diagnostic.

In the next part of the diagnostic, deviations from the average current are integrated over time to eliminate transient effects from the calculation. When the integration reaches the value of OPEN SCR TRIP THRESH (P.601), an open SCR fault is generated.

If you are experiencing nuisance SCR faults, you can use these parameters to increase the tolerance to conditions that could trigger an open SCR fault.

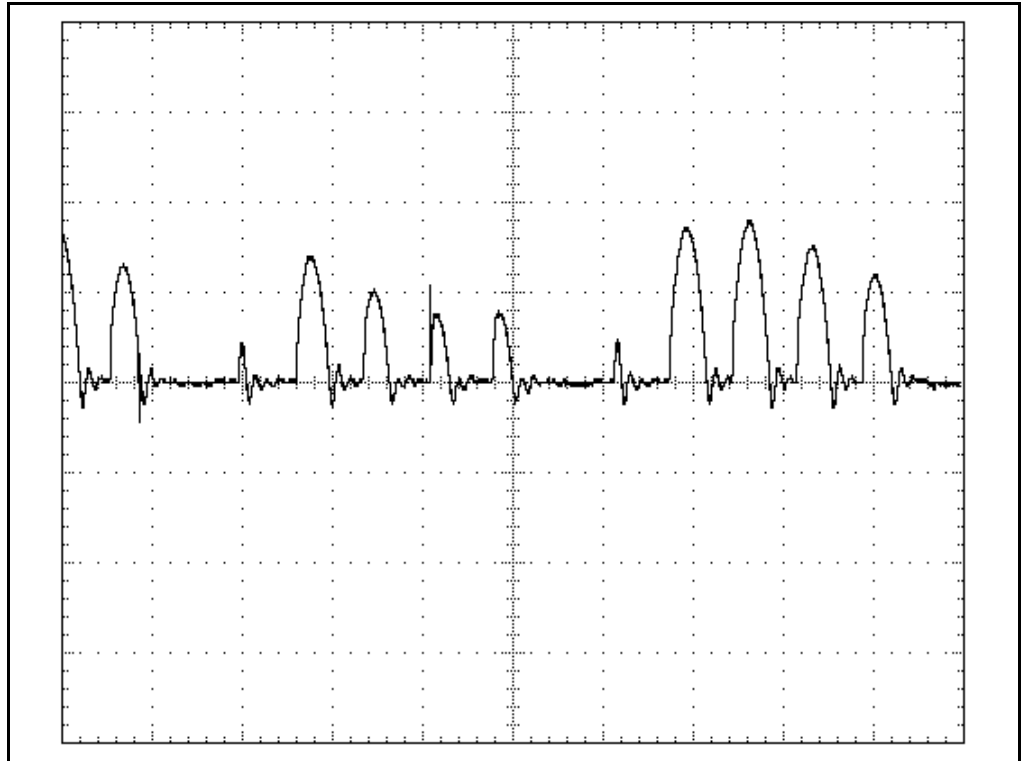


Figure 13.2 – Load SCRs Fail to Turn On

OPEN SCR SENSITIVITY (P.600)

Open SCR diagnostic sensitivity adjustment.

Parameter Range:	0 to 100%
Default Setting:	50%
Parameter Type:	Tunable
OIM Menu Path(s):	Current Minor Loop (CML) - SCR Diagnostics

Unbalanced AC lines can cause load sharing differences between SCRs. Increase the value of this parameter to increase the tolerance of SCR load sharing differences due to unbalanced lines.

OPEN SCR TRIP THRESH (P.601)

Open SCR trip threshold. Extremely unusual load conditions or severe current loop instability can cause nuisance open SCR faults.

Parameter Range:	800 to 4000
Default Setting:	1600
Parameter Type:	Tunable
OIM Menu Path(s):	Current Minor Loop (CML) - SCR Diagnostics

Increasing this parameter increases the tolerance of such disturbances.

13.5 Armature Phase Fire Test



ATTENTION: Only qualified electrical personnel familiar with the construction and operation of this equipment and the hazards involved should perform this test. Read and understand this section in its entirety before proceeding. Failure to observe this precaution could result in severe bodily injury or loss of life.

ATTENTION: This is an open loop test. Lock the motor shaft or disconnect the motor armature leads from the drive and replace them with a dummy load. Failure to observe this precaution could result in severe bodily injury or loss of life.


ATTENTION: If the field is disconnected, the armature must be locked to prevent rotation. Failure to observe this precaution could result in bodily injury.

ATTENTION: This equipment is at line voltage when AC power is connected to the drive. Disconnect and lock out incoming power to the drive before proceeding. After power is removed, verify that no voltage exists at power terminals 181, 182, and 183 before touching any internal parts of the drive. Failure to observe this precaution could result in severe bodily injury or loss of life.

An armature phase fire test mode is available to verify the operation of the S6 or S6R rectifier bridge. This test should only be performed by qualified personnel. Note that this test is not available through the DCM.

To perform an armature phase fire test:

- Step 1. Lockout and tag power as necessary.
- Step 2. Turn off power to the drive.
- Step 3. Either lock the motor armature to prevent rotation or disconnect the motor armature leads from the drive and replace with a dummy load.

When locking the motor armature, the motor field winding can be disconnected to prevent excessive torque. If the motor field winding is disconnected, jumper J20 should be set to DISABLE to inhibit field current loss faults.
- Step 4. Turn on power to the drive. The drive must be stopped and the Drive Ready Indicator must be ON.
- Step 5. Set CONTROL SOURCE SELECT to KEYPAD.
- Step 6. On the OIM, select Current Minor Loop (CML) – SCR Diagnostics – Armature Phase Fire Test.
- Step 7. Set PHASE FIRE TST BRIDGE (P.310). This parameter must be set to the appropriate value before activating the armature phase fire test mode.
- Step 8. Attach an oscilloscope to the armature current feedback test point (J17+, J22– on the Regulator board). Note that the CS3000 software oscilloscope mode does not have sufficient bandwidth for this test.
- Step 9. Press . The armature phase fire test mode is now active. The OIM Running indicator will be on.

Step 10. Set PHASE FIRE TEST DELTA (P.309) to 55 degrees. Slowly increase PHASE FIRE TEST DELTA until a steady pattern of “bumps” appears on the oscilloscope. If all thyristors in the selected bridge are operating, there will be six bumps per AC line cycle, similar to the example in figure 13.1. If any bumps are missing, one or more thyristors are not conducting, similar to the example in figure 13.3.

Note that conduction will not begin until the firing angle is sufficiently advanced (PHASE FIRE TEST DELTA (P.309) more than 60 degrees). A rate limit block limits the rate of change of firing angle advances to prevent sudden increases in current. To prevent the drive from entering continuous conduction during this test, PHASE FIRE TEST DELTA (P.309) should not exceed 89 degrees.

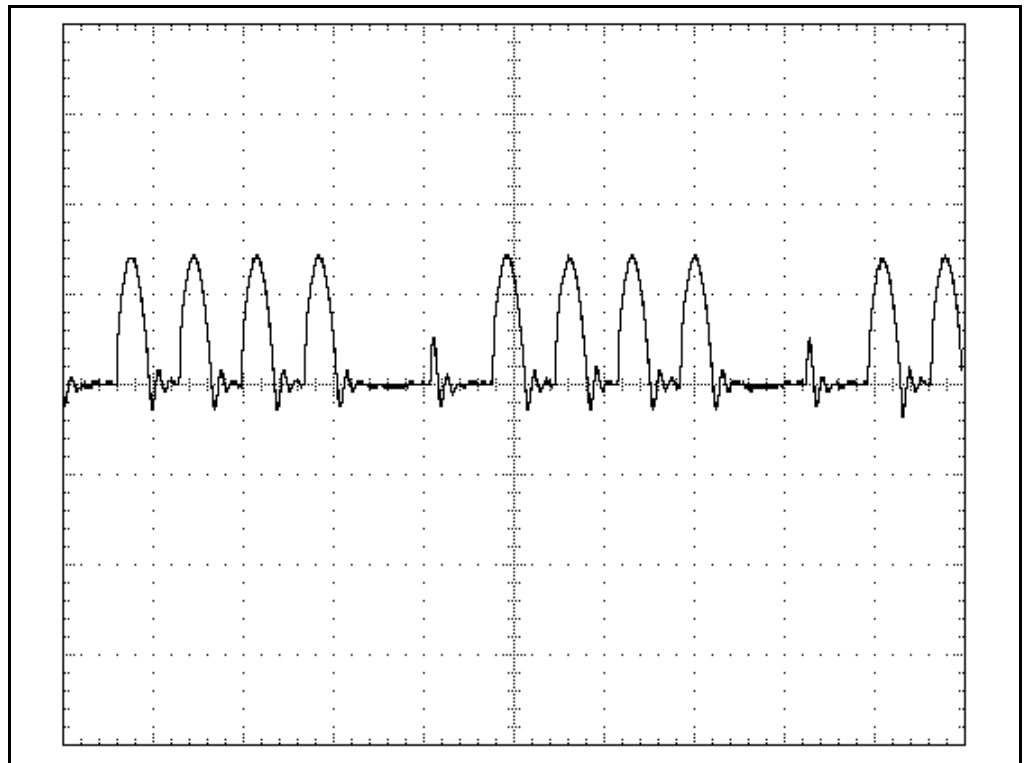



Figure 13.3 – Thyristors Fail to Conduct

Step 11. Press  to stop the armature phase fire test.

Step 12. Turn off power to the drive (lockout and tag as necessary).

Step 13. Either unlock the motor armature or remove the dummy load and reconnect the motor armature leads.

If the motor field winding was disconnected, reconnect it and return jumper J20 to its original position (typically ENABLE).

PHASE FIRE TEST DELTA (P.309)

The test firing conduction angle of the SCRs. If equal to 0, the armature power bridge is off. If it is set to 180, the armature power bridge is fully on.

Parameter Range:	0 to 180 DEGREE
Default Setting:	0 DEGREE
Parameter Type:	Tunable
OIM Menu Path(s):	Current Minor Loop (CML) – SCR Diagnostics – Armature Phase Fire Test.



ATTENTION: The armature phase fire test is unregulated. To prevent excess motor speed, either disconnect the armature leads from the drive and replace with a similar load or disconnect the field leads from the drive. Lock the motor armature shaft securely to prevent rotation in either direction prior to selecting this test. Failure to observe this precaution could result in severe bodily injury or loss of life.

PHASE FIRE TST BRIDGE (P.310)

Selects which armature bridge (forward or reverse) is used during the phase fire test. This input can only be changed while the drive is stopped.

Parameter Range:	ON OFF
Default Setting:	OFF
Parameter Type:	Tunable
OIM Menu Path(s):	Current Minor Loop (CML) - SCR Diagnostics - Armature Phase Fire Test

OFF selects the forward bridge (A1 positive with respect to A2). ON selects the reverse bridge (A1 negative with respect to A2).

13.6 Setting Reversed Tachometer or Reversed Encoder Lead Detection

The FlexPak 3000 drive includes an algorithm for detecting reversed speed feedback wiring. The logic verifies that the difference between the speed reference and the speed feedback is greater than the threshold set by TACH LEAD FLT THRESH (P.227) for the amount of time set by TACH LEAD FLT DELAY (P.228). When the threshold is greater than the difference for the specified delay, and the speed reference and speed feedback are opposite in polarity, a REVERSED TACH LEADS fault is generated (fault F00014).

Fault F00014 can also be caused by an overhauling load, improper drive tuning, or a tachometer or encoder loss.

The tachometer lead fault parameters have default values that are set so that reversed tachometer lead detection is effectively disabled. You must empirically determine values for these parameters so that reversed tachometer or encoder wiring can be detected without generating nuisance faults.

The ability to check for reversed tachometer lead faults is useful for machine manufacturers that require their equipment to be disassembled for shipping and reassembled and rewired at a customer site.

This option is not available for AC tachometers.

TACH LEAD FLT DELAY (P.228)

The amount of time that parameter P.227 (TACH LEAD FLT THRESH) must be exceeded before a REVERSED TACH LEADS fault (F00014) is generated.

Parameter Range:	0 to 32767 msec
Default Setting:	10000 msec
Parameter Type:	Tunable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

TACH LEAD FLT THRESH (P.227)

The threshold after which a REVERSED TACH LEADS fault (F00014) is generated.

Parameter Range:	0.0 to 250.0% of TOP SPEED
Default Setting:	200.0%
Parameter Type:	Tunable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)

A REVERSED TACH LEADS fault is generated if the difference between the speed reference and speed feedback is greater than this value for at least the amount of time set by TACH LEAD FLT DELAY.

13.7 Setting Up Inverting Fault Avoidance

An inverting fault is an uncontrollable high current resulting from commutation failure. It is typically caused by an excessive armature-to-line voltage ratio, which can be caused by situations such as a line voltage dip, a poorly tuned field regulator, or an overhauling load. Inverting faults can also be caused by thyristor misfiring induced by noise, or a current minor loop rate limit that is set too fast.

Inverting faults can cause:

- clearing of the AC line fuses that protect the armature thyristors
- tripping of an inverting fault circuit breaker
- clearing of an armature DC fuse
- loss of thyristors
- degradation of commutator due to high current
- flashover in the motor or power unit

Inverting faults are only a concern in regenerative DC drive applications. Typically, a regenerative drive application uses a regenerative power unit (S6R). Non-regenerative power units (S6) can also be used in a regenerative configuration, such as an unwinder using continuous regeneration or if the drive uses field reversing for stopping.

Inverting fault avoidance can be used in regenerative drive applications to prevent the occurrence of an inverting fault. If inverting fault avoidance is used, the drive recognizes conditions that could lead to an inverting fault and dynamically adjusts drive operation to prevent an inverting fault.

INV FAULT AVOID SEL (P.312)

Allows you to determine how the drive responds to an inverting fault.

See table 13.3 for results of the parameter settings.

Parameter Range:	1 = DISABLED 2 = FAULT IMMEDIATELY 3 = DELAY BEFORE FAULT
Default Setting:	DISABLED
Parameter Type:	Configurable
OIM Menu Path(s):	Additional Parameters (listed by parameter number)



ATTENTION: When activated, inverting fault avoidance takes control of the current minor loop by either forcing the current reference to zero (if the drive is regenerating) or by disabling the regenerative bridge (if the drive is not regenerating). The user must analyze the application to determine whether or not inverting fault avoidance should be used. Failure to observe this precaution could result in bodily injury.

ATTENTION: Enabling the inverting fault avoidance logic does not guarantee that an inverting fault will not occur in all instances. The user must provide safeguards against inverting faults. Failure to observe this precaution could result in bodily injury.

Table 13.3 – Inverting Fault Avoidance Settings

Parameter Setting	Is Drive Regenerating or Attempting to Regenerate?	Drive Action
DISABLED	n/a	None.
FAULT IMMEDIATELY	Yes	<ul style="list-style-type: none"> • Immediately stops (coast/DB). • Generates an INVERTING FAULT AVOIDED fault (F00015).
	No (drive is motoring)	<ul style="list-style-type: none"> • Generates an INVERTING FAULT AVOIDED alarm (A00005). • Continues normal operation on the motoring bridge until a request to regenerate is detected. <p>A request to regenerate occurs when the current minor loop reference and feedback become opposite polarity. When a request to regenerate is detected, the drive immediately stops (coast/DB) and generates an INVERTING FAULT AVOIDED fault (F00015).</p>
DELAY BEFORE FAULT	Yes	<ul style="list-style-type: none"> • Immediately forces the current minor loop reference to zero. • Logs an INVERTING FAULT AVOIDED alarm (A00005). • Continues operate normally for up to two seconds. The drive can generate a motoring current as needed but will coast while a demand for regenerative current exists. • If the demand for regenerative current persists for approximately two seconds, the drive: <ul style="list-style-type: none"> • Stops (coast/DB). • Generates an INVERTING FAULT AVOIDED fault (F00015). • If the conditions that caused the alarm return to normal before two seconds, the drive returns to normal operation (the regenerative bridge is re-enabled) without stopping.
	No (drive is motoring)	<ul style="list-style-type: none"> • Logs an INVERTING FAULT AVOIDED alarm. • Continues normal operation on the motoring bridge until a request to regenerate is detected. • When a request to regenerate is detected, the drive continues operate normally for up to two seconds. The drive can generate a motoring current as needed but will coast while a demand for regenerative current exists. • If the demand for regenerative current persists for approximately two seconds, the drive: <ul style="list-style-type: none"> • Stops (coast/DB). • Generates an INVERTING FAULT AVOIDED fault (F00015). • If the conditions that caused the alarm return to normal before two seconds, the drive returns to normal operation (the regenerative bridge is re-enabled) without stopping.

13.8 Checking the AC Line Period and Voltage

AC LINE PERIOD (P.393)

The AC line period as measured by the drive in microseconds. Line period = 1/line frequency in Hertz.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Current Minor Loop (CML) - Three Phase AC Line

AC LINE VOLTAGE (P.392)

The AC line RMS voltage as measured by the drive.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Current Minor Loop (CML) - Three Phase AC Line

PHASE LOSS DETECTION EN (P.609)

Enables or disables phase loss detection.

Parameter Range:	DISABLE ENABLE
Default Setting:	ENABLE
Parameter Type:	Configurable
OIM Menu Path(s):	Current Minor Loop (CML) - Three Phase AC Line

When set to ENABLE, a PHASE LOSS fault (F00016) is generated when the measured AC line voltage drops below 75% of the value specified by NOMINAL AC LINE VOLTS (P.307) for more than 2 seconds.

13.9 Checking Drive Information

You can use these parameters to determine your drive regulator type, if your power unit is S6R (regenerative) or S6 (non-regenerative), and regulator software version.

J15 REGULATOR TYPE (P.799)

Indicates the position of jumper J15, REGULATOR TYPE. This jumper selects the type of regulator, SPEED/VOLTAGE or CURRENT/TORQUE. This jumper is only read at powerup.

Parameter Range:	SPEED/VOLTAGE CURRENT/TORQUE
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Information Current Minor Loop (CML) - CML Test Points

When the drive is configured as a speed regulator (J15 on the Regulator board set to SPEED), the input selected by AUTO REFERENCE SELECT (P.103) is used as a speed reference.

When the drive is configured as a torque regulator, (J15 on the Regulator board set to CURRENT), the input selected by AUTO REFERENCE SELECT (P.103) is used as a torque reference to the current minor loop.

See the hardware manual for information on setting J15.

POWER UNIT TYPE (P.795)

Indicates if the drive uses an S6R (regenerative) or an S6 (non-regenerative) power unit.

Parameter Range:	S6 (NON-REGEN) S6R (REGEN)
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Information

If the power unit type is S6 (non-regenerative), NEGATIVE CURRENT LIM (P.006) will be automatically fixed to 0, and REVERSE DISABLE (P.015) fixed to DISABLE (preventing reverse direction).

REGULATOR SW VERSION (P.794)

Lists the regulator software version.

Parameter Range:	n/a
Default Setting:	n/a
Parameter Type:	Output
OIM Menu Path(s):	Drive Information

APPENDIX A

Block Diagrams

In these block diagrams:

- All caps indicate parameter names. For example: MOTOR RATED ARM AMPS.
- Output parameters are in parenthesis. For example: (FIELD ECONOMY ACTIVE).
- All caps and italics indicate selectable options. For example: REGISTER.
- * indicates a default setting. For example: *REGISTER

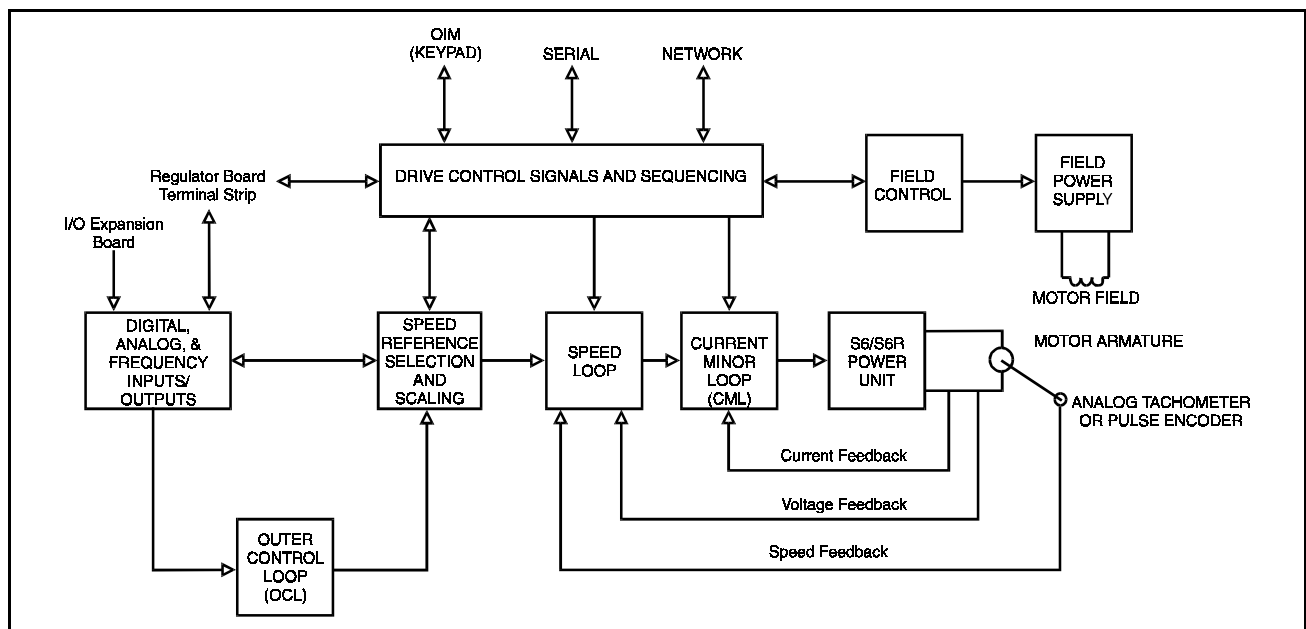


Figure A.1 – Overview Block Diagram of the FlexPak 3000 Drive

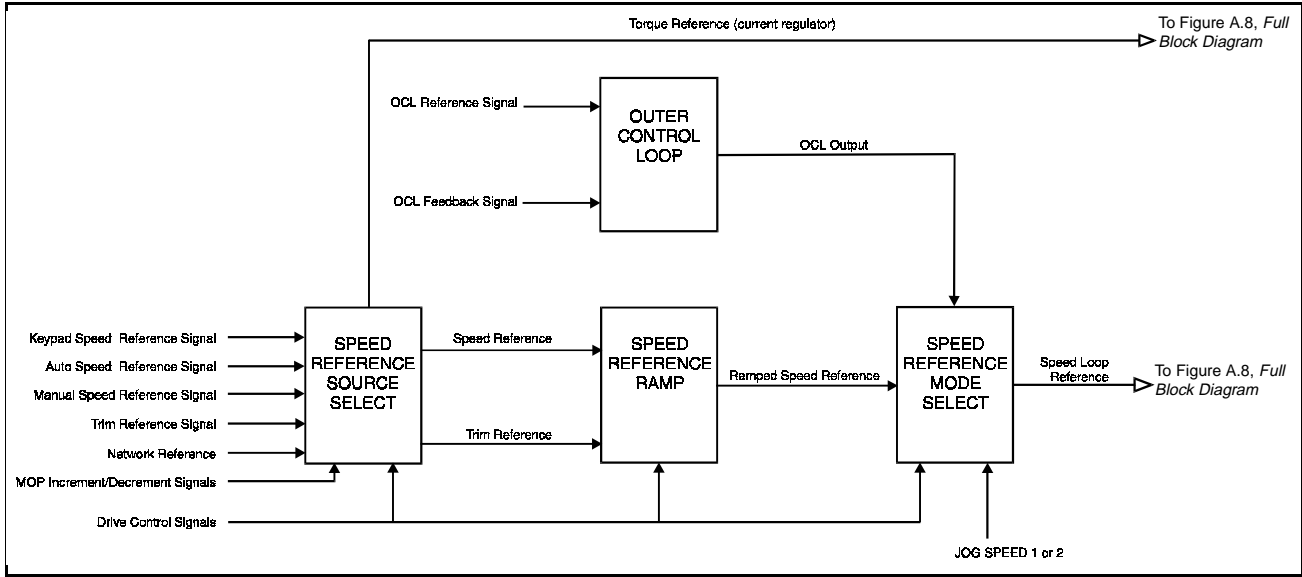


Figure A.2 – Speed Reference Overview

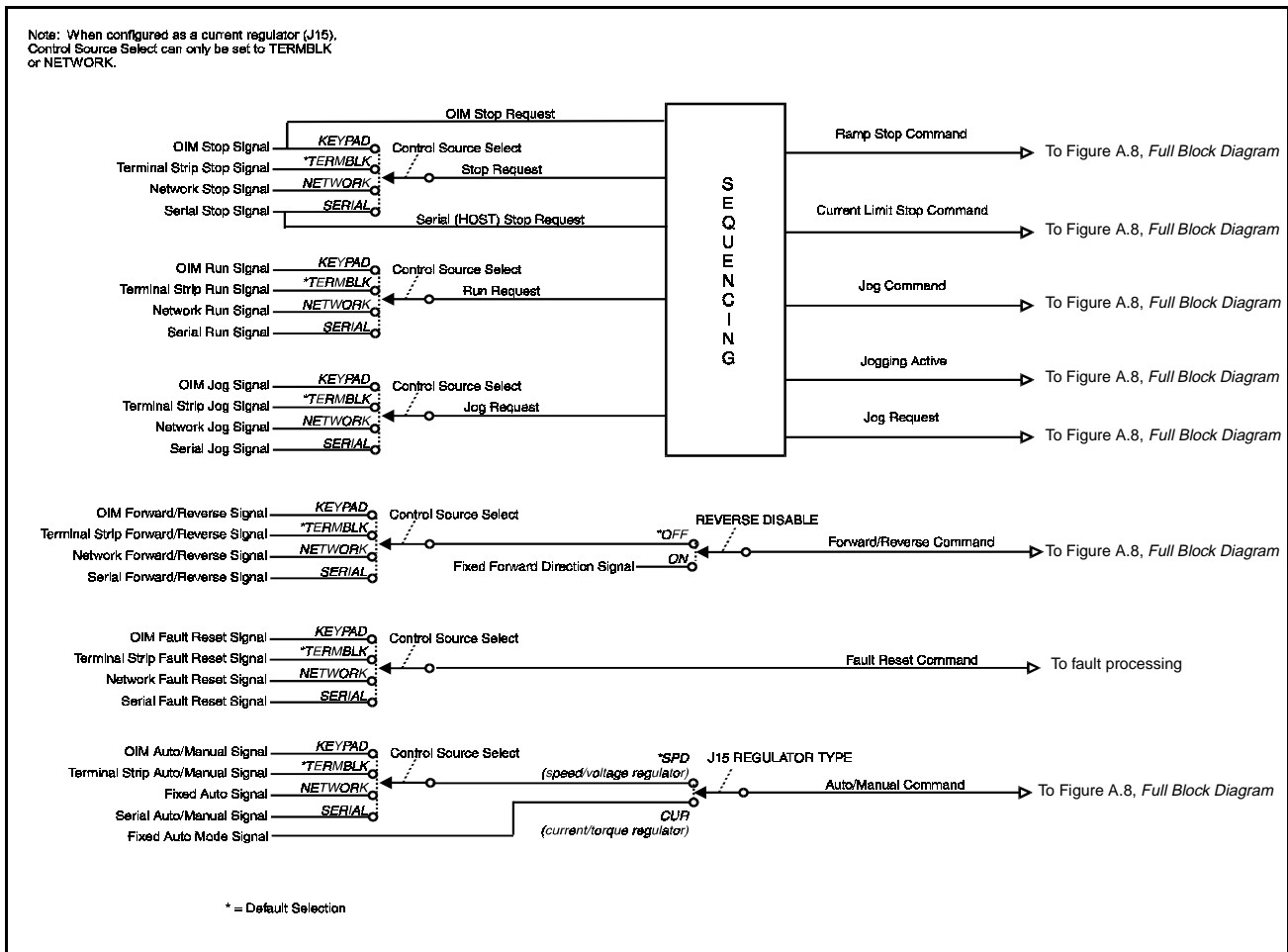


Figure A.3 – Drive Sequencing Overview

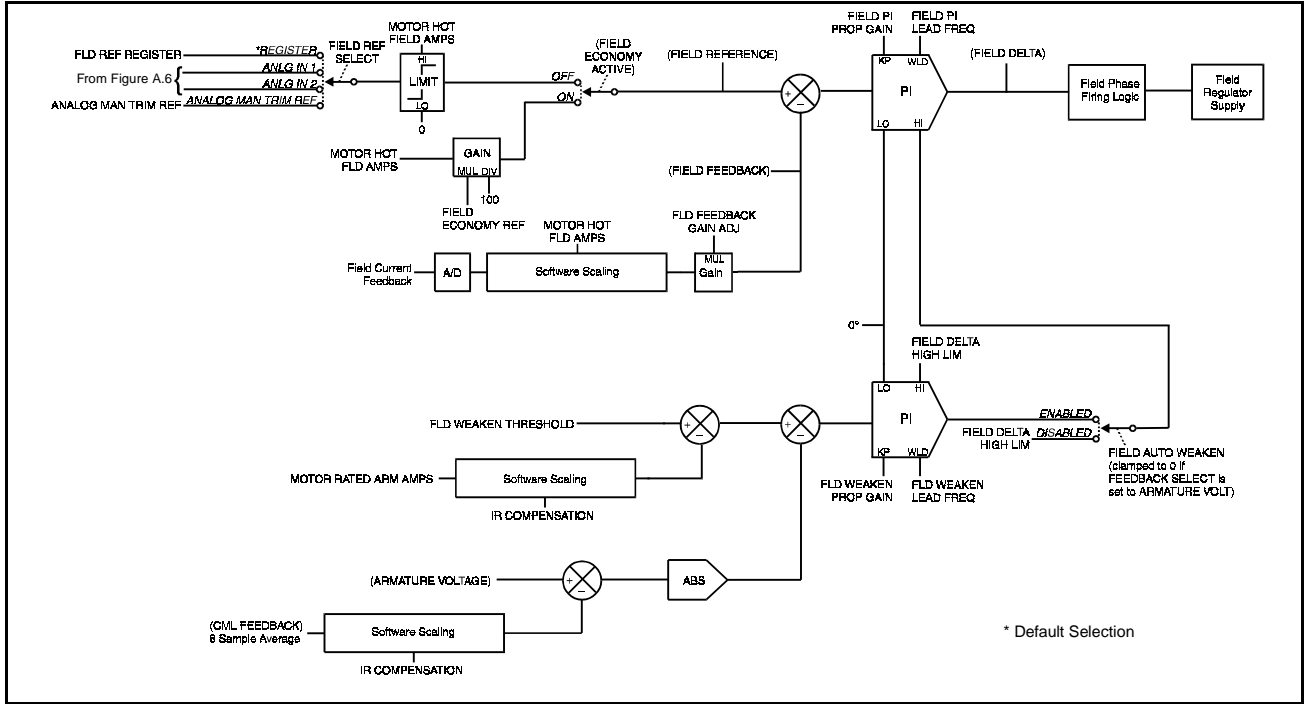


Figure A.4 – Field Block Diagram if Field Current Regulator Kit is Installed

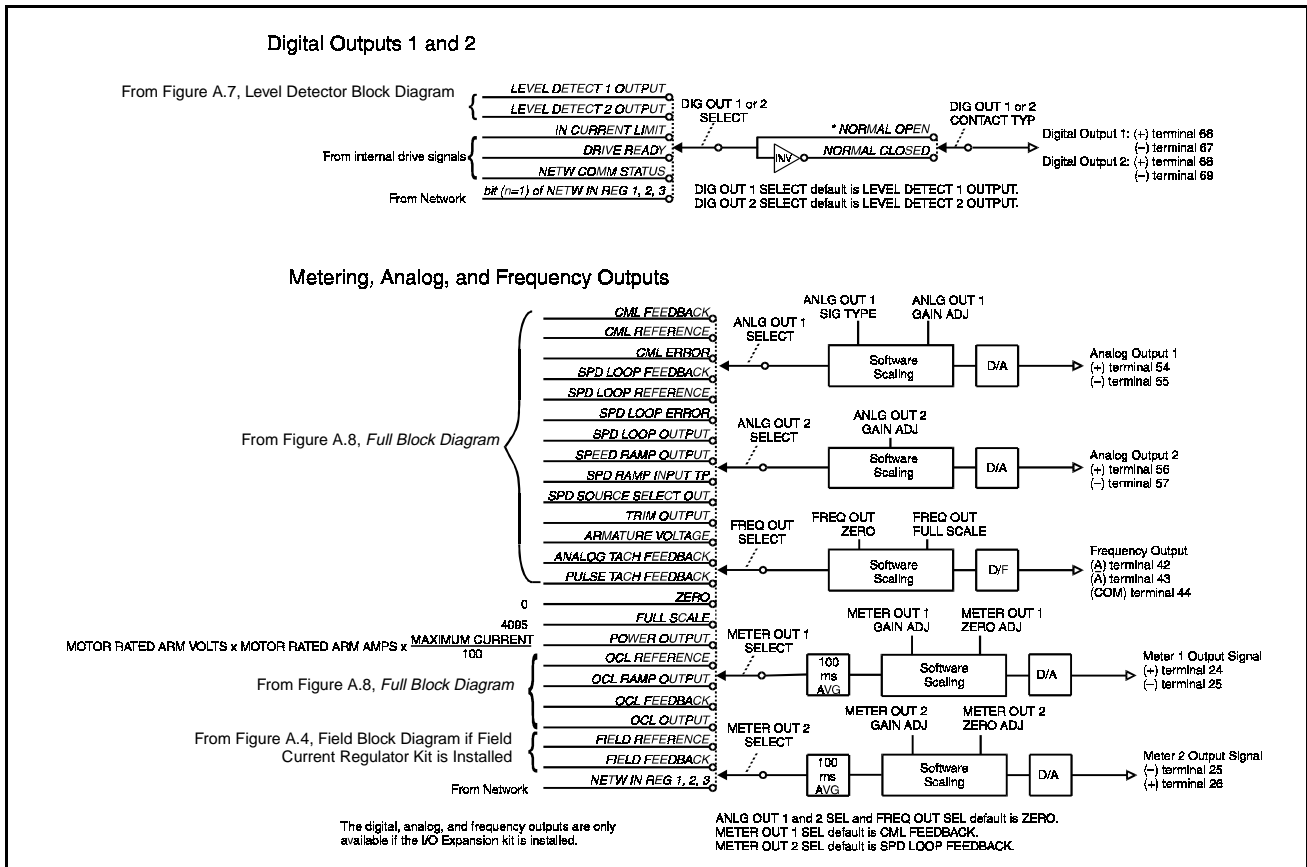
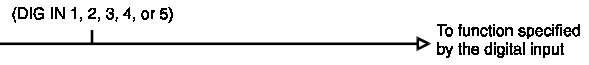


Figure A.5 – Digital, Metering, Frequency, and Analog Outputs Block Diagram

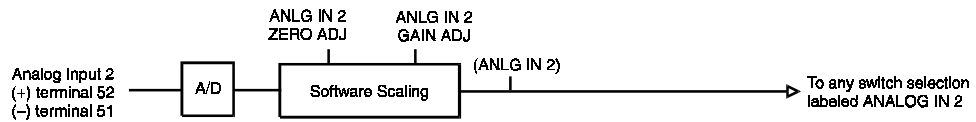
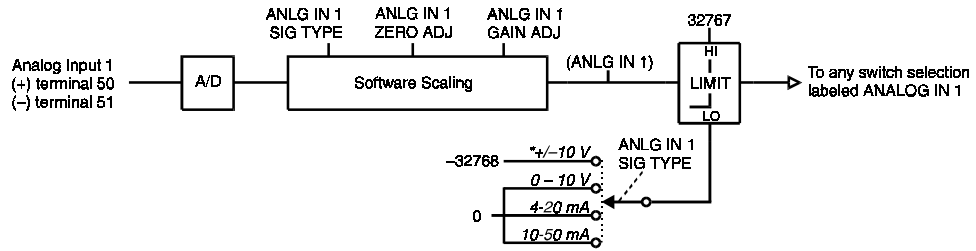
Digital Inputs 1 through 5

- Digital Input 1: terminal 59 (Preset Speed Select)
- Digital Input 2: terminal 60 (Preset Speed Select)
- Digital Input 3: terminal 62 (MOP Decrement)
- Digital Input 4: terminal 63 (MOP Increment)
- Digital Input 5: terminal 64 (OCL Enable)

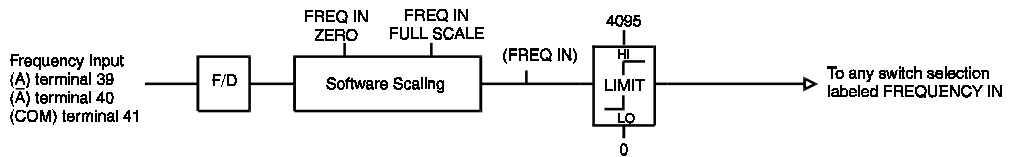
+24 VDC available at terminal 14 on Regulator board and at terminal 58 or 61 on I/O Expansion board



Analog Inputs

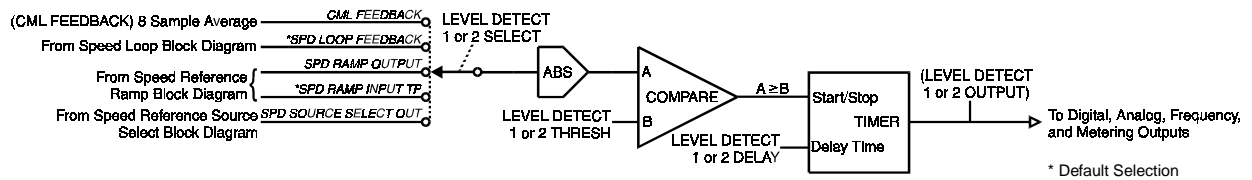


Frequency Input



* = Default Selection

Figure A.6 – Digital, Analog, and Frequency Inputs Block Diagram



* = Default Selection

Figure A.7 – Level Detector Block Diagram

New Features in Version 4.3

The FlexPak 3000 drive Version 4.3 software adds a configurable scan loop time to the previous version of the drive. See parameter P.019 in chapter 5.

APPENDIX C

Parameter Settings Record

This table provides space for you to record input parameter settings for reference.

Table C.1 – Parameter Settings Quick Reference Table

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
ACCELERATION TIME (P.001)	0.1 to 300.0 seconds	5.0 seconds		
AMX NETW REF SELECT (P.911)	<ul style="list-style-type: none"> • DIRECT • BROADCAST n (n=1 to 8) 	DIRECT		
ANALOG TACH GAIN ADJ (P.201)	0.750 to 1.250	1.000		
ANALOG TACH ZERO ADJ (P.202)	-200 to 200	0		
ANLG AUTO GAIN ADJ (P.101)	0.750 to 1.250	1.000		
ANLG AUTO SIGNAL TYPE (P.100)	<ul style="list-style-type: none"> • 0-10V • +/-10V • 4-20mA • 10-50mA 	0-10V		
ANLG AUTO ZERO ADJ (P.102)	-200 to 200	0		
ANLG IN 1 GAIN ADJ (P.415)	0.750 to 2.250	1.000		
ANLG IN 1 SIG TYPE (P.413)	<ul style="list-style-type: none"> • 0-10 V • +/-10 V • 4-20 mA • 10-50 mA 	+/-10 V		
ANLG IN 1 ZERO ADJ (P.414)	-200 to 200	0		
ANLG IN 2 GAIN ADJ (P.417)	0.750 to 2.250	1.000		
ANLG IN 2 ZERO ADJ (P.416)	-200 to 200	0		
ANLG MAN REF GAIN ADJ (P.104)	0.750 to 1.250	1.000		
ANLG MAN REF ZERO ADJ (P.105)	-200 to 200	0		
ANLG OUT 1 GAIN ADJ (P.420)	0.500 to 1.300	1.000		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
ANLG OUT 1 SELECT (P.418)	<ul style="list-style-type: none"> • CML FEEDBACK (P.397) • CML REFERENCE (P.396) • CML ERROR (P.398) • SPD LOOP FEEDBACK (P.296) • SPD LOOP REFERENCE (P.295) • SPD LOOP ERROR (P.297) • SPD LOOP OUTPUT (P.299) • SPEED RAMP OUTPUT (P.199) • SPEED RAMP INPUT TP (P.198) • SPD SOURCE SELECT OUT (P.193) • TRIM OUTPUT (P.197) • ARMATURE VOLTAGE (P.289) • ANALOG TACH FEEDBACK (P.291) • PULSE TACH FEEDBACK (P.292) • ZERO • FULL SCALE • POWER OUTPUT • OCL REFERENCE (P.845) • OCL RAMP OUTPUT (P.846) • OCL FEEDBACK (P.847) • OCL OUTPUT (P.848) • FIELD REFERENCE (P.590) • FIELD FEEDBACK (P.589) • NETW IN REG 1 (P.905) • NETW IN REG 2 (P.906) • NETW IN REG 3 (P.907) 	ZERO		
ANLG OUT 1 SIG TYPE (P.419)	<ul style="list-style-type: none"> • 0–10 V • +/- 10 V • 4-20 mA 	+/- 10 V		
ANLG OUT 2 GAIN ADJ (P.422)	0.500 to 1.300	1.000		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
ANLG OUT 2 SELECT (P.421)	<ul style="list-style-type: none"> • CML FEEDBACK (P.397) • CML REFERENCE (P.396) • CML ERROR (P.398) • SPD LOOP FEEDBACK (P.296) • SPD LOOP REFERENCE (P.295) • SPD LOOP ERROR (P.297) • SPD LOOP OUTPUT (P.299) • SPEED RAMP OUTPUT (P.199) • SPEED RAMP INPUT TP (P.198) • SPD SOURCE SELECT OUT (P.193) • TRIM OUTPUT (P.197) • ARMATURE VOLTAGE (P.289) • ANALOG TACH FEEDBACK (P.291) • PULSE TACH FEEDBACK (P.292) • ZERO • FULL SCALE • POWER OUTPUT • OCL REFERENCE (P.845) • OCL RAMP OUTPUT (P.846) • OCL FEEDBACK (P.847) • OCL OUTPUT (P.848) • FIELD REFERENCE (P.590) • FIELD FEEDBACK (P.589) • NETW IN REG 1 (P.905) • NETW IN REG 2 (P.906) • NETW IN REG 3 (P.907) 	ZERO		
ANLG TACH VOLTS/1000 (P.203)	18.0 to 200.0 VOLTS/1000 RPM	18.0 VOLTS/1000 RPM		
ARM VOLTAGE GAIN ADJ (P.204)	0.750 to 1.250	1.000		
ARM VOLTAGE ZERO ADJ (P.205)	-200 to 200	0		
AUTO MODE MIN BYPASS (P.111)	<ul style="list-style-type: none"> • OFF • ON 	OFF		
AUTO MODE RAMP BYPASS (P.112)	<ul style="list-style-type: none"> • OFF • ON 	OFF		
AUTO REFERENCE SELECT (P.103)	<ul style="list-style-type: none"> • ANALOG • FREQUENCY IN 	ANALOG		
CML FEEDBACK GAIN ADJ (P.300)	0.900 to 1.100	1.000		
CML PI LEAD FREQUENCY (P.302)	10 to 500 RAD/S	100 RAD/S		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
CML PI PROP GAIN (P.301)	0.000 to 4.000	0.250		
CML REF LIMIT SELECT (P.311)	<ul style="list-style-type: none"> • 1 = SPD LOOP PI LIMITS • 2 = REGISTER 	1		
CML REF RATE LIMIT (P.303)	1 to 1000 msec	40 msec		
CNI PROG/RUN MODE (P.915)	<ul style="list-style-type: none"> • 1 = STOP • 2 = USE LAST REF • 3 = USE TRMBLK CNTL 	1		
CONTROL SOURCE (P.000)	<ul style="list-style-type: none"> • KEYPAD • SERIAL • TERMBLK • NETWORK 	KEYPAD		
CT TURNS RATIO (P.010)	<ul style="list-style-type: none"> • 139 • 208 • 417 • 833 • 2000 • 5230 • OTHER 	n/a		
CURRENT COMPOUNDING (P.209)	-50 to 50%	0%		
DECELERATION TIME (P.002)	0.1 to 300.0 seconds	5.0 seconds		
DEVNET POLL MSG TYPE (P.913)	<ul style="list-style-type: none"> • CONTROL ONLY • CONTROL+CONFIG 	CONTROL ONLY		
DIG IN 0 SELECT (P.428)	<ul style="list-style-type: none"> • 1 = BRUSH WEAR INPUT • 2 = JOG SPEED SELECT • 3 = OCL ENABLE 	1		
DIG OUT 1 CONTACT TYP (P.410)	<ul style="list-style-type: none"> • NORMAL OPEN • NORMAL CLOSED 	NORMAL OPEN		
DIG OUT 1 SELECT (P.409)	<ul style="list-style-type: none"> • LEVEL DETECT 1 OUTPUT • LEVEL DETECT 2 OUTPUT • IN CURRENT LIMIT • DRIVE READY • NETW COMM STATUS • NETW IN REG 1 (BIT 0) • NETW IN REG 2 (BIT 0) • NETW IN REG 3 (BIT 0) 	LEVEL DETECT 1 OUTPUT		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
DIG OUT 2 CONTACT TYP (P.412)	<ul style="list-style-type: none"> NORMAL OPEN NORMAL CLOSED 	NORMAL OPEN		
DIG OUT 2 SELECT (P.411)	<ul style="list-style-type: none"> LEVEL DETECT 1 OUTPUT LEVEL DETECT 2 OUTPUT IN CURRENT LIMIT DRIVE READY NETW COMM STATUS NETW IN REG 1 (BIT 1) NETW IN REG 2 (BIT 1) NETW IN REG 3 (BIT 1) 	LEVEL DETECT 2 OUTPUT		
ENHANCED FLD VOLT ADJ (P.500)	<ul style="list-style-type: none"> 0 to 180 (J21 set to B-C) 0 to 120 (J21 set to A-C) 	84 0 when the Field Current Regulator kit is installed		
FEEDBACK SELECT (P.200)	<ul style="list-style-type: none"> ARMATURE VOLT DC TACH PULSE TACH AC TACH 	ARMATURE VOLT		
FIELD AUTO WEAKEN (P.517)	<ul style="list-style-type: none"> DISABLED ENABLED 	DISABLED		
FIELD DELTA HIGH LIM (P.587)	0 to 180 DEGREE	130 DEGREE		
FIELD ECONOMY DELAY (P.501)	0 to 27 minutes	5 minutes		
FIELD ECONOMY REF (P.511)	0 to 100%	0%		
FIELD LOSS THRESHOLD (P.512)	<ul style="list-style-type: none"> 50 to 100% of MOTOR HOT FLD AMPS (P.510) when FEEDBACK SELECT (P.200) is set to ARMATURE VOLT 0 to 100% of MOTOR HOT FLD AMPS (P.510) when FEEDBACK SELECT (P.200) is set to DC TACH, PULSE TACH, or AC TACH 	60% of MOTOR HOT FLD AMPS (P.510)		
FIELD PI LEAD FREQ (P.515)	0 to 282.70 RAD/S	1.50 RAD/S		
FIELD PI PROP GAIN (P.514)	0.10 to 128.00	0.50		
FIELD REF REGISTER (P.513)	0 to MOTOR HOT FLD AMPS	MOTOR HOT FLD AMPS		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
FIELD REF SELECT (P.521)	1 = REGISTER 2 = ANALOG MAN TRIM REF 3 = ANALOG IN 1 4 = ANALOG IN 2	1		
FLD FEEDBACK GAIN ADJ (P.516)	0.900 to 1.100	1.000		
FLD WEAKEN LEAD FREQ (P.520)	0.01 to 282.70 RAD/S	0.50 rad/s		
FLD WEAKEN PROP GAIN (P.519)	0.01 to 128.00	1.60		
FLD WEAKEN THRESHOLD (P.518)	0 to 120% of MOTOR RATED ARM VOLTS (P.009)	95% of MOTOR RATED ARM VOLTS (P.009)		
FREQ IN FULL SCALE (P.424)	2.0 to 250.0 kHz	250.0 kHz		
FREQ IN ZERO (P.423)	2.0 to FREQ IN FULL SCALE kHz	2.0 kHz		
FREQ OUT FULL SCALE (P.427)	2.0 to 250.0 kHz	250.0 kHz		
FREQ OUT SELECT (P.425)	<ul style="list-style-type: none"> • CML FEEDBACK (P.397) • CML REFERENCE (P.396) • CML ERROR (P.398) • SPD LOOP FEEDBACK (P.296) • SPD LOOP REFERENCE (P.295) • SPD LOOP ERROR (P.297) • SPD LOOP OUTPUT (P.299) • SPEED RAMP OUTPUT (P.199) • SPEED RAMP INPUT TP (P.198) • SPD SOURCE SELECT OUT (P.193) • TRIM OUTPUT (P.197) • ARMATURE VOLTAGE (P.289) • ANALOG TACH FEEDBACK (P.291) • PULSE TACH FEEDBACK (P.292) • ZERO • FULL SCALE • POWER OUTPUT • OCL REFERENCE (P.845) • OCL RAMP OUTPUT (P.846) • OCL FEEDBACK (P.847) • OCL OUTPUT (P.848) • FIELD REFERENCE (P.590) • FIELD FEEDBACK (P.589) • NETW IN REG 1 (P.905) • NETW IN REG 2 (P.906) • NETW IN REG 3 (P.907) 	ZERO		
FREQ OUT ZERO (P.426)	2.0 to FREQ OUT FULL SCALE kHz	2.0 kHz		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
INERTIA COMP SELECT (P.221)	<ul style="list-style-type: none"> • NONE • INTERNAL • ANALOG IN 1 • ANALOG IN 2 • NETW IN REG 1 • NETW IN REG 2 • NETW IN REG 3 	NONE		
INV FAULT AVOID SEL (P.312)	<ul style="list-style-type: none"> • 1 = DISABLED • 2 = FAULT IMMEDIATELY • 3 = DELAY BEFORE FAULT 	DISABLED		
IR COMPENSATION (P.206)	0 to 50%	0%		
JOG ACCEL/DECEL TIME (P.013)	0.1 to 300.0 seconds	3.0 seconds		
JOG OFF DELAY TIME (P.121)	0.0 to 10.0 seconds	1.0 second		
JOG SPEED 1 (P.012)	0 to MAXIMUM SPEED (RPM or user-defined units)	250 RPM		
JOG SPEED 2 (P.017)	0 to MAXIMUM SPEED (RPM or user-defined units)	250 RPM		
LEVEL DETECT 1 DELAY (P.604)	0.0 to 300.0 seconds	10.0 seconds		
LEVEL DETECT 1 SELECT (P.602)	<ul style="list-style-type: none"> • CML FEEDBACK • SPD LOOP FEEDBACK • SPD RAMP INPUT TP • SPEED RAMP OUTPUT • SPD SOURCE SELECT OUT 	SPD LOOP FEEDBACK		
LEVEL DETECT 1 THRESH (P.603)	0.1 to 100.0% or MAXIMUM CURRENT	10.0%		
LEVEL DETECT 2 DELAY (P.607)	0.0 to 300.0 seconds	10.0 seconds		
LEVEL DETECT 2 SELECT (P.605)	<ul style="list-style-type: none"> • CML FEEDBACK • SPD LOOP FEEDBACK • SPD RAMP INPUT TP • SPEED RAMP OUTPUT • SPD SOURCE SELECT OUT 	SPD RAMP INPUT TP		
LEVEL DETECT 2 THRESH (P.606)	0.1 to 100.0% or MAXIMUM CURRENT	10.0%		
MANUAL REF SELECT (P.106)	<ul style="list-style-type: none"> • ANALOG • MOP 	ANALOG		
MAXIMUM CURRENT (P.007)	25 to 200 %FLA	150 %FLA		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
MAXIMUM SPEED (P.004)	1 to TOP SPEED (RPM or user-defined units)	500 RPM		
METER OUT 1 GAIN ADJ (P.400)	1.100 to 1.900	1.000		
METER OUT 1 SELECT (P.404)	<ul style="list-style-type: none"> • CML FEEDBACK (P.397) • CML REFERENCE (P.396) • CML ERROR (P.398) • SPD LOOP FEEDBACK (P.296) • SPD LOOP REFERENCE (P.295) • SPD LOOP ERROR (P.297) • SPD LOOP OUTPUT (P.299) • SPEED RAMP OUTPUT (P.199) • SPEED RAMP INPUT TP (P.198) • SPD SOURCE SELECT OUT (P.193) • TRIM OUTPUT (P.197) • ARMATURE VOLTAGE (P.289) • ANALOG TACH FEEDBACK (P.291) • PULSE TACH FEEDBACK (P.292) • ZERO • FULL SCALE • POWER OUTPUT • OCL REFERENCE (P.845) • OCL RAMP OUTPUT (P.846) • OCL FEEDBACK (P.847) • OCL OUTPUT (P.848) • FIELD REFERENCE (P.590) • FIELD FEEDBACK (P.589) • NETW IN REG 1 (P.905) • NETW IN REG 2 (P.906) • NETW IN REG 3 (P.907) 	CML FEEDBACK		
METER OUT 1 ZERO ADJ (P.402)	-200 to 200	0		
METER OUT 2 GAIN ADJ (P.401)	0.100 to 1.900	1.000		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
METER OUT 2 SELECT (P.405)	<ul style="list-style-type: none"> • CML FEEDBACK (P.397) • CML REFERENCE (P.396) • CML ERROR (P.398) • SPD LOOP FEEDBACK (P.296) • SPD LOOP REFERENCE (P.295) • SPD LOOP ERROR (P.297) • SPD LOOP OUTPUT (P.299) • SPEED RAMP OUTPUT (P.199) • SPEED RAMP INPUT TP (P.198) • SPD SOURCE SELECT OUT (P.193) • TRIM OUTPUT (P.197) • ARMATURE VOLTAGE (P.289) • ANALOG TACH FEEDBACK (P.291) • PULSE TACH FEEDBACK (P.292) • ZERO • FULL SCALE • POWER OUTPUT • OCL REFERENCE (P.845) • OCL RAMP OUTPUT (P.846) • OCL FEEDBACK (P.847) • OCL OUTPUT (P.848) • FIELD REFERENCE (P.590) • FIELD FEEDBACK (P.589) • NETW IN REG 1 (P.905) • NETW IN REG 2 (P.906) • NETW IN REG 3 (P.907) 	SPD LOOP FEEDBACK		
METER OUT 2 ZERO ADJ (P.403)	–200 to 200	0		
MINIMUM SPEED (P.003)	0 to MAXIMUM SPEED (RPM or user-defined units)	250 RPM		
MOP ACCEL TIME (P.115)	ACCELERATION TIME to 300.0 seconds	5.0 seconds		
MOP DECEL TIME (P.120)	DECELERATION TIME to 300.0 seconds	5.0 seconds		
MOP RESET ENABLE (P.116)	<ul style="list-style-type: none"> • OFF • ON 	OFF		
MOTOR HOT FLD AMPS (P.510)	0.11 to installed supply rating (4.00, 10.00, or 20.00 amps)	0.01 amps		
MOTOR RATED ARM AMPS (P.008)	0 to 3000.0 amps	8.0 amps		
MOTOR RATED ARM VOLTS (P.009)	160 to 675 volts	240 volts		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
NEG CURRENT LIM SEL (P.224)	<ul style="list-style-type: none"> • REGISTER • ANALOG IN 1 • ANALOG IN 2 • NETW IN REG 1 • NETW IN REG 2 • NETW IN REG 3 	REGISTER		
NEGATIVE CURRENT LIM (P.006)	<p>When NEG CUR LIM INV EN (P.226) = ENABLED: 0 to MAXIMUM CURRENT (%FLA)</p> <p>When NEG CUR LIM INV EN (P.226) = DISABLED: –MAXIMUM CURRENT to 0 (%FLA)</p>	±150 %FLA		
NEG CUR LIM INV EN (P.226)	<ul style="list-style-type: none"> • DISABLED • ENABLED 	ENABLED		
NETW COMM LOSS SELECT (P.901)	<ul style="list-style-type: none"> • FAULT • USE LAST REF • USE TRMBLK REF • USE TRMBLK CNTL 	FAULT		
NETW CONNECT TYPE (P.910)	<ul style="list-style-type: none"> • BASIC • FULL 	BASIC		
NETW DROP NUMBER (P.900)	<p>For AutoMax Network Communication kit: 1 to 55 if NETW CONNECT TYPE = BASIC; 1 to 52 if NETW CONNECT TYPE = FULL</p> <p>For DeviceNet Interface kit: 0 to 63 (NETW CONNECT TYPE value does not affect)</p> <p>For ControlNet Network Communication kit: 1 to 99 (NETW CONNECT TYPE value does not affect)</p>	1		
NETW OUT REG 1 SELECT (P.902)	–32768 to 32767	0		
NETW OUT REG 2 SELECT (P.903)	–32768 to 32767	0		
NETW OUT REG 3 SELECT (P.904)	–32768 to 32767	0		
NETW REGISTER MAP SEL (P.914)	<ul style="list-style-type: none"> • 1 = ORIGINAL • 2 = ALTERNATE 	1		
NETWORK BAUD RATE (P.912)	<ul style="list-style-type: none"> • 0.0 Kbaud • 125.0 Kbaud • 250.0 Kbaud • 500.0 Kbaud 	0.0 Kbaud		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
NOMINAL AC LINE FREQ (P.306)	48 to 62 Hz	60 Hz		
NOMINAL AC LINE VOLTS (P.307)	200 to 575 VAC	230 VAC		
NORMALIZED INERTIA (P.222)	0.05 to 65.20 seconds	1.00 second		
OCL FEEDBACK SELECT (P.804)	<ul style="list-style-type: none"> • NONE • CML FEEDBACK • ANALOG IN 1 • ANALOG IN 2 • 5 = SPEED LOOP OUTPUT • 6 = ANALOG AUTO REFERENCE • 7 = NETWORK IN REG 1 • 8 = NETWORK IN REG 2 • 9 = NETWORK IN REG 3 	NONE		
OCL LEADLAG LOW FREQ (P.806)	0.01 to 34.90 RAD/S	1.00 RAD/S		
OCL LEADLAG RATIO (P.807)	2 to 20	10		
OCL LEADLAG SELECT (P.805)	<ul style="list-style-type: none"> • LEAD/LAG • BYPASS • LAG/LEAD 	BYPASS		
OCL PI LEAD FREQ (P.809)	0.00 to 141.37 RAD/S	1.00 RAD/S		
OCL PI NEGATIVE LIMIT (P.811)	0 to 100% of TOP SPEED (P.011)	100%		
OCL PI POSITIVE LIMIT (P.810)	0 to 100% of TOP SPEED (P.011)	100%		
OCL PI PROP GAIN (P.808)	0.10 to 128.00	2.00		
OCL PROP TRIM SELECT (P.813)	DISABLED ENABLED	DISABLED		
OCL REF RAMP TIME (P.802)	0.0 to 300.0 seconds	10.0 seconds		
OCL REF REGISTER (P.801)	-4095 to 4095	0		
OCL REF ROUNDING (P.803)	0 to 50%	0%		
OCL REFERENCE SELECT (P.800)	<ul style="list-style-type: none"> • REGISTER • ANALOG IN 1 • ANALOG IN 2 • FREQUENCY IN • NETW IN REG 1 • NETW IN REG 2 • NETW IN REG 3 	REGISTER		
OCL TRIM RANGE (P.812)	-100. to 100.0% of TOP SPEED (P.011)	0.0%		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
OCL TYPE3 POSN REG EN (P.814)	<ul style="list-style-type: none"> • DISABLED • ENABLED 	DISABLED		
OPEN SCR SENSITIVITY (P.600)	0 to 100%	50%		
OPEN SCR TRIP THRESH (P.601)	800 to 4000	1600		
PHASE FIRE TEST DELTA (P.309)	0 to 180 DEGREE	0 DEGREE		
PHASE FIRE TST BRIDGE (P.310)	<ul style="list-style-type: none"> • OFF • ON 	OFF		
PHASE LOSS DETECT EN (P.609)	<ul style="list-style-type: none"> • DISABLE • ENABLE 	ENABLE		
PLL MAXIMUM ERROR (P.308)	2 to 1000 μ sec	2 μ sec		
POS CURRENT LIM SEL (P.223)	<ul style="list-style-type: none"> • REGISTER • ANALOG IN 1 • ANALOG IN 2 • NETW IN REG 1 • NETW IN REG 2 • NETW IN REG 3 	REGISTER		
POSITIVE CURRENT LIM (P.005)	0 to MAXIMUM CURRENT (%FLA)	150 %FLA		
PRESET SPEED 1 (P.117)	MINIMUM SPEED to MAXIMUM SPEED (RPM or user-defined units)	250 RPM		
PRESET SPEED 2 (P.118)	MINIMUM SPEED to MAXIMUM SPEED (RPM or user-defined units)	250 RPM		
PRESET SPEED 3 (P.119)	MINIMUM SPEED to MAXIMUM SPEED (RPM or user-defined units)	250 RPM		
PULSE TACH PPR (P.207)	18 to 2500 PPR	18 PPR		
PULSE TACH QUADRATURE (P.208)	<ul style="list-style-type: none"> • ON • OFF 	ON		
RAMP STOP DECEL TIME (P.018)	0.1 to 300.0 seconds	5.0 seconds		
REVERSE DISABLE (P.015)	<ul style="list-style-type: none"> • OFF • ON 	OFF		
S-CURVE ROUNDING (P.014)	0 to 50%	0%		
SELF TUNE BRIDGE (P.220)	<ul style="list-style-type: none"> • FORWARD • REVERSE 	FORWARD		
SELF TUNE FIELD RANGE (P.218)	0.90 to 5.00	1.00		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
SELF TUNE STABILITY (P.219)	10 to 100	25		
SPD LEADLAG LOW FREQ (P.214)	0.01 to 69.81 RAD/S when: <ul style="list-style-type: none"> • FEEDBACK SELECT (P.200) = ARMATURE VOLT • SPD LOOP SCAN TIME (P.019) = 10 MS 0.01 to 139.62 rad/s when: <ul style="list-style-type: none"> • FEEDBACK SELECT (P.200) ≠ ARMATURE VOLT • SPD LOOP SCAN TIME (P.019) = 5 MS 	1.00 RAD/S		
SPD LEADLAG RATIO (P.213)	2 to 20	2		
SPD LEADLAG SELECT (P.216)	<ul style="list-style-type: none"> • LEAD/LAG • BYPASS • LAG/LEAD 	BYPASS		
SPD LOOP LAG BYPASS (P.217)	<ul style="list-style-type: none"> • ON • OFF 	ON		
SPD LOOP LAG FREQ (P.215)	.001 to 139.62 RAD/S when: <ul style="list-style-type: none"> • FEEDBACK SELECT (P.200) = ARMATURE VOLT • SPD LOOP SCAN TIME (P.019) = 10 MS 0.01 to 279.67 rad/s when: <ul style="list-style-type: none"> • FEEDBACK SELECT (P.200) ≠ ARMATURE VOLT • SPD LOOP SCAN TIME (P.019) = 5 MS 	1.00 RAD/S		
SPD LOOP PI INIT SEL	<ul style="list-style-type: none"> • 0 = ZERO • 1 = SPD LOOP PI INITI VAL • 2 = ANALOG MAN TRIM REF (P.194) 	0		
SPD LOOP PI INIT VAL	-32768 to 32767	0		
SPD LOOP PI LEAD FREQ (P.212)	.001 to 282.74 RAD/S when: <ul style="list-style-type: none"> • FEEDBACK SELECT (P.200) = ARMATURE VOLT • SPD LOOP SCAN TIME (P.019) = 10 MS 0.01 to 327.67 rad/s when: <ul style="list-style-type: none"> • FEEDBACK SELECT (P.200) ≠ ARMATURE VOLT • SPD LOOP SCAN TIME (P.019) = 5 MS 	3.00 RAD/S		
SPD LOOP PI PROP GAIN (P.211)	0.10 to 128.00	4.40		

Table C.1 – Parameter Settings Quick Reference Table (Continued)

Parameter	Parameter Selection/ Adjustment Range	Initial Factory Setting (Default)	Your Data	
			Date	Setting
SPD LOOP PI RESET	<ul style="list-style-type: none"> • 0 = OFF • 1 = ON 	0		
SPD LOOP SCAN TIME	<ul style="list-style-type: none"> • 5 msec • 10 msec 	5 msec		
SPEED FEEDBACK GAIN	1000 to 32000	1000		
STOP DECEL SELECT (P.122)	<ul style="list-style-type: none"> • 1 = DECELERATION TIME • 2 = RAMP STOP DECEL TIME 	1		
STOP MODE SELECT (P.114)	<ul style="list-style-type: none"> • RAMP • COAST/DB • CURRENT LIMIT 	COAST/DB		
STOP SPEED THRESHOLD (P.113)	0 to MAXIMUM SPEED (RPM or user-defined units)	50 RPM		
TACH LEAD FLT DELAY (P.228)	0 to 32767 msec	10000 msec		
TACH LEAD FLT THRESH (P.227)	0.0 to 250.0% of TOP SPEED	200.0%		
TACH LOSS SCR ANGLE (P.608)	0 to 127 DEGREE	109 DEGREE		
TOP SPEED (P.011)	5 to 5000 RPM	500 RPM		
TRIM MODE SELECT (P.110)	<ul style="list-style-type: none"> • NO TRIM • INCREMENTAL • PROPORTIONAL 	NO TRIM		
TRIM RANGE (P.109)	0.0 to 100.0%	0.0%		
TRIM REFERENCE SELECT (P.108)	<ul style="list-style-type: none"> • ANALOG MANUAL • REGISTER • ANALOG IN 1 • NETW IN REG 1 • NETW IN REG 2 • NETW IN REG 3 • ANALOG IN 2 	REGISTER		
TRIM REF REGISTER (P.107)	±100.0%	0%		
UNDERWIND ENABLE	<ul style="list-style-type: none"> 0 = DISABLED (overwind) 1 = ENABLED (underwind) 	0		

Table C.2 – Jumper Settings

Jumper Number	Jumper Name	Default Setting	Final Setting
J15	REGULATOR TYPE	SPEED	
J16	OIM PROGRAM	ENABLE	
J20	FIELD LOSS DETECT	ENABLE	
J21	FIELD SUPPLY	NOT APPLICABLE ¹	
J19	MANUAL REF	POT	
J14	TACH V RANGE	62	
J11	TACH V SCALE	16	
J10	AUTO REF	VOLTS	
J12	AUTO REF	VOLTS	
J18	ARM I FB RB	Position 4	

¹Only applicable when the optional Enhanced Field Supply kit is installed

APPENDIX D

Numeric Parameter List

This list is provided as a convenience for finding specific parameter descriptions. For an alphabetic listing, see the index.

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006	NEGATIVE CURRENT LIM	5-16
007	MAXIMUM CURRENT	6-2
008	MOTOR RATED ARM AMPS	6-8
009	MOTOR RATED ARM VOLTS	5-5
010	CT TURNS RATIO	6-8
011	TOP SPEED	4-24
012	JOG SPEED 1	4-27
013	JOG ACCEL/DECEL TIME	4-26
014	S-CURVE ROUNDING	4-21
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017	JOG SPEED 2	4-27
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019	SPD LOOP SCAN TIME	5-2
100	ANLG AUTO SIGNAL TYPE	4-5
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102	ANLG AUTO ZERO ADJ	4-5
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109	TRIM RANGE	4-15
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111	AUTO MODE MIN BYPASS	4-18
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113	STOP SPEED THRESHOLD	4-23
114	STOP MODE SELECT	4-23
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118	PRESET SPEED 2	4-12
119	PRESET SPEED 3	4-12
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121	JOG OFF DELAY TIME	4-27
122	STOP DECEL SELECT	4-22
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189	TORQUE REFERENCE	6-5
191	MOP OUTPUT	4-10
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199	SPEED RAMP OUTPUT	4-22
200	FEEDBACK SELECT	5-3
201	ANALOG TACH GAIN ADJ	5-7
202	ANALOG TACH ZERO ADJ	5-7
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204	ARM VOLTAGE GAIN ADJ	5-4
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514	FIELD PI PROP GAIN	8-6
515	FIELD PI LEAD FREQ	8-6
516	FLD FEEDBACK GAIN ADJ	8-7
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518	FLD WEAKEN THRESHOLD	8-10
519	FLD WEAKEN PROP GAIN	8-10
520	FLD WEAKEN LEAD FREQ	8-10
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802	OCL REF RAMP TIME	9-5
803	OCL REF ROUNDING	9-6
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805	OCL LEADLAG SELECT	9-11
806	OCL LEADLAG LOW FREQ	9-10
807	OCL LEADLAG RATIO	9-11
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902	NETW OUT REG 1 SELECT	10-4
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GLOSSARY

altitude - The atmospheric altitude (height above sea level) at which the motor or drive will be operating.

armature -The portion of the DC motor that rotates.

armature resistance - Measured in ohms at 25 degrees Celsius (cold).

base speed - The speed that a DC motor develops at rated armature voltage and rated field current with rated load applied. Typically nameplate data.

configurable - Input parameter whose values can only be modified while the drive is stopped (not running or jogging).

constant speed - Used to describe a motor that changes speed only slightly from a no-load to a full-load condition.

DC motor - A motor using either generated or rectified DC power. A DC motor is usually used when variable speed operation is required.

DB - Dynamic Braking.

default value - Parameter values that are stored in the drive's read-only memory (ROM).

drive - Power converting equipment supplying electrical power to a motor.

efficiency - The ratio of mechanical output to electrical input. It represents the effectiveness with which the motor converts electrical energy to mechanical energy.

field - A term commonly used to describe the stationary (stator) member of a DC motor. The field provides the magnetic field with which the mechanically rotating (armature or rotor) member interacts.

horsepower - The measure of the rate of work. One horsepower is equivalent to lifting 33,000 pounds to a height of one foot in one minute. The horsepower of a motor is expressed as a function of torque and RPM. For motors, you can approximate horsepower using this formula:

$$HP = T \times \frac{RPM}{5250}$$

where:

- HP = horsepower
- T = Torque (in lb-ft)
- RPM = revolutions per minute

inertial load - A load (such as flywheel or fan) that tends to cause the motor shaft to continue to rotate after power has been removed (stored kinetic energy). If this continued rotation cannot be tolerated, some mechanical or electrical braking means must be applied. This application might require a special motor due to the energy required to accelerate the inertia. Inertia is measured in either lb-ft² or oz-in².

$$\text{Inertia Reflected to the Shaft of the Motor} = \text{Load Inertia} \times \left(\frac{\text{Load RPM}}{\text{Motor RPM}} \right)^2$$

input parameter - You can change the value of the parameter through the OIM.

LCD - Liquid Crystal Display.

LED - Light Emitting Diode.

motor - A device that converts electrical energy to mechanical energy to turn a shaft.

motor electrical time constant - The ratio of electrical inductance (L_a) to armature resistance (R_a).

motor identification -

- Frame designation (actual frame size in which the motor is built)
- Horsepower, speed, design and enclosure
- Voltage, frequency and number of phases of power supply
- Class of insulation and time rating
- Application

motor nameplate - The plate on the outside of a motor that describes the motor, HP, voltage, RPM, efficiency, design, enclosure, etc.

motor thermostat - Unit applied directly to the motor's windings that senses winding temperature and might automatically break the circuit in an overheating situation.

non-retentive - Changes to the parameter value are not saved when power is removed.

output parameter - Provides output information. Value cannot be changed through the OIM.

power (P) in kW - The measure of the rate of work. One kilowatt (kW) is equivalent to lifting 98 kg to a height of one meter in one second. The kW rating of a motor is expressed as a function of torque and RPM. For motors, you can use this approximate formula:

$$P = T \times \frac{\text{RPM}}{9550}$$

where:

- P = horsepower
- T = Torque (in Nm)
- RPM = revolutions per minute

rated full load current - Armature current in amperes.

retentive - Parameter value is stored in the drive even when power is off. To save changes to the values, a Memory Save must be performed before removing power.

RPM - revolutions per minute. The number of times per minute the shaft of the motor (machine) rotates.

service factor (SF) - When used on a motor nameplate, a number that indicates how much above the nameplate rating a motor can be loaded without causing serious degradation. For example, a 1.15 SF can produce 15% greater torque than a 1.0 SF rating of the same motor.

tachometer - Normally used as a rotation sensing device. Tachometers are typically attached to the output shaft of a motor requiring close speed regulation. The tachometer feeds its signal to a control loop, which adjusts its input to the motor accordingly.

top speed - The highest speed a drive can achieve. Top speed equals base speed when there is no field weakening.

torque - Turning force delivered by a motor or gearmotor shaft, usually expressed in pounds-feet or newton-meters:

$$\text{lb-ft} = \text{HP} \times \frac{5250}{\text{RPM}} = \text{Full Load Torque}$$

$$\text{Nm} = \text{P(kW)} \times \frac{9550}{\text{RPM}} = \text{Full Load Torque}$$

tunable - Input parameter whose value can be modified at any time (when the drive is stopped, running, or jogging).

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