GEH-6385

GE Industrial Systems

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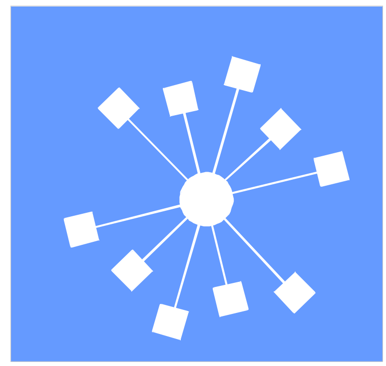

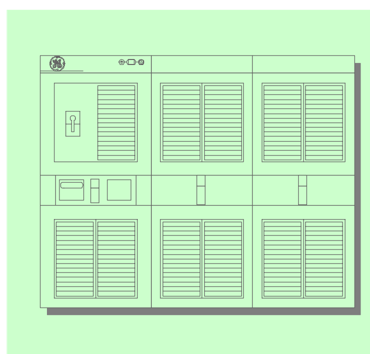

Innovation Series™

Medium Voltage – GP Type G Drives

Reference and Troubleshooting
2300 V Drives

GE Industrial Systems

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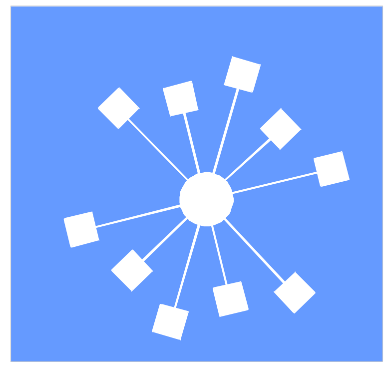

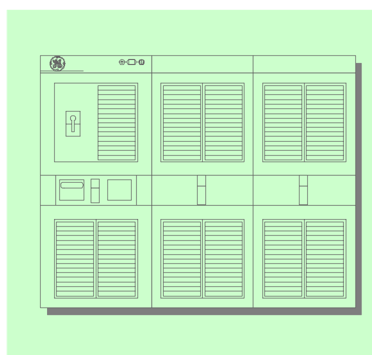

Innovation Series™

Medium Voltage – GP Type G Drives

Reference and Troubleshooting 2300 V Drives

Innovation Series

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Safety Symbol Legend

Warning	**Indicates a procedure, condition, or statement that, if not strictly observed, could result in personal injury or death.**

Caution	**Indicates a procedure, condition, or statement that, if not strictly observed, could result in damage to or destruction of equipment.**

Note Indicates an essential or important procedure, condition, or statement.

Warning

This equipment contains a potential hazard of electric shock or burn. Only personnel who are adequately trained and thoroughly familiar with the equipment and the instructions should install, operate, or maintain this equipment.

Isolation of test equipment from the equipment under test presents potential electrical hazards. If the test equipment cannot be grounded to the equipment under test, the test equipment's case must be shielded to prevent contact by personnel.

To minimize hazard of electrical shock or burn, approved grounding practices and procedures must be strictly followed.

Warning

To prevent personal injury or equipment damage caused by equipment malfunction, only adequately trained personnel should modify any programmable machine.

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Chapter 1 Overview

Introduction

This document provides reference and troubleshooting information for the 2300 V model of the Innovation Series™ Medium Voltage – GP Type G drives. The purpose of the document is to assist installation and maintenance technicians in understanding the drive's diagnostic and configuration software, as well as using fault codes to troubleshoot drive problems.

Chapter 1 defines the document contents. Its purpose is to present a general product overview for the reader, as follows:

Chapter 2, Faults and Troubleshooting, lists and defines drive fault messages, with troubleshooting suggestions if a fault occurs.

Chapter 3, Functions/Parameters, lists and describes the drive application program functions, including input parameters, output variables, and configuration.

Chapter 4, Wizards, describes in detail the automated Windows-based "forms" that guide the user through drive configuration and tuneup.

Chapter 5, Signal Mapping, describes LAN interfaces and parameter configuration for variable signal mapping.

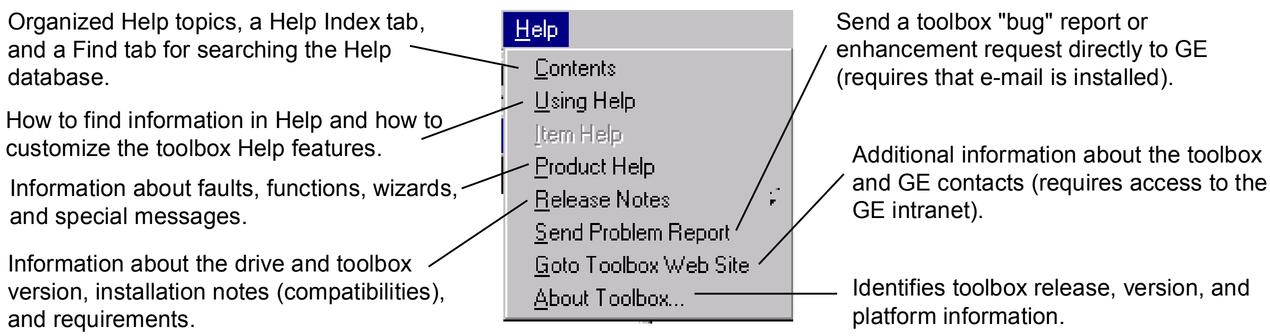
Note The information in Chapters 2, 3, and 4 is duplicated from the GE Control System Toolbox's online Help files. This document, GEH-6385, is provided as assistance when the toolbox is not available or was not purchased with the drive system. (Refer to *Using Toolbox Help for Reference and Troubleshooting* in this chapter.)

Using Toolbox Help for Reference and Troubleshooting

GE document GEH-6401 describes toolbox features and use.

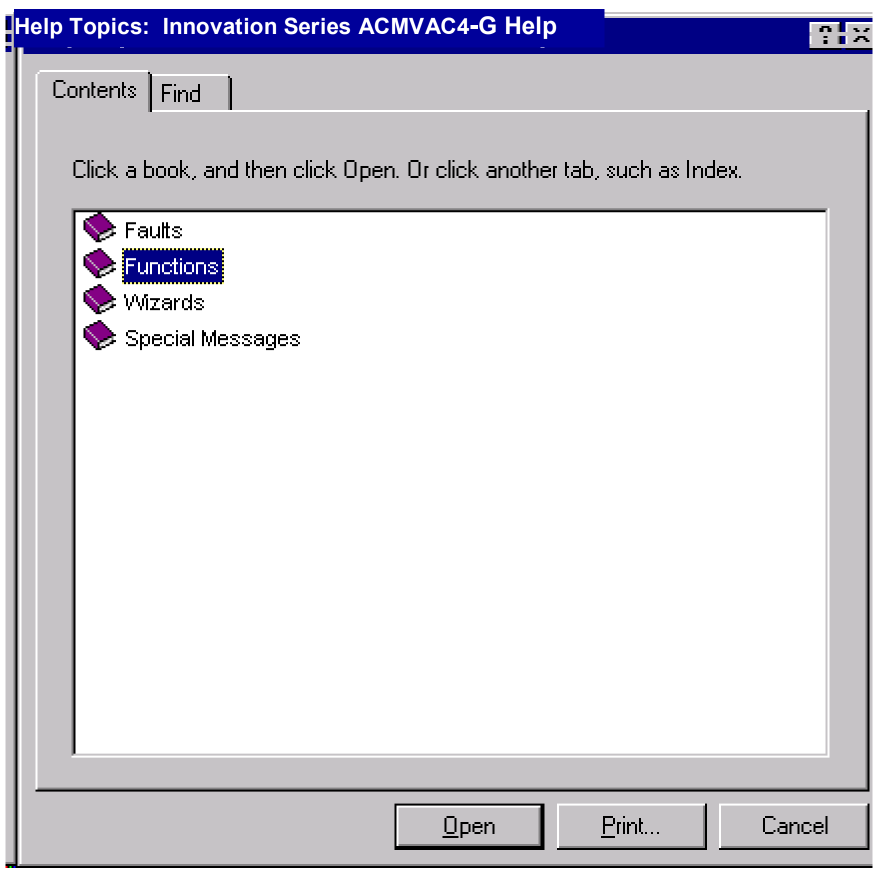
The GE Control System Toolbox is an **optionally** purchased drive configuration program used to tune and commission the drive as needed for each application. The toolbox provides Microsoft® Windows®-based menus, block diagrams, dialog boxes, and wizards on a PC-based drive interface.

When you choose **Help** on the toolbox main menu bar, a drop-down menu provides several options for finding information.



From that menu, select **Product Help** to access online help files that contain the **fault, function,** and **wizard** information provided in this manual.

Drive firmware and associated reference files may change with product upgrades and revisions. The information provided in this document, GEH-6385, is current at the time of its issue. However, the toolbox Help files provided with your drive may be a more current representation of your drive configuration.



Related Documents

If needed for supplementary information, refer to the following documents for the Innovation Series Medium Voltage – GP Type G drives, as applicable:

GEH-6381, Installation and Startup

GEH-6382, User's Guide

GEH-6401, Control System Toolbox

How to Get Help

If help is needed beyond the instructions provided in the documentation, contact GE as follows:

"+" indicates the international access code required when calling from outside of the USA.

GE Industrial Systems
Product Service Engineering
1501 Roanoke Blvd.
Salem, VA 24153-6492 USA

Phone: + 1 800 533 5885 (United States, Canada, Mexico)
+ 1 540 378 3280 (International)
Fax: + 1 540 387 8606 (All)

Notes

Chapter 2 Faults and Troubleshooting

Introduction

For information on using the keypad refer to the drive User's Guide, GEH-6382.

GEH-6401 describes the toolbox.

The drive software includes selftest diagnostics to aid in troubleshooting. When these tests detect an unfavorable condition, they output fault indications to the drive's operator interfaces: the door-mounted Drive Diagnostic Interface (DDI, referred to as the *keypad*) or a connected PC running the GE Control System Toolbox (the *toolbox*). An operator can then use either interface to examine the fault and clear it, as applicable.

This chapter lists and defines the relevant fault messages for the drive, with troubleshooting suggestions. It is organized as follows:

Warning

This equipment contains a potential hazard of electric shock or burn. Only adequately trained persons who are thoroughly familiar with the equipment and the instructions should maintain this equipment.

Types of Faults

There are currently two types of fault conditions:

- **Alarm faults** indicate conditions that you should note, but that are not serious enough to automatically shut down or trip the drive. If the condition goes away, some alarm faults clear themselves and the display then identifies the alarm as *brief*. Otherwise, you must stop the drive to clear this type of fault.
- **Trip faults** indicate a more serious condition that needs to be corrected. Therefore, it trips the drive. The drive should not be restarted until the condition is corrected.

You can clear most faults by selecting *Clear Faults* on the drive's keypad or in the (optional) toolbox program.

Fault Indication

The DSPX board is the IS200DSPX Digital Signal Processor, located in the drive control rack.

The drive indicates a fault condition on the keypad, toolbox display, and on the DSPX board.

On the keypad, a fault icon appears in the right side of the display: The operator can then use the keypad to access the fault/alarm description (see Figure 5-1) and to clear the fault.

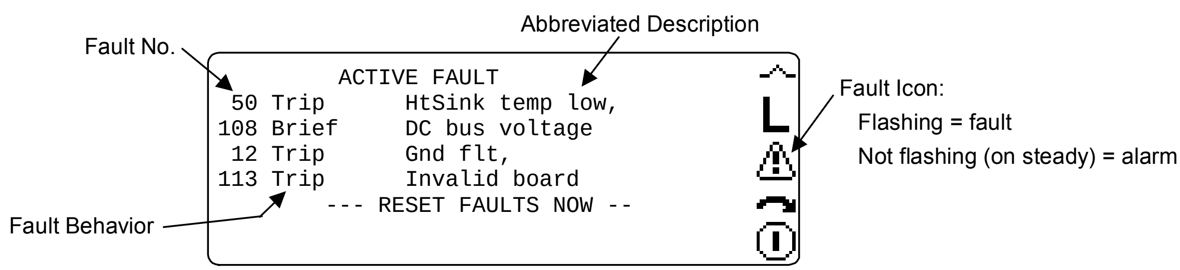


Figure 2-1. Sample Fault Display Screen on Keypad

The toolbox uses a Windows®-based PC display. When a fault occurs, the word *Alarm* or *Trip* appears in the lower right corner of the screen. You can view a description and clear the fault using the toolbox functions. (GE publication GEH-6401 describes these tools and this feature.)

The **DSPX Fault LED** displays at the front of the drive's control rack. This red indicator is on solid for a fault and flashes for an alarm.

A fault is identified by an assigned **number** and abbreviated **description**. Both of these are displayed when an operator examines a fault using the keypad (see Figure 2-1) or the toolbox.

Table 2-1 lists the drive faults and their probable cause.

Fault Descriptions

Note When troubleshooting leads to a hardware inspection or component replacement, be sure to follow the procedures described in the drive *User's Guide, GEH-6382*. This will help ensure that the equipment operates correctly.

Caution

When troubleshooting leads to a hardware inspection or component replacement, be sure to follow the procedures described in the drive *User's Guide, GEH-6382*. This will help prevent damage caused by incorrect installation and ensure that the equipment operates correctly.

Table 2-1. Fault Definitions and Probable Cause

No.	Name	Type	Description
1	*CPFP isolation lost*	Trip	The *CPFP isolation lost* trip fault is hardware generated. The CPFP power supply isolation card is indicating that power supply isolation to the phase modules has been compromised. The CPFP card is designed to provide control power to circuit cards in the high voltage compartment. This card has a double voltage barrier that isolates the phases from each other and from the control. This fault indicates that one of these voltage barriers has failed. This is a dangerous situation since failure of the second barrier could cause dangerous voltages to conduct into the control cabinet or cause a phase-phase short on the CPFP card. The fault is generated when the status light conducted via fiber from the CPFP goes out. The fiber connects CPFP (PWR OK) to FOSA (SPARE-R). Check that the fiber is installed correctly. Disconnect the fiber from FOSA and look for the status light traveling up the fiber. If you do not see a light then the problem is on CPFP. If there is light then the problem is on FOSA or BICM. ***Primary causes:*** CPFP power supply failure Fiber not connected ***Possible board failures:*** CPFP FOSA BICM ***Possible wiring faults:*** Power distribution wiring to CPFP.
2	*Illegal seq state*	Trip	The *Illegal seq state* trip fault occurs when the sequencer state (variable *Sequencer state*) is unrecognized. This trip may occur during system development but should not occur in the field.

No.	Name	Type	Description
3	*Cont failed to close*	Trip	The *Cont failed to close* trip fault occurs when contactor A is commanded to open or close and fails to do so within the allowed time (defined by parameter *MA pickup time*). ***Primary causes:*** The contactor A feedback is missing or bad. ***Possible configuration faults:*** The allowed time for contactor A to open and close is too short. The allowed time is represented by parameter *MA pickup time*. Contactor A feedback is enabled when no contactor is present in the system. In the absence of the contactor, parameter *MA contactor fbk* should be set equal to Disable. ***Related functions:*** *Main Contactor Configuration*
4	*Local flt*	Trip	The *Local flt* trip fault occurs when the local permissive circuit is open and a *Run request*, *Jog request*, *Full flux request*, or diagnostic test (cell test, pulse test, autotune) request is issued. ***Possible wiring faults:*** The connections to ATBA terminal board locations 8 (L115), 10 (L24), and 12 (LCOM) are missing or damaged. The connection to backplane connector J2 is missing or damaged.
5	*Tool requested trip*	Trip	The *Tool requested trip* trip fault is generated from the engineering monitor issuing the “uf” command. It is for test purposes only.
6	*Run cmd during init*	Alarm	The *Run cmd during init* alarm occurs when a *Run request*, *Jog request*, *Full flux request*, or diagnostic test (cell test, pulse test, autotune) request is issued during drive initialization. When the alarm occurs, the request to perform a drive action is ignored. ***Primary causes:*** The external application layer issues a request to perform a drive action during drive initialization. An external input (i.e. digital input) used to request a drive action was high during drive initialization.
7	*Over speed*	Trip	The *Over speed* trip fault occurs when the magnitude of speed (variable *Speed reg fbk*) is greater than the over speed threshold (parameter *Over speed flt level*). ***Primary causes:*** Motor speed is too high. ***Possible configuration faults:*** Parameter *Over speed flt level* is set too low. ***Related functions:*** *Speed Control Fault Check*
8	*Timed over current*	Trip	The *Timed over current* trip fault occurs when one of the squared phase currents (variables *Ia^2 filtered*, *Ib^2 filtered*, and *Ic^2 filtered*) in the timed over current detection model exceeds the timed over current threshold level. This fault indicates that the motor has exceeded its thermal limit.
9	*EE flash corrupted*	Trip	The *EE flash corrupted* trip fault occurs when the memory containing the drive parameters is determined to be bad during drive initialization. *EE flash corrupted* requires a hard reset to clear. ***Possible board failures:*** DSPX

No.	Name	Type	Description
10	*Run cmd w high flux*	Alarm	The *Run cmd w high flux* alarm occurs when a *Run request*, *Jog request*, *Full flux request*, or diagnostic test (cell test, pulse test, autotune) request is issued and the variable *Flux reference* is greater than 2 percent rated flux (*100% Flux*). ***Primary causes:*** An attempt is made to restart the drive quickly. Normally four rotor time constants are required to allow the flux to decay after the drive stops running. ***Related functions:*** *Sequencer Permissives*
11	*EE erase failed*	Alarm	The *EE erase failed* trip fault occurs when the preparation of memory for the next parameter save operation fails to happen satisfactorily. The next parameter save operation is expected to be invalid, and the integrity of future parameter save operations are in doubt. *EE erase failed* requires a hard reset to clear. ***Possible board failures:*** DSPX
12	*Gnd flt, coarse*	Trip	The *Gnd flt, coarse* trip fault occurs when a large ground current is detected. The trip fault occurs when the magnitude of the sum of the three phase currents is too large.
13	*Vdc Fbk voltage trim*	Alarm	The *Vdc Fbk voltage trim* alarm occurs when the automatic Vdc feedback trim function on the BICM is not functioning correctly. You will not receive this warning unless you are using drive firmware version V02.21.00B or higher AND you have a BICMH1AB version card or higher. Older versions of software and hardware suffer from Vdc feedback inaccuracy, which can lead to problems in some circumstances. Getting the trim function to operate properly is important to optimum performance of the drive. There are several situations that can lead to this alarm. First, make sure you have run the *Cell Test Wizard* (either fiber optic test or bridge cell test) at least once when the DC link is fully discharged (<100V). This wizard calibrates the DC bus feedback and saves a parameter in the drive. This procedure does not need to be repeated unless hardware has changed in the drive or the previously saved parameter was overwritten by a parameter downloaded from the toolbox. If this procedure has not been performed then this alarm is generated. Second, make sure that JP1 on the BICMH1AB card has been moved to the non-default position. This jumper enables the circuit that this alarm is concerned with. The jumper JP1 being in the dashed-box indicates the non-default position. The jumper being in the solid box indicates the default position. The default position is used only when the card is placed in drives that have software versions prior to V02.21.00B If both if these steps fail to clear this alarm then your BICM card may be defective. Primary board failures BICM
14	*Cap buff init failed*	Alarm	The capture buffer initialization has failed to allocate enough memory to run the capture buffer. The capture buffer has been disabled and will not run. However the drive should operate normally. A new version of firmware is required to correct this problem.
15	*MA cont not closed*	Trip	The *MA cont not closed* trip fault occurs when the MA feedback indicates that the MA contactor is open when it is commanded to close.

No.	Name	Type	Description
16	*Illegal req for xfer*	Alarm	The *Illegal req for xfer* alarm occurs when a motor transfer command is issued and a trip fault is present in the drive. The alarm may also occur when a motor transfer command is issued at the same time a diagnostic test (cell test, pulse test, autotune) is active. ***Primary causes:*** The external application layer issues an inappropriate motor transfer request.
17	*Transfer req aborted*	Trip	The *Transfer req aborted* trip fault occurs when the motor control is unable to synchronize to the utility line in the allotted time in response to a motor transfer request.
18	*Tune up failed*	Trip	The *Tune up failed* trip fault occurs when an attempt to run the motor control tune up or the speed regulator tune up fails. ***Primary causes:*** The external application layer issues an inappropriate motor control tune up request or speed regulator tune up request. An attempt by the motor control tune up or the speed regulator tune up to initialize the diagnostic message stack fails.
19	*Ext ref out of range*	Alarm	The *Ext ref out of range* alarm occurs when the external line reference voltage is outside of the allowable range.
20	*TOC pending*	Alarm	The *TOC pending* alarm occurs when one of the squared phase currents (variables *Ia^2 filtered*, *Ib^2 filtered*, and *Ic^2 filtered*) in the timed over current detection model exceeds the timed over current alarm level. This alarm indicates that the motor is nearing its thermal limit.
21	*System flt*	Trip	The *System flt* trip fault occurs when the system permissive circuit is open and a *Run request*, *Jog request*, *Full flux request*, or diagnostic test (cell test, pulse test, autotune) request is issued. ***Possible wiring faults:*** The connections to ATBA terminal board locations 2 (S115), 4 (S24), and 6 (SCOM) are missing or damaged..
22	*Run before MA closed*	Trip	The *Run before MA closed* trip fault occurs when a *Run request*, *Jog request*, or *Full flux request* is issued to the motor control sequencer before contactor A is closed. ***Related functions:*** *Sequencer Permissives* *Main Contactor Configuration*
23	*Flying restrt disabl*	Trip	The *Flying restrt disabl* trip fault occurs when a *Run request*, *Jog request*, *Full flux request*, or diagnostic test (cell test, pulse test, autotune) request is issued when the motor is not at zero speed. *Flying restrt disabl* can be turned off and the drive allowed to start when the motor is not at zero speed by placing the drive in flying restart mode. Flying restart mode is enabled by setting parameter *Flying restart* equal to *Enable fly restart*. ***Related functions:*** *Sequencer Permissives*

No.	Name	Type	Description
24	*Power dip*	Trip	The *Power dip* trip fault occurs when the DC link voltage feedback (variable *DC bus voltage*) falls below the power dip level and remains below the power dip level longer than the power dip time. The power dip time is configurable through parameter *Power dip control*. If the DC link voltage feedback is at some moments below the power dip level and at some moments above the power dip level, the trip fault can occur. If over any time interval the DC link feedback spends more time below the power dip level than above the power dip level, and the time difference is greater than the power dip time, *Power dip* occurs. ***Possible configuration faults:*** Power dip functionality is disabled because parameter *Power dip control* is set incorrectly. To enable power dip functionality parameter *Power dip control* should be set equal to *0.500 sec (Enable)*. ***Related functions:*** *Power Dip Protection*
25	*Cur reg in limit*	Alarm	The *Cur reg in limit* alarm occurs when the X and/or Y current regulator output enter limits for more than 1 sec. It is cleared when the X and/or Y current regulator come out of limit for more than of equal to 1 sec. ***Primary causes:*** The tachometer feedback is bad. Large motor parameters errors. Motor inverter connection opens while running. Power dip. Loss of current feedback.
26	*Volt reg in limit*	Alarm	The *Volt reg in limit* alarm occurs when the X and/or Y voltage regulator output enter limits for more than 1 sec. It is cleared when the X and/or Y voltage regulator come out of limit for more than of equal to 1 sec. ***Primary causes:*** Motor inverter connection opens while running. Power dip. Loss of voltage feedback.
28	*R1 meas in limit*	Alarm	The *R1 meas in limit* alarm occurs when the total primary resistance measured during drive pre-flux is outside of a reasonable bound. The total primary resistance consists of the stator and cable resistances. When the fault condition is present, the motor control does not use the resistance measurement.
29	*R2 meas in limit*	Alarm	The *R2 meas in limit* alarm occurs when the online calculation of rotor resistance exceeds the positive or negative saturation level. The saturation levels are 80 percent and -40 percent. ***Primary causes:*** The rotor resistance calculation is incorrect due a large error in motor parameters.
30	*Tach loss trip*	Trip	The *Tach loss trip* fault occurs when the difference between the tachometer feedback (variable *Motor speed*) and the estimated speed (variable *Calculated speed*) is too large. The trip fault can be disabled by setting parameter *Tach loss fault mode* equal to Trip. ***Primary causes:*** The tachometer feedback is bad. The estimated speed is incorrect due to large errors in motor parameters. ***Related functions:*** *Tach Loss Detection*

No.	Name	Type	Description
31	*Tach loss alarm*	Alarm	The *Tach loss alarm* occurs when the difference between the tachometer feedback (variable *Motor speed*) and the estimated speed (variable *Calculated speed*) is too large. When the alarm occurs, the drive dynamically switches to tachless control mode. The drive continues tachless operation until the fault is cleared by an operator. *Tach loss fault mode* can be used to change the fault behavior to trip if required. ***Primary causes:*** The tachometer feedback is bad. The estimated speed is incorrect due to large errors in motor parameters. ***Related functions:*** *Tach Loss Detection*
32	*IOC phase A*	Trip	The *IOC phase A* trip fault is hardware generated. The trip fault occurs when the current measured by the phase A shunt exceeds the instantaneous overcurrent threshold, which is positive or negative 250 percent rated shunt current. It also occurs within 25 microseconds when the phase A current experiences a step change of 100 percent rated shunt. When either condition is detected, the power bridge IGBT gating is disabled immediately. ***Possible board failures:*** SHCA FOSA BICM HFPA (FU4) ***Possible wiring faults:*** Connections between FOSA and SHCA.
33	*IOC phase B*	Trip	The *IOC phase B* trip fault is hardware generated. The trip fault occurs when the current measured by the phase B shunt exceeds the instantaneous overcurrent threshold, which is positive or negative 250 percent rated shunt current. It also occurs within 25 microseconds when the phase B current experiences a step change of 100 percent rated shunt. When either condition is detected, the power bridge IGBT gating is disabled immediately. ***Possible board failures:*** SHCA FOSA BICM HFPA (FU4) ***Possible wiring faults:*** Connections between FOSA and SHCA.
34	*IOC phase C*	Trip	The *IOC phase C* trip fault is hardware generated. The trip fault occurs when the current measured by the phase C shunt exceeds the instantaneous overcurrent threshold, which is positive or negative 250 percent rated shunt current. It also occurs within 25 microseconds when the phase C current experiences a step change of 100 percent rated shunt. When either condition is detected, the power bridge IGBT gating is disabled immediately. ***Possible board failures:*** SHCA FOSA BICM HFPA (FU4) ***Possible wiring faults:*** Connections between FOSA and SHCA.

No.	Name	Type	Description
36	*BICM card clock fail*	Trip	The *BICM card clock fail* trip fault occurs when FPGA logic on the BICM cannot detect the presence of either one of its clock signals. One of the clocks it is looking for is generated by a crystal on the BICM itself and the other is transmitted via the rack backplane from DSPX. ***Primary causes:*** Card or connector failure. ***Possible board failures:*** BICM DSPX CABP (Backplane)
37	*Rack pwr supply lost*	Trip	The *Rack pwr supply lost* trip fault occurs when logic on the BICM cannot detect the presence of one of the power supplies being generated by RAPA. The power supplies monitored include P5, P15, N15 and I24. These supplies are distributed via the backplane to control cards including BICM. I24 is also brought to ATBA for use in customer I/O. ***Primary causes:*** Short across one of the monitored power supplies Power supply module failure ***Possible board failures:*** BICM RAPA CABP (Backplane)
38	*DC bus imbalance*	Trip	The *DC bus imbalance* trip fault occurs when the magnitude of the upper and lower half of the DC bus circuits in the bridge differ by more than 10% of nominal. A typical Nominal DC bus voltage would be 3500V so a difference of around 350V would trigger this trip fault. If the fault occurs immediately after but not during a DC bus charge cycle completes then a ground fault in the input section of the drive should be suspected. Check the transformer secondary windings and the input line filter assemblies for a ground. ***Primary causes:*** One or more failed bleeder resistors (BRES1-6). A ground fault in the input rectifier section A ground fault in a transformer secondary winding.
39	*DC pos bus over volt*	Trip	The *DC pos bus over volt* trip fault is hardware generated. The trip fault occurs when the positive DC link voltage is too large. ***Possible board failures:*** FOSA DSPX
40	*DC neg bus over volt*	Trip	The *DC neg bus over volt* trip fault is hardware generated. The trip fault occurs when the negative DC link voltage is too large. ***Possible board failures:*** FOSA DSPX
41	*DC bus over voltage*	Trip	The *DC bus over voltage* trip fault occurs when the DC link voltage feedback (variable *DC bus voltage*) is too large. The main purpose of the trip fault is to detect excessive and potentially dangerous DC link voltages. When the over voltage condition is detected the power bridge is shut off immediately. ***Possible board failures:*** FOSA DSPX

No.	Name	Type	Description
42	*DC bus under voltage*	Trip	The *DC bus under voltage* trip fault occurs when the DC link voltage feedback (variable *DC bus voltage*) is too low. The trip fault only occurs when the drive is running. ***Possible board failures:*** FOSA DSPX
43	*Ground flt alm, LP*	Alarm	The *Ground flt alm, LP* alarm occurs when a large ground current is detected by the BICM Motor Ground Protection. The alarm occurs when the BICM ground current (variable *Gnd cur signal*) is greater than the BICM ground current alarm level (parameter *Gnd signal alarm on*). *Ground flt alm, LP* clears when the BICM ground current drops below the BICM ground current alarm turn off level (parameter *Gnd signal alarm off*). The alarm can be disabled by inhibiting BICM Motor Ground Protection functionality. Set parameter *Detector mode* equal to *Disable*. ***Possible configuration faults:*** The value of the BICM ground current alarm level, represented by parameter *Gnd signal alarm on*, is too low. ***Possible board failures:*** VATF-MID FOSA BICM DSPX
44	*Ground flt, LP*	Trip	The *Ground flt, LP* trip fault occurs when a large ground current is detected by the BICM Motor Ground Protection. The trip fault occurs when the BICM ground current (variable *Gnd cur signal*) is greater than the BICM ground current trip fault level (parameter *Gnd signal trip lvl*). *Ground flt, LP* can be disabled by inhibiting BICM Motor Ground Protection functionality. Set parameter *Detector mode* equal to *Disable*. ***Possible configuration faults:*** The value of the BICM ground current fault threshold, represented by parameter *Gnd signal trip lvl*, is too low. ***Possible board failures:*** VATF-MID FOSA BICM DSPX
45	*AC filter fuse blown*	Alarm	The *AC filter fuse blown* alarm occurs when the BICM Motor Ground Protection detects that the MOV fuse has blown. The trip fault occurs when the BICM fuse circuit is open. *AC filter fuse blown* can be disabled by inhibiting BICM Motor Ground Protection functionality. Set parameter *Detector mode* equal to *Disable*. ***Possible board failures:*** VATF-MID FOSA BICM DSPX

No.	Name	Type	Description
46	*X stop*	Trip	The *X stop* trip fault occurs when the X stop circuit is open and when X stop is configured as a trip fault. X stop is configured as a trip fault when parameter *X stop mode* is set equal to *Trip flt stop*. Any other setting for parameter *X stop mode* disables the *X stop* trip fault. The state of the X stop circuit is determined by the value of the variable to which parameter *X stop request sel* points. The *X stop* trip fault can be disabled, along with all other X stop behavior, by setting parameter *X stop request sel* equal to Unused. ***Related functions:*** *Stopping Commands and Modes*
47	*Run req & xstop open*	Trip	The *Run req & xstop open* trip fault occurs when the X stop circuit is open, the drive is stopped, and one of the following requests is issued: *Run request*, *Jog request*, or *Full flux request*. The state of the X stop circuit is determined by the value of the variable to which parameter *X stop request sel* points. The trip fault can be disabled, along with all other X stop behavior, by setting parameter *X stop request sel* equal to Unused. ***Related functions:*** *Sequencer Permissives* *Stopping Commands and Modes*
48	*BICM card temp low*	Trip	The *BICM card temp low* trip fault occurs when the sensor on BICM measures a temperature that is –20C or below. *BIC ambient temp* is the variable being monitored to generate this fault. ***Primary causes:*** Failed thermal sensor on BICM. Ambient temperature is too low. ***Possible board failures:*** BICM
49	*HtSink DB temp low*	Trip	The *HtSink DB temp low* trip fault occurs when the dynamic brake heatsink temperature (variable *DB heat sink temp*) is too low. The main purpose of this trip fault is to detect the absence of the thermal sensor input from the heatsink. ***Primary causes:*** The DB heatsink thermal sensor input is not present. No power to TFBA card or TFBA card failure. ***Possible board failures:*** BICM TFBA CPFP ***Possible wiring faults:*** Thermal sensor input to TFBA is missing or damaged. ***Related functions:*** *Heatsink Thermal Protection*

No.	Name	Type	Description
50	*HtSink DS temp low*	Trip	The *HtSink DS temp low* trip fault occurs when the diode source heatsink temperature (variable *DS heat sink temp*) is too low. The main purpose of the fault is to detect the absence of the thermal sensor input from the heatsink. ***Primary causes:*** The DS heatsink thermal sensor input is not present. No power to TFBA card or TFBA card failure. ***Possible board failures:*** BICM TFBA CPFP ***Possible wiring faults:*** Thermal sensor input to TFBA is missing or damaged ***Related functions:*** *Heatsink Thermal Protection*
51	*HtSink A temp low*	Trip	The *HtSink A temp low* trip fault occurs when heatsink A temperature (variable *Heat sink A temp*) is too low. ***Related functions:*** *Heatsink Thermal Protection*
52	*HtSink B temp low*	Trip	The *HtSink B temp low* trip fault occurs when when heatsink B temperature (variable *Heat sink B temp*) is too low. ***Related functions:*** *Heatsink Thermal Protection*
53	*HtSink C temp low*	Trip	The *HtSink C temp low* trip fault occurs when when heatsink C temperature (variable *Heat sink C temp*) is too low. ***Related functions:*** *Heatsink Thermal Protection*
54	*Ambient temp low*	Trip	The *Ambient temp low* trip fault occurs when the ambient temperature (variable *Bridge ambient temp*) is too low. The main purpose of the trip fault is to detect the absence of the ambient thermal sensor input. ***Primary causes:*** The ambient thermal sensor input is not present. ***Possible board failures:*** BICM ***Possible wiring faults:*** The thermal sensor input to backplane connector J4 pins 7 and 8 is missing or damaged.
55	*AC line fuse blown*	Trip	The *AC line fuse blown* trip fault occurs when one of the fuses feeding the diode source assembly opens. ***Primary causes:*** Loss of I24 supply on CTBC feeding this string . Shorted diode in source bridge.
56	*DB resistor overload*	Trip	The *DB resistor overload* trip fault occurs when the dynamic braking resistor thermal model indicates that the dynamic braking package has exceeded its rating. ***Primary causes:*** Incorrect configuration of DB thermal model. DB resistor package has not been sized correctly for application.

No.	Name	Type	Description
57	*DB resistor hot*	Alarm	The *DB resistor hot* alarm occurs when the dynamic braking resistor thermal model indicates that the dynamic braking package is approaching its rating. ***Primary causes:*** Incorrect configuration of DB thermal model. DB resistor package is marginal for application.
58	*Motor reac parms bad*	Trip	The *Motor reac parms bad* trip fault occurs when the primary motor reactance parameters have values that are not appropriate relative to one another. ***Primary causes:*** Internal calculations are performed using *Starting react Xst*, *Magnetizing react Xm*, *Stator lkg react X1*,and *Rotor lkg react X2*. The relationship between these parameters should be: (*Rotor lkg react X2* || *Magnetizing react Xm*) + *Stator lkg react X1* > *Starting react Xst*. This should be corrected before attempting to run the drive.
63	*BICM card over temp*	Fault	The *BICM card over temp* trip fault occurs when the sensor on BICM measures a temperature above 60C. The drive control electronics cannot operate reliably above this temperature. Reset the fault after the temperature drops below 60C. *BIC ambient temp* is the variable being monitored to generate this fault. ***Primary causes:*** Blocked air flow to control rack. Control rack cooling fan failure. Ambient temperature is too high. ***Possible board failures:*** BICM
64	*HtSink DB over temp*	Trip	The *HtSink DB over temp* trip fault occurs when the dynamic brake heatsink temperature (variable *DB heat sink temp*) is too high. ***Related functions:*** *Heatsink Thermal Protection*
65	*HtSink DS over temp*	Trip	The *HtSink DS over temp* trip fault occurs when the diode source heatsink temperature (variable *DS heat sink temp*) is too high. The bridge turns off in response to the fault to protect the IGBTs from thermal damage. ***Primary causes:*** Airflow to the heatsink is not sufficient. Blower is not operating correctly. ***Possible board failures:*** BICM ***Related functions:*** *Heatsink Thermal Protection*
66	*HtSink A over temp*	Trip	The *HtSink A over temp* trip fault occurs when heatsink A temperature (variable *Heat sink A temp*) is too high. ***Related functions:*** *Heatsink Thermal Protection*
67	*HtSink B over temp*	Trip	The *HtSink B over temp* trip fault occurs when heatsink B temperature (variable *Heat sink B temp*) is too high. ***Related functions:*** *Heatsink Thermal Protection*

No.	Name	Type	Description
68	*HtSink C over temp*	Trip	The *HtSink C over temp* trip fault occurs when heatsink C temperature (variable *Heat sink C temp*) is too high. ***Related functions:*** *Heatsink Thermal Protection*
69	*BICM card hot*	Alarm	The *BICM card hot* alarm occurs when the sensor on BICM measures a temperature that is hot. The sensed temperature is above 55C and the control electronics are operating outside of their design parameters. If the temperature continues to rise and exceeds 60C, the drive will trip. This warning is generated in order to allow time for corrective action to be taken. *BIC ambient temp* is the variable being monitored to generate this alarm. ***Primary causes:*** Blocked air flow to control rack. Control rack cooling fan failure. Ambient temperature is too high. ***Possible board failures:*** BICM
70	*HtSink DB temp hot*	Alarm	The *HtSink DB temp hot* alarm occurs when the dynamic brake heatsink temperature (variable *DB heat sink temp*) is high. ***Related functions:*** *Heatsink Thermal Protection*
71	*HtSink DS temp hot*	Alarm	The *HtSink DS temp hot* alarm occurs when the diode source heatsink temperature (variable *DS heat sink temp*) is high. ***Related functions:*** *Heatsink Thermal Protection*
72	*HtSink A temp hot*	Alarm	The *HtSink A temp hot* alarm occurs when heatsink A temperature (variable *Heat sink A temp*) is high. ***Related functions:*** *Heatsink Thermal Protection*
73	*HtSink B temp hot*	Alarm	The *HtSink B temp hot* alarm occurs when heatsink B temperature (variable *Heat sink B temp*) is high. ***Related functions:*** *Heatsink Thermal Protection*
74	*HtSink C temp hot*	Alarm	The *HtSink C temp hot* alarm occurs when heatsink C temperature (variable *Heat sink C temp*) is high. ***Related functions:*** *Heatsink Thermal Protection*
75	*Switchgear not ready*	Alarm	The *Switchgear not ready* alarm occurs when the permissive string to close the main switchgear is not present. This permissive string ends at BTBH(8) and includes customer contacts used to open the main. The primary purpose of the alarm is to prevent charging of the DC bus until the switchgear is ready to close. ***Primary causes:*** Switchgear not racked in. Customer switchgear permissive not met.
76	*HtSink DB rise high*	Alarm	The *HtSink DB rise high* alarm occurs when the dynamic brake heatsink temperature (variable *DB heat sink temp*) is too far above the ambient temperature (variable *Bridge ambient temp*). ***Related functions:*** *Heatsink Thermal Protection*

No.	Name	Type	Description
77	*HtSink DS rise high*	Alarm	The *HtSink DS rise high* alarm occurs when the diode source heatsink temperature (variable *DS heat sink temp*) is too far above the ambient temperature (variable *Bridge ambient temp*). ***Related functions:*** *Heatsink Thermal Protection*
78	*HtSink A rise high*	Alarm	The *HtSink A rise high* alarm occurs when heatsink A temperature (variable *Heat sink A temp*) is too far above the ambient temperature (variable *Bridge ambient temp*). ***Related functions:*** *Heatsink Thermal Protection*
79	*HtSink B rise high*	Alarm	The *HtSink B rise high* alarm occurs when heatsink B temperature (variable *Heat sink B temp*) is too far above above the ambient temperature (variable *Bridge ambient temp*). ***Related functions:*** *Heatsink Thermal Protection*
80	*HtSink C rise high*	Alarm	The *HtSink C rise high* alarm occurs when heatsink A temperature (variable *Heat sink C temp*) is too far above above the ambient temperature (variable *Bridge ambient temp*). ***Related functions:*** *Heatsink Thermal Protection*
81	*HtSink temp imbalanc*	Trip	The *HtSink temp imbalanc* trip fault occurs when two of the measured heatsink temperatures differ by an amount exceeding heatsink imbalance fault level. The main purpose of the trip fault is to detect the absence of a thermal sensor input from the heatsink, the failure of the sensor itself or heat pipe failure. ***Primary causes:*** A heatsink thermal sensor input is not present. A heatsink thermal sensor is defective The heatpipe system is defective. ***Possible board failures:*** BICM ***Related functions:*** *Heatsink Thermal Protection*
82	*HtSink blower failed*	Trip	The *HtSink blower failed* trip fault occurs when the drive is running and the cooling fans are not operating. ***Primary causes:*** Blower starter tripped due to blower motor overload or failure. ***Related functions:*** *Heatsink Thermal Protection*
83	*Run permissive lost*	Alarm	The *Run permissive lost* alarm occurs when the run permissive circuit is open. The state of the run permissive circuit is determined by the value of the variable to which parameter *Run permissive sel* points. The alarm can be disabled by setting parameter *Run permissive sel* equal to *Unused*. ***Related functions:*** *Sequencer Permissives*
84	*Cont req while flt*	Alarm	The *Cont req while flt* alarm occurs when contactor A is commanded to close and a trip fault is present in the drive.

No.	Name	Type	Description
85	*Flux req while flt*	Alarm	The *Flux req while flt* alarm occurs when a flux command is issued and a trip fault is present in the drive. The alarm may also occur when a flux command is issued at the same time a diagnostic test (cell test, pulse test, autotune) is active. ***Primary causes:*** The external application layer issues an inappropriate flux enable request.
86	*AC line over voltage*	Trip	The *AC line over voltage* trip fault occurs when the control firmware detects that the magnitude of the AC line is above the value of *Line OV fault level*, which has a suggested value of 117% of nominal. The voltage magnitude used for this comparison is a processed by a low-pass filter. This filter is set to 1.2 rad/sec as a default, so transient over-voltages are allowed above the threshold value without causing this trip fault. ***Primary causes:*** AC line voltage is excessive. ***Possible configuration faults:*** Source has been applied at a voltage other than that set by the factory. ***Possible board failures:*** VATF-SRC FOSA BICM DSPX
87	*AC line voltage high*	Alarm	The *AC line voltage high* alarm occurs when the control firmware detects that the magnitude of the AC line is above the value of *Line OV alarm level*, which has a suggested value of 112% of nominal. The voltage magnitude used for this comparison is a low-pass filtered version of the fastest version. The filter is set to 1.2 rad/sec as a default, so transient voltage above the alarm turn-on value can occur without causing this alarm. This alarm will cease once the filtered value of voltage magnitude has decreased to below *Line OV alarm clear*, which has a suggested value of 110% of nominal. ***Primary causes:*** AC line voltage is marginally excessive. ***Possible configuration faults:*** Source has been applied at a voltage other than that set by the factory. ***Possible board failures:*** VATF-SRC FOSA BICM DSPX

No.	Name	Type	Description
88	*AC line under volt*	Trip	The *AC line under volt* trip fault occurs when the control firmware detects that the magnitude of the ac line is below the value of *Line UV fault level*, which has a suggested value of 50% of the nominal ac line input. The voltage magnitude used for this comparison is a low-pass filtered version of the signal. The filter is set to 1.2 rad/sec as a default, so transient voltages below the alarm turn-on value can occur without causing this trip fault. ***Primary causes:*** AC line voltage too low. ***Possible configuration faults:*** Source has been applied at a voltage other than that set by the factory. ***Possible board failures:*** VATF-SRC FOSA BICM DSPX
89	*AC line volts low*	Alarm	The *AC line volts low* alarm occurs when the control firmware detects that the magnitude of the ac line is below the value of *Line UV alarm level*, which has a suggested value of 88% of nominal. The voltage magnitude used for this comparison is a low-pass filtered version of the fastest version. The filter is set to 1.2 rad/sec as a default, so transient voltage above the alarm turn-on value can occur without causing this alarm. This alarm will cease once the filtered value of voltage magnitude has increased to above the value of *Line UV alarm clear*, which has a suggested value of 90% of nominal. ***Primary causes:*** AC line voltage is marginally low. ***Possible configuration faults:*** Source has been applied at a voltage other than that set by the factory. ***Possible board failures:*** VATF-SRC FOSA BICM DSPX
90	*AC line over freq*	Trip	The *AC line over freq* trip fault occurs when the control firmware detects that the frequency of the AC line is above the value of *Over freq flt level*, which has a suggested value of 125% of nominal. The frequency value used for this comparison is a low-pass filtered version of the fastest version. The filter is set to .2 rad/sec as a default, so transient over-frequency values are allowed above the threshold value without causing this trip fault. ***Primary causes:*** AC line frequency is excessive. ***Possible configuration faults:*** Source has been applied at a 60hz while the factory setup value, *AC grid frequency* was at 50hz. ***Possible board failures:*** VATF-SRC FOSA BICM DSPX

No.	Name	Type	Description
91	*AC line freq high*	Alarm	The *AC line freq high* alarm occurs when the control firmware detects that the frequency of the AC line is above the value of *Over freq alm level*, which has a suggested value of nominal frequency plus 17.3 rad/sec. The frequency value used for this comparison is a low-pass filtered version of the fastest version. The filter is set to .2 rad/sec as a default, so transient over-frequency values are allowed above the threshold value without causing this alarm. This alarm will cease once the filtered value of filtered frequency has decreased to below the value of *Over freq alm clear*, which has a suggested value of nominal frequency plus 15.7rad/sec. ***Primary causes:*** AC line frequency is marginally excessive. ***Possible configuration faults:*** Source has been applied 60hz while the factory setup value, *AC grid frequency* was at 50hz. ***Possible board failures:*** VATF-SRC FOSA BICM DSPX
92	*AC line under freq*	Trip	The *AC line under freq* trip fault occurs when the control firmware detects that the frequency of the AC line is below the value of *Under freq flt level*, which has a suggested value of nominal of 50% of nominal. The frequency value used for this comparison is a low-pass filtered version of the fastest version. The filter is set to .2 rad/sec as a default, so transient under-frequency values are allowed below the threshold value without causing this trip fault. ***Primary causes:*** AC line frequency is low. ***Possible configuration faults:*** Source has been applied at 50hz while the factory setup value, *AC grid frequency* was at 60hz. ***Possible board failures:*** VATF-SRC FOSA BICM DSPX

No.	Name	Type	Description
93	*AC line freq low*	Alarm	The *AC line freq low* alarm occurs when the control firmware detects that the frequency of the AC line is below the value of *Under freq alm level*, which has a suggested value of nominal minus 17.3rad/sec. The frequency value used for this comparison is a low-pass filtered version of the fastest version. The filter is set to .2 rad/sec as a default, so transient under-frequency values are allowed below the threshold value without causing this alarm. This alarm will cease once the filtered value of filtered frequency has increased to a value above below the value of *Under freq alarm clr*, which has a suggested value of nominal frequency minus 15.7rad/sec. ***Primary causes:*** AC line frequency is transiently low. ***Possible configuration faults:*** Source has been applied at 50hz while the factory setup value, *AC grid frequency* was at 60hz. ***Possible board failures:*** VATF-SRC FOSA BICM DSPX
94	*Stat charger timeout*	Trip	The *Stat charger timeout* trip fault occurs when the static charger is unable to completely charge the DC bus. Normal charge operation terminates when the DC bus reaches 90% of its nominal level. At this point the charger is turned off and the switch gear is closed. If after around 70 seconds of charging the DC bus does not reach this threshold then the trip fault is generated and the charging sequence is aborted. ***Primary causes:*** Static charger failure. DC bus capacitor defective.
95	*Stat charger failed*	Trip	The *Stat charger failed* trip fault occurs when the static charger reports a fault during its operation. The DC bus charging procedure stops when the trip fault occurs. ***Primary causes:*** Static charger failure.
96	*Switchgear failure*	Trip	The *Switchgear failure* trip fault occurs when the AC line switchgear does not close in response to a close command during the bus charging sequence. The trip fault also occurs when the switchgear opens unexpectedly during drive operation. ***Primary causes:*** Switchgear defective. Switchgear opened via external command. Switchgear tripped.
97	*Vdc <200v after 5sec*	Trip	The *Vdc <200v after 5sec* trip fault occurs when the static charger fails to charge the DC bus voltage to 200 volts within 5 seconds. The DC bus charging procedure stops when the trip fault occurs. ***Primary causes:*** Static charger failure. Local Fault or System Fault Active DC bus shorted. DC feedback not working.

No.	Name	Type	Description
98	*Ambient over temp*	Trip	The *Ambient over temp* trip fault occurs when the ambient temperature (variable *Bridge ambient temp*) is too high. The main purpose of the trip fault is to use the ambient temperature measurement to detect a condition which could endanger the power bridge. ***Primary causes:*** The bridge environment and running conditions cause the ambient temperature to rise above a safe operating level. ***Possible board failures:*** BICM ***Possible wiring faults:*** The thermal sensor input to backplane connector J4 pins 7 and 8 is damaged.
99	*Ambient temp hot*	Alarm	The *Ambient temp hot* alarm occurs when the ambient temperature (variable *Bridge ambient temp*) is too high. The main purpose of the alarm is to use the ambient temperature measurement to detect a condition which could endanger the power bridge. ***Primary causes:*** The bridge environment and running conditions cause the ambient temperature to rise above a safe operating level. ***Possible board failures:*** BICM ***Possible wiring faults:*** The thermal sensor input to backplane connector J4 pins 7 and 8 is damaged.
100	*Phase A cur offset*	Trip	The *Phase A cur offset* trip fault occurs when the phase A current offset (variable *Phs A current offset*) is too large. The current offset threshold level is 1 percent of the rated shunt current (parameter *IPN shunt size*). *Phs A current offset* is the output of an automatic current offset calculation. The trip fault only occurs when the offset calculation is not active. *Phase A cur offset* evaluates phase A current feedback information collected while the power bridge is turned off, when current feedbacks should be zero. It uses the information to detect power bridge and feedback circuitry problems.
101	*Phase B cur offset*	Trip	The *Phase B cur offset* trip fault occurs when the phase B current offset (variable *Phs B current offset*) is too large. The current offset threshold level is 1 percent of the rated shunt current (parameter *IPN shunt size*). *Phs B current offset* is the output of an automatic current offset calculation. The trip fault only occurs when the offset calculation is not active. *Phase B cur offset* evaluates phase B current feedback information collected while the power bridge is turned off, when current feedbacks should be zero. It uses the information to detect power bridge and feedback circuitry problems.
102	*Phase C cur offset*	Trip	The *Phase C cur offset* trip fault occurs when the phase C current offset (variable *Phs C current offset*) is too large. The current offset threshold level is 1 percent of the rated shunt current, represented by parameter *IPN shunt size*. *Phs C current offset* is the output of an automatic current offset calculation. The trip fault only occurs when the offset calculation is not active. *Phase C cur offset* evaluates phase C current feedback information collected while the power bridge is turned off, when current feedbacks should be zero. It uses the information to detect power bridge and feedback circuitry problems.

No.	Name	Type	Description
103	*A-B voltage offset*	Trip	The *A-B voltage offset* trip fault occurs when the A-B line-line voltage offset (variable *A-B, Voltage offset*) is too large. *A-B, Voltage offset* is the output of an automatic voltage offset calculation. The trip fault only occurs when the offset calculation is not active. *A-B voltage offset* evaluates A-B voltage feedback information collected while the power bridge is turned off, when voltage feedbacks should be zero. It uses the information to detect power bridge and feedback circuitry problems.
104	*B-C voltage offset*	Trip	The *B-C voltage offset* trip fault occurs when the B-C line-line voltage offset (variable *B-C, Voltage offset*) is too large. *B-C, Voltage offset* is the output of an automatic voltage offset calculation. The trip fault only occurs when the offset calculation is not active. *B-C voltage offset* evaluates B-C voltage feedback information collected while the power bridge is turned off, when voltage feedbacks should be zero. It uses the information to detect power bridge and feedback circuitry problems.
105	*Pulse tst config bad*	Trip	The *Pulse tst config bad* trip fault occurs when the pulse test configuration parameters are invalid and the pulse test is invoked. The purpose of the fault is to prevent the pulse test from running under poorly defined conditions. ***Primary causes:*** One or more of the following parameters is negative: *Pulse 1 on time*, *Mid pulse off time*, *Pulse 2 on time*, *Post pulse off time*.
106	*Ckt board list fail*	Trip	The *Ckt board list fail* trip fault occurs when the electronic board ID interrogation which happens during drive initialization fails. Each circuit board in the rack has an electronic ID. *Ckt board list fail* requires a hard reset to clear. ***Primary causes:*** A circuit board is not seated properly in its backplane sockets. The electronic ID part on a circuit board has experienced a failure.
107	*Motor volt offs high*	Alarm	The *Motor volt offs high* alarm occurs when the line-line voltage offset measurements are invalid when the drive is started. Generally the alarm occurs when the drive is stopped and quickly started again. The voltage offsets are represented by variables *A-B, Voltage offset* and *B-C, Voltage offset*. They are the outputs of automatic voltage offset measurements. They are valid for a certain length of time after the measurements are performed. The voltage offset measurements are performed when the drive is started and enough time has elapsed to cause the previous voltage offset measurements to be invalid. However, there is an exception to this statement. The offset measurements are not performed during the flux decay time, which begins when the drive is stopped and continues for 8 rotor time constants. When the drive is started during the flux decay time, and the previous offset measurements are invalid because too much time has elapsed since they were performed, the *Motor volt offs high* alarm occurs. ***Related functions:*** *Line-Line Voltage Protection*
108	*DC bus voltage low*	Alarm	The *DC bus voltage low* alarm occurs when the DC link voltage feedback (variable *DC bus voltage*) is too low. The alarm clears when the DC link voltage feedback rises to an acceptable voltage, which is the under voltage threshold plus a hysteresis voltage. *DC bus voltage low* only occurs when the drive is stopped. ***Possible board failures:*** FOSA DSPX

No.	Name	Type	Description
109	*Task 1 exec overrun*	Alarm	The *Task 1 exec overrun* alarm occurs when Task 1 exceeds its allotted CPU execution time. This alarm may occur during system development but should not occur in the field. ***Primary causes:*** Task 1 contains too much functionality to complete in the specified execution time. ***Possible board failures:*** DSPX
110	*Task 2 exec overrun*	Alarm	The *Task 2 exec overrun* alarm occurs when Task 2 exceeds its allotted CPU execution time. This alarm may occur during system development but should not occur in the field. ***Primary causes:*** Task 2 contains too much functionality to complete in the specified execution time. Task 1 contains too much functionality. Although it completes in its specified execution time, it does not allow Task 2 to run to completion. ***Possible board failures:*** DSPX
111	*Task 3 exec overrun*	Alarm	The *Task 3 exec overrun* alarm occurs when Task 3 exceeds its allotted CPU execution time. This alarm may occur during system development but should not occur in the field. ***Primary causes:*** Task 3 contains too much functionality to complete in the specified execution time. Task 1 and Task 2 contain too much functionality. Although they complete in their specified execution time, they do not allow Task 3 to run to completion. ***Possible board failures:*** DSPX
112	*ADL msg stack fail*	Alarm	The *ADL msg stack fail* alarm occurs when an attempt by autotune or cell test to allocate or free message stack memory fails. The purpose of the alarm is to indicate failure in the use of dynamic memory with asynchronous drive language functionality. This alarm may occur during system development but should not occur in the field. ***Primary causes:*** An attempt to allocate or free memory on behalf of the ADL message stack failed.
113	*Invalid board set*	Trip	The *Invalid board set* trip fault occurs when the electronic board ID interrogation which happens during initialization does not produce the expected set of circuit boards. Each circuit board in the rack has an electronic ID which contains board type and revision information. Each Innovation Series product has an expected set of circuit boards. If any of the expected boards is missing, or if incorrect boards are present, the drive cannot operate properly. The circuit boards that the drive has identified can be obtained by making the following GE Control System Toolbox menu selections: View, Reports, Drive Version and Hardware Info. ***Primary causes:*** A circuit board which is required for the drive to operate properly is not present. A circuit board which should not be used in the drive is present. A circuit board is not seated properly in its backplane socket. The electronic ID part on a circuit board has experienced a failure.

No.	Name	Type	Description
114	*Ain 1 signal alarm*	Alarm	The *Ain 1 signal alarm* occurs when the level of analog input number 1 (variable *Analog input 1*) is too low. The alarm level is specified by parameter *Analog in 1 flt lev*. The alarm can occur only when parameter *Analog in 1 flt mode* is set equal to Low level alarm. The alarm is disabled for any other setting for parameter *Analog in 1 flt mode*. The main purpose of *Ain 1 signal alarm* is to detect a low 4-20 mA signal. The low level may indicate that a signal is missing which is required for the drive to operate properly. ***Primary causes:*** The analog input number 1 signal source is absent or unhealthy. ***Possible configuration faults:*** The analog input 1 alarm level, represented by parameter *Analog in 1 flt lev*, is set incorrectly. The analog input number 1 gain, represented by parameter *Analog in 1 gain*, is set incorrectly. The analog input number 1 offset, represented by parameter *Analog in 1 offset*, is set incorrectly. The analog input number in 1 flt mode, represented by parameter *Analog in 1 flt mode*, is set incorrectly. ***Possible wiring faults:*** The connections between the analog signal source and ATBA terminal board locations 38 (AI1P) and 40 (AI1N) are missing or damaged.
115	*Ain 1 signal trip*	Trip	The *Ain 1 signal trip* fault occurs when the level of analog input number 1 (variable *Analog input 1*) is too low. The trip fault level is specified by parameter *Analog in 1 flt lev*. The trip fault can occur only when parameter *Analog in 1 flt mode* is set equal to Low level trip. The trip fault is disabled for any other setting for parameter *Analog in 1 flt mode*. The main purpose of *Ain 1 signal trip* is to detect a low 4-20 mA signal. The low level may indicate that a signal is missing which is required for the drive to operate properly. ***Primary causes:*** The analog input number 1 signal source is absent or unhealthy. ***Possible configuration faults:*** The analog input 1 trip fault level, represented by parameter *Analog in 1 flt lev*, is set incorrectly. The analog input number 1 gain, represented by parameter *Analog in 1 gain*, is set incorrectly. The analog input number 1 offset, represented by parameter *Analog in 1 offset*, is set incorrectly. The analog input number in 1 flt mode, represented by parameter *Analog in 1 flt mode*, is set incorrectly. ***Possible wiring faults:*** The connections between the analog signal source and ATBA terminal board locations 38 (AI1P) and 40 (AI1N) are missing or damaged.

No.	Name	Type	Description
116	*Ain 2 signal alarm*	Alarm	The *Ain 2 signal alarm* occurs when the level of analog input number 2 (variable *Analog input 2*) is too low. The alarm level is specified by parameter *Analog in 2 flt lev*. The alarm can occur only when parameter *Analog in 2 flt mode* is set equal to Low level alarm. The fault is disabled for any other setting for parameter *Analog in 2 flt mode*. The main purpose of *Ain 2 signal alarm* is to detect a low 4-20 mA signal. The low level may indicate that a signal is missing which is required for the drive to operate properly. ***Primary causes:*** The analog input number 2 signal source is absent or unhealthy. ***Possible configuration faults:*** The analog input 2 alarm level, represented by parameter *Analog in 2 flt lev*, is set incorrectly. The analog input number 2 gain, represented by parameter *Analog in 2 gain*, is set incorrectly. The analog input number 2 offset, represented by parameter *Analog in 2 offset*, is set incorrectly. The analog input number in 2 flt mode, represented by parameter *Analog in 2 flt mode*, is set incorrectly. ***Possible wiring faults:*** The connections between the analog signal source and ATBA terminal board locations 44 (AI2P) and 46 (AI2N) are missing or damaged.
117	*Ain 2 signal trip*	Trip	The *Ain 2 signal trip* fault occurs when the level of analog input number 2 (variable *Analog input 2*) is too low. The trip fault level is specified by parameter *Analog in 2 flt lev*. The trip fault can occur only when parameter *Analog in 2 flt mode* is set equal to Low level trip. The trip fault is disabled for any other setting for parameter *Analog in 2 flt mode*. The main purpose of *Ain 2 signal trip* is to detect a low 4-20 mA signal. The low level may indicate that a signal is missing which is required for the drive to operate properly. ***Primary causes:*** The analog input number 2 signal source is absent or unhealthy. ***Possible configuration faults:*** The analog input 2 trip fault level, represented by parameter *Analog in 2 flt lev*, is set incorrectly. The analog input number 2 gain, represented by parameter *Analog in 2 gain*, is set incorrectly. The analog input number 2 offset, represented by parameter *Analog in 2 offset*, is set incorrectly. The analog input number in 2 flt mode, represented by parameter *Analog in 2 flt mode*, is set incorrectly. ***Possible wiring faults:*** The connections between the analog signal source and ATBA terminal board locations 44 (AI2P) and 46 (AI2N) are missing or damaged.
118	*Illegal req for sby*	Alarm	The *Illegal req for sby* alarm occurs when a *Standby command* is issued and a trip fault is present in the drive. The alarm may also occur when a *Standby command* is issued at the same time a diagnostic test (cell test, pulse test, autotune) is active. ***Primary causes:*** The external application layer issues an inappropriate standby request.

No.	Name	Type	Description
119	*Start permissive bad*	Alarm	The *Start permissive bad* alarm occurs when the start permissive circuit is open and the drive is stopped. The state of the start permissive circuit is determined by the value of the variable which parameter *Start permissive sel* selects. The alarm can be disabled by setting parameter *Start permissive sel* equal to Unused. ***Related functions:*** *Sequencer Permissives*
121	*DBS1 IGDM card flt*	Trip	The *DBS1 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.
122	*DBS2 IGDM card flt*	Trip	The *DBS2 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.

No.	Name	Type	Description
123	*AS1 IGDM card flt*	Trip	The *AS1 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.
124	*AS2 IGDM card flt*	Trip	The *AS2 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.

No.	Name	Type	Description
125	*AS3 IGDM card flt*	Trip	The *AS3 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.
126	*AS4 IGDM card flt*	Trip	The *AS4 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.

No.	Name	Type	Description
127	*BS1 IGDM card flt*	Trip	The *BS1 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.
128	*BS2 IGDM card flt*	Trip	The *BS2 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.

No.	Name	Type	Description
129	*BS3 IGDM card flt*	Trip	The *BS3 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.
130	*BS4 IGDM card flt*	Trip	The *BS4 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.

No.	Name	Type	Description
131	*CS1 IGDM card flt*	Trip	The *CS1 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.
132	*CS2 IGDM card flt*	Trip	The *CS2 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.

No.	Name	Type	Description
133	*CS3 IGDM card flt*	Trip	The *CS3 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.
134	*CS4 IGDM card flt*	Trip	The *CS4 IGDM card flt* trip fault is hardware generated. The trip fault occurs when the bridge control has lost communication with the indicated IGDM module. This communication occurs via fiber optic cable between the FOSA and the IGDM. During normal operation the IGDM transmits continuous light back to FOSA. Any loss of this signal triggers this trip fault. Several unrelated situations can cause the light to stop transmitting. Run the *Cell Test Wizard* to identify any failed devices. ***Primary causes:*** CPFP power supply failure IGDM failure A desat fault on the indicated IGBT was detected. ***Possible board failures:*** IGDM CPFP FOSA BICM ***Possible wiring faults:*** Fiber optic connection between FOSA and IGDM Power distribution wiring from CPFP.

No.	Name	Type	Description
135	*AC line transient*	Alarm	The *AC line transient* alarm occurs as a result of significant phase lock loop error or significant phase imbalance. A phase imbalance signal is calculated by subtracting a control calculated threshold from a filtered signal which is formed by filtering the sum of two signals. One of these signals is the phase lock loop error and the other is the error between the demodulated real component of line voltage and the measured magnitude of the line. The calculated threshold phase imbalance level which is computed by the control is based on the magnitude of the input line voltage. This calculated phase imbalance threshold represents a phase imbalance of about 18% or a phase lock loop error of about 6.7 degrees. The phase imbalance signal which is a result of the previously mentioned subtraction is equal to about 18% imbalance when it becomes positive. The phase imbalance signal feeds an integrator designed to cause the *AC line transient* alarm when the threshold has been exceeded for a very short time. That amount of time is dependent upon the amount of the phase imbalance, but the alarm will occur eventually if the imbalance signal remains positive. ***Primary causes:*** AC line disturbances. Transient phase imbalances. Weak control of frequency on diesel generator sets or gas turbine generator sets. Very fast voltage magnitude changes. Damaged reactor or transformer ***Possible board failures:*** VATF-SRC FOSA BICM DSPX

No.	Name	Type	Description
136	*AC line watchdog*	Trip	The *AC line watchdog* trip fault will occur when the *AC line transient* alarm persists for about one second. Both the trip fault and the alarm are a result of significant phase lock loop error or significant phase imbalance. A phase imbalance signal is calculated by subtracting a control calculated threshold from a filtered signal which is formed by filtering the sum of two signals. One of these signals is the phase lock loop error and the other is the error between the demodulated real component of line voltage and the measured magnitude of the line. The calculated threshold phase imbalance level which is computed by the control is based on the magnitude of the input line voltage. This calculated phase imbalance threshold represents a phase imbalance of about 18% or a phase lock loop error of about 6.7 degrees. The phase imbalance signal which is a result of the previously mentioned subtraction is equal to about 18% imbalance when it becomes positive. The phase imbalance signal feeds an integrator designed to cause the *AC line transient* alarm when the threshold has been exceeded for a very short time. That amount of time is dependent upon the amount of the phase imbalance, but the alarm will occur eventually if the imbalance signal remains positive. If the alarm persists continuously for about one second, the *AC line watchdog* trip fault will occur. ***Primary causes:*** AC line disturbances. Transient phase imbalances. Weak control of frequency on diesel generator sets or gas turbine generator sets. Very fast voltage magnitude changes. Damaged reactor or transformer ***Possible board failures:*** VATF-SRC FOSA BICM DSPX
137	*AC line rev phs seq*	Trip	The *AC line rev phs seq* trip fault occurs when the control senses that the rotation of the AC line is opposite of what is expected. This condition is checked only one time after the control is powered up. When the phase lock loop locks for the first time, just after the charging sequence has begun, the sign of *PLL frequency* is checked against the expected sign. The expected sign is determined by the setting of *Phase rotation req*. If Forward sequence is selected, the sign of *PLL frequency* is expected to be positive, otherwise, it must be negative. If the expected sign is not found, the trip fault is given. *AC line rev phs seq* requires a hard reset to clear. Before changing *Phase rotation req*, review the rotation of any AC cooling pumps or blowers in the drive. Incorrect phase sequence can lead to ineffective air or water flow in the cooling system. ***Primary causes:*** Control senses wrong phase sequence. ***Possible board failures:*** VATF-SRC FOSA BICM DSPX ***Possible wiring faults:*** Main AC input lines to source are not in correct phase sequence. Sensing wires to FOSA are in wrong sequence.

No.	Name	Type	Description
138	*AC line vfb offset*	Trip	The *AC line vfb offset* trip fault occurs when the voltage feedback offset being calculated for line voltage feedbacks is above the allowable threshold. The system integrates the voltages seen on the AC input terminals. The results of this integration should be near zero since the input waveform is a sine wave. If the input line-line voltages integrate to a non-zero value above a predefined threshold this trip fault is generated. ***Primary causes:*** Bad VCO Circuit. Incorrect sensor wiring. Large DC current component through transformer. ***Possible board failures:*** VATF-SRC FOSA BICM DSPX ***Possible wiring faults:*** Check wiring of VATF-SRC sensor inputs to phase leg.
139	*AC line failed*	Trip	The *AC line failed* trip fault occurs when the phase lock loop fails to synchronize during the start up sequence. ***Primary causes:*** The AC line is missing. There is a large AC line imbalance. There is a blown fuse.
140	*Xfrmr over temp*	Trip	The *Xfrmr over temp* trip occurs when the transformer over temperature circuit is open. The control input which points to the over temperature circuit is selected by parameter *Xfrmr OT fault sel*. *Xfrmr over temp* can be disabled by setting parameter *Xfrmr OT fault sel* equal to *Unused*.
141	*Xfrmr temp hot*	Alarm	The *Xfrmr temp hot* alarm occurs when the transformer over temperature circuit is open. The control input which points to the over temperature circuit is selected by parameter *Xfrmr OT fault sel*. *Xfrmr temp hot* can be disabled by setting parameter *Xfrmr OT fault sel* equal to *Unused*.
142	*Motor over temp*	Trip	The *Motor over temp* trip fault occurs when the motor overtemperature circuit is open. The state of the motor overtemperature circuit is selected by parameter *Motor OT fault sel*. *Motor over temp* can be disabled by setting parameter *Motor OT fault sel* equal to Unused. ***Related functions:*** *Motor Overtemperature Detection*
143	*Motor temp hot*	Alarm	The *Motor temp hot* trip fault occurs when the motor overtemperature circuit is open. The state of the motor overtemperature circuit is selected by parameter *Motor OT fault sel*. *Motor temp hot* can be disabled by setting parameter *Motor OT fault sel* equal to Unused. ***Related functions:*** *Motor Overtemperature Detection*
144	*Unrecognized IPN*	Trip	The *Unrecognized IPN* trip fault occurs when the specified Intelligent Part Number (IPN) is not a valid combination of fields for the Innovation Series product. The IPN should correspond to the drive nameplate. *Unrecognized IPN* requires a hard reset to clear.

No.	Name	Type	Description
145	*Customer use NC flt*	Trip	The *Customer use NC flt* trip fault occurs when the customer normally closed circuit is open. The state of the normally closed circuit is selected by parameter *User NC fault sel*.
146	*Customer use NC alm*	Alarm	The *Customer use NC alm* alarm occurs when the customer normally closed circuit is open. The state of the normally closed circuit is selected by parameter *User NC fault sel*.
147	*Customer use NO flt*	Trip	The *Customer use NO flt* trip fault occurs when the customer normally open circuit is closed. The state of the normally open circuit is selected by parameter *User NO fault sel*.
148	*Customer use NO alm*	Alarm	The *Customer use NO alm* alarm occurs when the customer normally open circuit is closed. The state of the normally open circuit is selected by parameter *User NO fault sel*.
149	*Sat curve data bad*	Trip	The *Sat curve data bad* trip fault occurs when the flux saturation curve is not monotonic. ***Primary causes:*** The saturation curve data entered by the operator is bad. The saturation curve data calculated by autotune is bad. ***Possible configuration faults:*** One or more of the saturation curve parameters is bad. The saturation curve parameters are *Flux curve amps 1*, *Flux curve amps 2*, *Flux curve amps 3*, *Flux curve amps 4*, *Flux curve amps 5*, *Flux curve voltage 1*, *Flux curve voltage 2*, *Flux curve voltage 3*, *Flux curve voltage 4*, and *Flux curve voltage 5*.
150	*Rated flux data bad*	Trip	The *Rated flux data bad* trip fault occurs when the motor control calculation of rated flux (variable *100% Flux*) does not converge to a stable value.
151	*Leakage curve bad*	Trip	The *Leakage curve bad* trip fault occurs when the leakage flux curve is not monotonic (i.e. Point 1 < point 2 < point 3 < point 4 < point 5). ***Primary causes:*** The calculated leakage curve has been derived from bad motor reactance data. The leakage curve data entered by the operator is bad. The leakage curve data calculated by autotune is bad. ***Possible configuration faults:*** When the leakage curve is not entered specifically point-by-point (see below) one is calculated from *Starting react Xst*, *Magnetizing react Xm*, *Stator lkg react X1*, and *Rotor lkg react X2*. The relationship between these parameters should be: (*Rotor lkg react X2* || *Magnetizing react Xm*) + *Stator lkg react X1* > *Starting react Xst*. If *Motor reac parms bad* fault is also present, this is the likely cause. When the leakage curve is not entered specifically point-by-point, one or more of the leakage curve parameters is bad. The leakage curve parameters are *Lkg flux current 1*, *Lkg flux current 2*, *Lkg flux current 3*, *Lkg flux current 4*, *Lkg flux current 5*, *Lkg flux voltage 1*, *Lkg flux voltage 2*, *Lkg flux voltage 3*, *Lkg flux voltage 4*, and *Lkg flux voltage 5*. If the leakage parameters are not set, the leakage curve is determined as above, or as the results of autotune.
152	*Invalid Time Base*	Trip	The *Invalid Time Base* trip fault occurs when the execution time base is invalid. Parameter *Exec time/Chop freq* contains valid choices for the time base. *Invalid Time Base* requires a hard reset to clear.

No.	Name	Type	Description
153	*DSPx Watchdog*	Trip Locke d	The *DSPx Watchdog* trip fault occurs when the DSPX EPLD stops seeing a watchdog toggle bit from the processor. A hard reset occurs and the fault is declared at initialization. *DSPx Watchdog* requires a hard reset to clear. ***Possible board failures:*** DSPX
154	*Reverse rotation*	Trip	The *Reverse rotation* trip fault occurs when the motor shaft is rotating opposite to the requested direction. ***Related functions:*** *Speed Control Fault Check*
155	*Failure to rotate*	Trip	The *Failure to rotate* trip fault occurs when speed regulator error grows large while the speed feedback is small. ***Related functions:*** *Speed Control Fault Check*
156	*Loss of spd control*	Alarm	The *Loss of spd control* trip fault occurs when the speed regulator error is too large. ***Related functions:*** *Speed Control Fault Check*
157	*Bic Watchdog*	Trip	The *Bic Watchdog* trip fault occurs when the BICM stops seeing a watchdog toggle bit from the DSPX. When the drive is running, BICM monitors a toggle bit being manipulated by DSPX. If DSPX does not toggle the bit on BICM within a predefined time interval, the BICM declares a fault and disables the bridge. This indicates that the processor cannot communicate reliably with the bridge interface card. *Bic Watchdog* requires a hard reset to clear. ***Possible configuration faults:*** The connected drive is a simulator but *Simulate mode act* is equal to *False*. Set *Simulate mode* equal to *Yes* to correct the problem. ***Possible board failures:*** BICM DSPX CABP (backplane)
158	*Bic watchdog echo*	Trip	The *Bic watchdog echo* trip fault occurs when the DSPX stops seeing the echo of the watchdog toggle bit that it writes to the BICM. This indicates that the processor cannot communicate reliably with the bridge interface card. ***Primary Causes:*** Bent backplane connector pins or poorly seated cards. ***Possible board failures:*** BICM DSPX CABP (backplane)
160	*LAN trip request*	Trip	The *LAN trip request* trip fault occurs when a request for a trip fault is received from the LAN by assertion of the reference Boolean signal *Trip request, lan*.
161	*LAN alarm request*	Alarm	The *LAN alarm request* alarm occurs when a request for an alarm is received from the LAN by assertion of the reference Boolean signal *Alarm request, lan*.

No.	Name	Type	Description
162	*LAN watchdog alarm*	Alarm	The *LAN watchdog alarm* occurs when the connection between DSPX and the Application/LAN interface becomes invalid. This includes one of the following conditions, depending upon the selection of *Network interface*: The Application/LAN interface Dual-Port RAM watchdog stops. The ISBus frames stop. The alarm is declared after the condition persists for several hundred microseconds.
163	*Restrictd fcn enabld*	Alarm	The *Restrictd fcn enabld* alarm occurs when the selected execution time base in the parameter *Exec time/Chop freq* restricts certain drive functionality due to timing limitations, or the ISBus network is selected by the *Network interface* parameter and the DSPX hardware does not support ISBus. Certain functions that are presently enabled will not run. ***Possible configuration faults:*** Execution time base is too low. Select alternate time base in parameter *Exec time/Chop freq*. LAN is enabled, but will not operate. Disable LAN by setting parameter *Network interface* to *None*. ISBus is selected, but will not operate. Deselect ISBus by setting parameter *Network interface*, or replace the DSPX HIA with a DSPX H1B.
164	*LAN heartbeat trip*	Trip	The *LAN heartbeat trip* occurs when all of the following conditions are present: Non-zero value is entered in Parameter *LAN heartbeat time*. The signal (*Heartbeat ref, lan*) fails to transition within in that time. The trip behavior is enabled by Parameter *LAN trips inhibit*. The *LAN connection ok* condition was previously detected.
165	*LAN heartbeat alarm*	Alarm	The *LAN heartbeat alarm* occurs when all of the following conditions are present: Non-zero value is entered in Parameter *LAN heartbeat time*. The signal (*Heartbeat ref, lan*) fails to transition within in that time. Either the trip behavior is inhibited by Parameter *LAN trips inhibit*, or the trip behavior is enabled but the *LAN connection ok* condition was not previously detected.
166	*Requird Parm Missing*	Trip	The *Requird Parm Missing* trip fault occurs when one of the required parameters either is not entered, “No Value” or has a value of zero. Check the following values, which can be found in the commissioning wizard. ***Primary causes:*** *Motor rated voltage*, Not entered *Motor rated freq*, Not entered *Motor rated current*, Not entered *Motor rated rpm*, Not entered *Motor rated power*, Not entered *Motor service factor*, Not entered
167	*Version mismatch*	Trip	The *Version mismatch* trip fault occurs at initialization when the drive pattern detects a product or version mismatch with the parameters stored in non-volatile RAM. Download parameters to fix.
168	*System ISBus error*	Alarm	The *System ISBus error* alarm occurs when an ISBus fault is detected in the DSPX control. The variable *Sys ISBus error reg* contains the bit-coded value of the last ISBus fault detected; each bit indicates a particular ISBus fault seen by the control. The variable *Sys ISBus error cnt* increments upon fault detection. Record the value of *Sys ISBus error reg* to assist factory troubleshooting efforts. Monitor the progression of *Sys ISBus error cnt* to obtain an indication of the rate of occurrence of fault conditions. Transient occurrence of this alarm upon initialization of the interface is expected.

No.	Name	Type	Description
169	*Frame PLL not OK*	Alarm	The *Frame PLL not OK* alarm occurs when phase-lock between the DSPX control and the System ISBus or (local ACL) is not assured. Detection of the fault is enabled when the parameter *Network interface* is configured to select an interface for which synchronized operation is supported. The presence of this alarm indicates that data coherency is compromised. Verify the integrity of IsBus connections and configurations. If this alarm persists in the absence of any other interface faults, then verify that *LAN frame time* is consistent with that of the host, and confirm the absence of overrides, particularly regarding the Frame phaselock loop and DSPX timebase. Transient occurrence of this alarm upon initialization of the interface is expected.

Chapter 3 Paramters/Functions

Introduction

Chapter 4 describes wizards.

Application firmware consists of coordinated blocks of code called **functions**. Each function performs a specific task in controlling the drive. **Parameters** are adjustable values within a function that allow you to configure and adjust the drive behavior. Parameters can be set and modified using wizards within the keypad and the optional toolbox.

The following is a list of the drive parameters and functionsIt is organized as follows:

Section ***Page***

Diagnostic and Utility Functions

Diagnostic and Utility Overview

The Innovation Series products contain a number of diagnostic functions. More information is available for the following topics.

- Capture Buffer
- General Purpose Constants
- General Purpose Filters
- Oscillator
- Position Feedback
- Predefined Constants
- Signal Level Detector (SLD)
- Simulator

Capture Buffer

The Innovation Series capture buffer is used to collect coherent data at a specified rate in the drive. The capture buffer is circular, and will collect a fixed number of samples of each data channel before overwriting the oldest data. The capture buffer can be triggered on any available variable signal in the drive by using a Boolean trigger mode or comparison to a value. The capture buffer will also trigger on a Trip fault. It is useful for capturing drive variables for troubleshooting field problems and capturing specific drive events. The Trend Recorder can display the capture buffer output.

Function Inputs

The following table specifies the input parameters to the *Capture Buffer* function.

Parameter	Description
Capture ch1 select	Selects capture buffer channel #1 variable.
Capture ch2 select	Selects capture buffer channel #2 variable.
Capture ch3 select	Selects capture buffer channel #3 variable.
	Channels 3 & 4 are active when *Capture buff config* is set to either *4 channels enabled* or *8 channels enabled*.
Capture ch4 select	Selects capture buffer channel #4 variable.
Capture ch5 select	Selects capture buffer channel #5 variable.
	Channels 5, 6, 7, & 8 are active when *Capture buff config* is set to *8 channels enabled*.
Capture ch6 select	Selects capture buffer channel #6 variable.
Capture ch7 select	Selects capture buffer channel #7 variable.
Capture ch8 select	Selects capture buffer channel #8 variable.

The following variable is also an input to the *Capture Buffer* function.

Variable	Description
Capture buffer ready	Enables or disables the capture buffer data collection.

Function Outputs

The following table specifies the status variables of the *Capture Buffer* function.

Variable	Description
Capture buffer stat	Indicates the status of the capture buffer. Possible values are: *Complete* - Capture buffer has completed its collection of data and is disabled. *Wait for trigger* - The capture buffer is waiting for the evaluation of the trigger condition to go True. *Post trigger capt* – Capture buffer has been triggered and is collecting post trigger data.
Capture triggered	Indicates if the capture buffer has been triggered. True/False
Number of channels	Indicates the number of channels that the capture buffer is configured to collect based on the setting of Capture buff config.
Capture buffer depth	Indicates the depth (i.e. number of samples) of the capture buffer. Capture buffer depth is inversely proportional to the number of channels collected.
Capture samp period	Indicates the interval at which the capture buffer collects data based on the values of the parameters Capture period and Capture period gain. Seconds
Total capture time	Indicates the total time that a full buffer would collect based on the values of Capture buffer depth, Capture period, and Capture period gain.

Function Configuration

The following table specifies the parameters that configure the size and execution rate of the capture buffer.

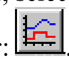
Parameter	Description
Capture buff config	Specifies the number of channels to collect. The depth of the capture buffer is inversely proportional to the number of channels collected. Possible values are: *2 channels enabled* *4 channels enabled* 8 channels enabled
	Note Whenever this parameter is modified, the capture buffer must be re-enabled to collect data with the new channel configuration.
Capture period	Determines the rate at which the capture buffer collects data. Each rate in the enumeration list is based on a particular execution rate in the processor. Actual execution rates vary between each Innovation Series product. Possible values are: *Disable* - Disables the capture buffer from collecting data. *Task 1 rate* - Collects data at the fastest execution rate of the processor. *Task 2 rate* - Collects data at n times slower than Task 1 rate. (n Task 1's are executed every 1 Task 2). *Task 3 rate* - Collects data at m times slower than Task 2 rate. (m Task 2's are executed every 1 Task 3).
	Note Whenever this parameter is modified, the capture buffer must be re-enabled to collect data at the new rate.
Capture period gain	Increases the collection period of the capture buffer (data is collected at a slower rate). For an integer value, n (>1), the capture buffer would collect data every n^{th} execution of the *Capture period*.
Cap re-enable delay	Controls an auto re-enable function for the capture buffer. This parameter sets the delay from when the capture buffer has completed its collection to when the capture buffer is re-enabled automatically. Minutes. The capture buffer will **only** re-enable when the drive is not stopped (*Stopped* is *False*). If *Cap re-enable delay* expires when the drive is stopped, the capture buffer will not re-enable until the drive is running again.
	Note A value of –1 disables the auto re-enable function.

The following table specifies the parameters that configure the capture buffer trigger control. The capture buffer will also automatically trigger on the rising edge of *Trip fault active*.

Parameter	Description
Capture pre trigger	Specifies the portion of the capture buffer that will be collected before the trigger occurs. Percent.
Capture trig select	Selects capture buffer trigger variable. The capture buffer will also automatically trigger on the rising edge of Trip fault active.
Capture trigger mode	Specifies the type of comparison against the variable selected in Capture trig select. Possible values are: *Boolean* - Triggers when variable is a 1. Variable in *Capture trig select* must be of Boolean type. *Inverted boolean* - Triggers when variable is a 0. Variable in *Capture trig select* must be of Boolean type. *Equal to level* - Triggers when variable is equal to value in *Capture trig level*. *Not equal to level* - Triggers when variable is not equal to value in *Capture trig level*. *Greater than level* - Triggers when variable is greater than value in *Capture trig level*. *Less than level* - Triggers when variable is equal to value in *Capture trig level*.
Capture trigger type	Specifies the behavior of the configurable trigger. Possible values are: Level Trigger - Will trigger when the comparison specified by Capture trigger mode has been satisfied. If the trigger condition is satisfied when the capture buffer is enabled, it will trigger immediately and collect post-trigger data. Edge Trigger - Will trigger on the rising edge of the trigger condition specified by Capture trigger mode.
Capture trig level	Specifies the threshold level for level-based trigger comparisons.

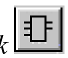
Function description

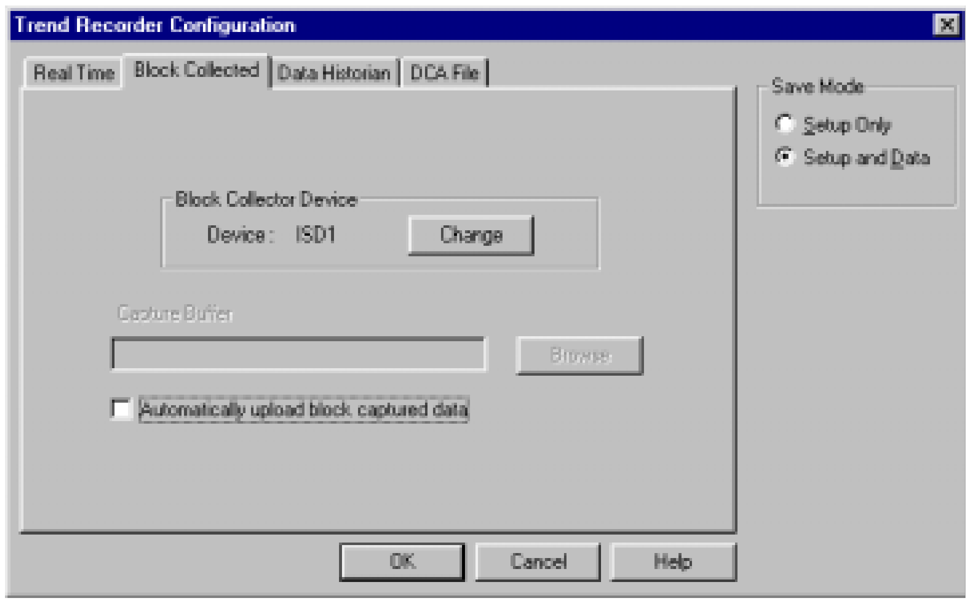
The capture buffer can be accessed from the Trend Recorder in the Control System Toolbox. To enable the Trend Recorder:

- From the *View* menu, select Trend Recorder <u>OR</u> select the Trend Recorder button on the toolbar: .

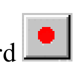
To enable the Innovation Series capture buffer from the Trend Recorder:

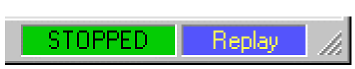
1. From the *Edit* menu, select *Configure* <u>OR</u> select the *Configure* button from the Trend Recorder toolbar: 
2. Select the *Block Collected* tab on the *Trend Recorder Configuration* dialog box and click *OK*.

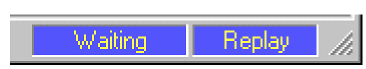
   This enables the *Upload*  and *Edit Block*  buttons on the Trend Recorder toolbar.



3. Select the *Edit Block* button from the toolbar, which brings up a block diagram that allows you to configure the capture buffer parameters described in the **Function Input** and **Function Configuration** sections. All of the parameter values must be sent to the drive for the capture buffer to work correctly.

4. Go back to the Trend Recorder and select the Record  button to enable the capture buffer. The toolbox status bar should change from a "Stopped" indicationto a waiting indication, as follows:





This indicates that the capture buffer is collecting data and waiting for the trigger.

To upload the capture buffer data into the Trend Recorder, select the **Upload** button from the Trend Recorder toolbar.

Capture Buffer Compatible Behavior

To view more than 4 channels or more than 512 samples, the *Capture Buffer* function should be used with a *GE Control System Toolbox* with a release of at least V6.1. *Toolbox* version prior to the V6.1 release can handle a maximum capture buffer size of 4 channels x 512 samples.

The capture buffer will present the collected data in a backward compatible format if used in conjunction with an older *Toolbox* release, however, because the capture buffer size has increased, only a sub-set of the data will be presented when viewed with an older *Toolbox*.

Related diagrams

- Capture Buffer Configuration (Capture)

General Purpose Constants

Each Innovation Series product provides three general purpose constants. The general purpose constants allow users to place constant values in device variables. The general purpose constants are particularly useful in configuring diagnostic functions.

Function inputs

The following table specifies the input parameters of the *General Purpose Constants* function.

Parameter	Description
GP Constant 1	User defined constant 1
GP Constant 2	User defined constant 2
GP Constant 3	User defined constant 3

Function outputs

The following table specifies the output variables of the *General Purpose Constants* function.

Variable	Description
GP Constant 1	User defined constant 1
GP Constant 2	User defined constant 2
GP Constant 3	User defined constant 3

Function description

The *General Purpose Constants* function sets the general purpose constant output variables equal to the general purpose constant input parameters:

GP Constant 1 = GP Constant 1

GP Constant 2 = GP Constant 2

GP Constant 3 = GP Constant 3

The units of the general purpose constants are determined by their use. For example, if one of the constants is used as a comparison level in a diagnostic function such as an SLD, the implied units of the constant are the internal control units of the signal against which the comparison is made. The units of the general purpose constant are not necessarily the display units of the comparison signal. For more information on the difference between display units and internal control units, see the *Language and Units Presentation* function help.

Related diagrams

- Diagnostic & Utility Functions (Diag_Util)

General Purpose Filters

Each Innovation Series product contains four general purpose filters. The general purpose filters allow users to filter signals with a specified bandwidth.

Function inputs

The following table specifies the input parameters of the *General Purpose Filters* function.

Parameter	Description
GP filter 1 sel	Selects input to general purpose filter 1
GP filter 2 sel	Selects input to general purpose filter 2
GP filter 3 sel	Selects input to general purpose filter 3
GP filter 4 sel	Selects input to general purpose filter 4

Function outputs

The following table specifies the output variables of the *General Purpose Filters* function.

Variable	Description
GP filter 1 output	General purpose filter 1 output
GP filter 2 output	General purpose filter 2 output
GP filter 3 output	General purpose filter 3 output
GP filter 4 output	General purpose filter 4 output

Function configuration

The following table specifies the configuration parameters of the *General Purpose Filters* function.

Parameter	Description
GP filter 1 bndwth	General purpose filter 1 bandwidth
GP filter 2 bndwth	General purpose filter 2 bandwidth
GP filter 3 bndwth	General purpose filter 3 bandwidth
GP filter 4 bndwth	General purpose filter 4 bandwidth

Function description

The operation of general purpose filter 1 is described here. Each of the four general purpose filters behaves in the same manner.

The input, output, and bandwidth of general purpose filter 1 are defined as follows:

Input = Variable selected by GP filter 1 sel

Output = GP filter 1 output

Bandwidth = GP filter 1 bndwth

The transfer functions for general purpose filter 1 is defined as follows:

$$\text{Output} = \frac{\text{Bandwidth}}{\text{s} + \text{Bandwidth}} \times \text{Input}$$

The general purpose filters run at the fastest execution rate available in the product. This is the same rate at which bridge feedbacks are collected, the fastest regulators are operated, and hardware commands are issued. The filter execution rate is generally faster than the 1-millisecond rate at which the application functions and the LAN communications occur.

Related diagrams

- Diagnostic & Utility Functions (Diag_Util)

Oscillator

Each Innovation Series product contains a diagnostic oscillator. The oscillator switches between a positive value and a negative value, spending the same amount of time at each level. The oscillator can be used as a reference signal source for test purposes.

Function outputs

The following table specifies the output variables of the *Oscillator* function.

Variable	Description
Sqr wave osc output	Oscillator square wave output

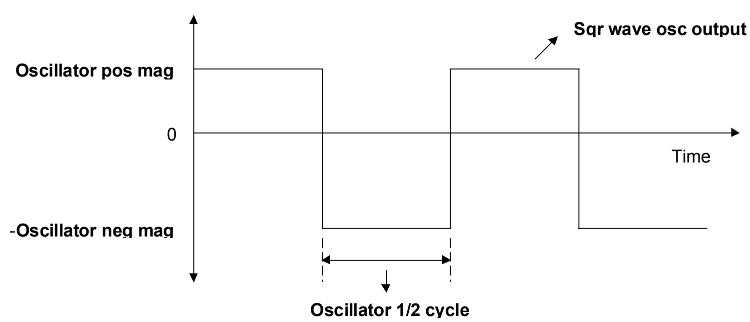
Function configuration

The following table specifies the configuration parameters of the *Oscillator* function.

Parameter	Description
Oscillator neg mag	Magnitude of the negative portion of oscillator output
Oscillator pos mag	Magnitude of the positive portion of oscillator output
Oscillator 1/2 cycle	Time that defines half of the oscillation period, sec
Oscillator enable	Enable oscillator

Function description

The *Oscillator* function produces a square wave output that switches between a positive value and a negative value. The function can be enabled or disabled via the parameter, *Oscillator enable*. The output levels and the period of the square wave are configurable. The following diagram shows how the configuration parameters generate the oscillator output.



Related diagrams

- Diagnostic & Utility Functions (Diag_Util)

Position Feedback

The *Position Feedback* function provides a set of position feedback signals in 22-bit floating point format.

Function inputs

The following tachometer signals are inputs to the *Position Feedback* function.

- Tachometer position: This signal is a 16-bit integer with units of A-quad-B counts.
- Marker count: This signal is a 16-bit integer that increments every time a marker pulse is detected.
- Marked tachometer position: This signal is a 16-bit integer with units of A-quad-B counts. It equals the tachometer position at the instant the marker pulse is detected.

The following table specifies the input parameters of the *Position Feedback* function.

Parameter	Description
Pos sample cmd sel	Selects the signal that specifies the sampling of tachometer position.

Function outputs

The following table specifies the output variables of the *Position Feedback* function.

Variable	Description
Position counter	Tachometer position extended to 22 bits and converted to floating point format.
Pos cntr mark	Marked tachometer position extended to 22 bits and converted to floating point format.
Pos down edge smp	Sampled version of Position counter, sampled on the falling edge of the sample signal.
Pos up edge sample	Sampled version of Position counter, sampled on the rising edge of the sample signal.

Function description

The output signals *Position counter* and *Pos cntr mark* are the tachometer position and the marked tachometer position extended from 16 to 22 bits. *Position counter* and *Pos cntr mark* roll over to zero (0) at the maximum value that can be represented in 22 bits (4,194,303). The transition happens in both the forward and backward directions.

Position counter is sampled when the signal selected by *Pos sample cmd sel* transitions between True and False. *Pos up edge sample* equals *Position counter* when the signal selected by *Pos sample cmd sel* changes from False to True. *Pos down edge smp* equals *Position counter* when the signal selected by *Pos sample cmd sel* changes from True to False.

The Task Interval Strobe shown on the *Position Feedback* diagram represents sampling of hardware that takes place at the Task 1 rate, the fastest execution rate available to the control. The Task 1 rate is faster than the fastest rate at which *Position counter* can be sampled.

Related diagrams

- Position Feedback Instrument (PosFbk)

Predefined Constants

Each Innovation Series product contains a number of predefined constants. These constants are available for use in a variety of functions. They are generally found on the selection lists for parameters that select control signals.

Floating point constants

The following floating point constants are available.

- Constant float 0.0
- Constant float -1.0
- Constant float 1.0

Integer constants

The following integer constants are available.

- Constant integer0
- Constant integer -1
- Constant integer1

Boolean constants

The following Boolean constants are available.

- Force True
- Force False

Unused constants

The Unused category of constants can be used to turn off certain product behaviors. See individual functional helps for information on how the Unused constants affect those functions.

The following Unused constants are available.

- Unused float
- Unused integer
- Unused boolean

Signal Level Detector (SLD)

Each Innovation Series product supplies three SLD channels. Each SLD does a level comparison on two inputs. The Boolean output of the SLD represents the status of the comparison. The nature of the comparison is configurable.

Function inputs

The following table specifies the input parameters of the *Signal Level Detector (SLD)* function.

Parameter	Description
SLD1 input 1 select	Selects SLD1 input 1 value
SLD1 input 2 select	Selects SLD1 input 2 value
SLD2 input 1 select	Selects SLD2 input 1 value
SLD2 input 2 select	Selects SLD2 input 2 value
SLD3 input 1 select	Selects SLD3 input 1 value
SLD3 input 2 select	Selects SLD3 input 2 value

Function outputs

The following table specifies the output variables of the *Signal Level Detector (SLD)* function.

Variable	Description
SLD1 status	Status of SLD1 comparison
SLD2 status	Status of SLD2 comparison
SLD3 status	Status of SLD3 comparison

Function configuration

The following table specifies the configuration parameters of the *Signal Level Detector (SLD)* function:

Parameter	Description
SLD1 compare mode	Type of comparison that the SLD1 function performs
SLD1 sensitivity	SLD1 comparison level
SLD1 hysteresis	SLD1 turn off deadband
SLD1 pick up delay	SLD1 turn on time delay, Seconds
SLD1 drop out delay	SLD1 turn off time delay, Seconds
SLD1 input 1 abs val	SLD1 input 1 mode (allows the absolute value to be used)
SLD2 compare mode	Type of comparison that the SLD2 function performs
SLD2 sensitivity	SLD2 comparison level
SLD2 hysteresis	SLD2 turn off deadband
SLD2 pick up delay	SLD2 turn on time delay, Seconds
SLD2 drop out delay	SLD2 turn off time delay, Seconds
SLD2 input 1 abs val	SLD2 input 1 mode (allows the absolute value to be used)
SLD3 compare mode	Type of comparison that the SLD3 function performs
SLD3 sensitivity	SLD3 comparison level
SLD3 hysteresis	SLD3 turn off deadband
SLD3 pick up delay	SLD3 turn on time delay, Seconds
SLD3 drop out delay	SLD3 turn off time delay, Seconds
SLD3 input 1 abs val	SLD3 input 1 mode (allows the absolute value to be used)

Function description

The following description explains the operation of SLD1. It also applies to SLD2 and SLD3.

Parameters *SLD1 input 1 select* and *SLD1 input 2 select* select device variables. They define the inputs for SLD1. The following table specifies how the inputs are formed based on the value of parameter *SLD1 input 1 abs val*.

SLD1 input 1 abs val	SLD1 Input Values
False	Input 1 = SLD1 input 1 select pointer value
	Input 2 = SLD1 input 2 select pointer value
True	Input 1 = Absolute value of SLD1 input 1 select pointer value
	Input 2 = SLD1 input 2 select pointer value

The parameter *SLD1 compare mode* determines the type of comparison that is performed on the two inputs. It determines how the configuration parameters *SLD1 sensitivity*, *SLD1 hysteresis*, *SLD1 pick up delay*, and *SLD1 drop out delay* are interpreted. It determines how the output *SLD1 status* is formed. The following tables specify the behavior of SLD1 for the different enumerations of *SLD1 compare mode*.

SLD1 compare mode = In1-In2>Sen	
Turn on condition	(Input 1 - Input 2) > SLD1 sensitivity
Turn on delay time	Turn on condition must remain valid for SLD1 pick up delay. After the delay SLD1 status = True.
Turn off condition	(Input 1 - Input 2) <= (SLD1 sensitivity - SLD1 hysteresis)
Turn off delay time	Turn off condition must remain valid for SLD1 drop out delay. After the delay SLD1 status = False.

SLD1 compare mode = In1-In2<Sen	
Turn on condition	(Input 1 - Input 2) < SLD1 sensitivity
Turn on delay time	Turn on condition must remain valid for SLD1 pick up delay. After the delay SLD1 status = True.
Turn off condition	(Input 1 - Input 2) >= (SLD1 sensitivity + SLD1 hysteresis)
Turn off delay time	Turn off condition must remain valid for SLD1 drop out delay. After the delay SLD1 status = False.

SLD1 compare mode = In1<>In2	
Turn on condition	Absolute value of (Input 1 - Input 2) > SLD1 sensitivity
Turn on delay time	Turn on condition must remain valid for SLD1 pick up delay. After the delay SLD1 status = True.
Turn off condition	Absolute value of (Input 1 - Input 2) <=(SLD sensitivity-SLD1 hysteresis)
Turn off delay time	Turn off condition must remain valid for SLD1 drop out delay. After the delay SLD1 status = False.

SLD1 compare mode = In1=In2

Turn on condition	Absolute value of (Input 1 - Input 2) <= SLD1 sensitivity
Turn on delay time	Turn on condition must remain valid for SLD1 pick up delay. After the delay SLD1 status = True.
Turn off condition	Absolute value of (Input 1 - Input 2) > (SLD1 sensitivity + SLD1 hysteresis)
Turn off delay time	Turn off condition must remain valid for SLD1 drop out delay. After the delay SLD1 status = False.

SLD1 compare mode = In1-In2>Sen one shot

Turn on condition	(Input 1 - Input 2) > SLD1 sensitivity
Turn on delay time	After the turn on condition is met a timer begins. The turn on condition does not need to remain valid while the timer runs. After SLD1 pick up delay expires SLD1 status = True.
Turn off condition	After SLD1 status goes True a timer begins. After SLD1 drop out delay expires SLD1 status = False. The minimum time SLD1 status is True is approximately 1 millisecond.
Reset condition	SLD 1 becomes active again when (Input 1 - Input 2) <= (SLD1 sensitivity - SLD1 hysteresis)

SLD1 compare mode = In1-In2<Sen one shot

Turn on condition	(Input 1 - Input 2) < SLD1 sensitivity
Turn on delay time	After the turn on condition is met a timer begins. The turn on condition does not need to remain valid while the timer runs. After SLD1 pick up delay expires SLD1 status = True.
Turn off condition	After SLD1 status goes True a timer begins. After SLD1 drop out delay expires SLD1 status = False. The minimum time SLD1 status is True is approximately 1 millisecond.
Reset condition	SLD 1 becomes active again when (Input 1 - Input 2) >= (SLD1 sensitivity + SLD1 hysteresis)

Related diagrams

- Signal Level Detection (SLD)

Simulator

The *Simulator* function allows the user to simulate the operation of the drive and motor without applying power to the motor, power bridge, and other equipment.

Function inputs

The following table specifies the input parameters of the *Simulator* function.

Parameter	Description
Ext sim spd enb sel	Selects the signal that disables the calculated model speed and allows the speed to be specified by another source.
Ext sim spd sel	Selects the variable motor speed that overrides the speed calculation. RPM
Ext sim trq sel	Selects the variable torque produced by an external load. Newton-meters

Function outputs

The following table specifies the output variables of the *Simulator* function.

Variable	Description
Simulated speed	Motor speed. Radians/second

Function configuration

The following table specifies the configuration parameters of the *Simulator* function.

Parameter	Description
Simulate mode	Enables drive and motor simulation.
Fixed ext sim spd	Constant motor speed that overrides the speed calculation. Radians/second.
Simulated load	Constant torque produced by an external load. Newton-meters or Pound-feet.
Sim const friction	Constant friction. Newton-meters or Pound-feet
Simulated inertia	Inertia of motor and load. Kilogram-meters^2 or Pound-feet^2
Simulated stiction	Constant stiction. Newton-meters or Pound-feet
Sim visc friction	Viscous friction coefficient. Newton-meters/RPM or Pound-feet/RPM

Control Diagnostic Variables

The *Control Diagnostic Variables* function outputs filtered diagnostic variables that are available to the user.

Function outputs

The following table specifies the output variables of the *Control Diagnostic Variables* function.

Variable	Description
AC line voltage mag	Filtered ac line magnitude. A true magnitude calculation of Vab and Vbc which is then filtered.
AC line frequency	Filtered ac line frequency produced by the phase lock loop.

Line Simulator

The *Line Simulator* function allows the user to simulate the operation of the drive and the ac line without applying power to the bridge.

Function inputs

The following table specifies the input parameters of the *Line Simulator* function.

Parameter	Description
Sim line frequency	AC line frequency in simulator mode. It is normally set to, but not restricted to, 50 or 60 Hertz.
Sim freq slew rate	Simulator frequency slew in radians/sec/sec. Setting this value to a something other than zero causes the frequency to slew continuously from (-)0.5 of nominal to (+)0.25 of nominal and back. This exercises the entire transient frequency range covered by the specification.
Sim A-N volt scale	Sim A-N volt scale can be used to attenuate phase A line to neutral voltage in order to simulate transient line conditions. The line to neutral voltage for phase A will be attenuated according to Sim A-N volt scale every 2.70046 Seconds. The duration of the transient is specified by the parameter Volt short time. The 2.70046 Seconds period was chosen so that the transient condition gradually walks through the sine wave. In order to simulate an open on phase A, set Sim A-N volt scale to 1.0, Sim B-N volt scale to 1.0, and Sim C-N volt scale to 0.5.
Sim B-N volt scale	Sim B-N volt scale behaves identically to Sim A-N volt scale except that it affects phase B instead of phase A.
Sim C-N volt scale	Sim C-N volt scale behaves identically to Sim A-N volt scale except that it affects phase C instead of phase A.
A-B volt fault scale	A-B volt fault scale simulates a line to line fault between phases A and B. The default for A-B volt fault scale is 0, providing no attenuation.

Function outputs

The following table specifies the output variables of the *Line Simulator* function.

Variable	Description
Simulate mode act	Simulator mode
Sim A-B line voltage	Simulator line to line voltage A-B
Sim B-C line voltage	Simulator line to line voltage B-C
Sim A-N line voltage	Simulator line to neutral voltage A
Sim B-N line voltage	Simulator line to neutral voltage B
Sim C-N line voltage	Simulator line to neutral voltage C

Function configuration

The following table specifies the configuration parameters of the *Line Simulator* function.

Parameter	Description
Simulate mode	Enables simulation mode.

Drive Configuration Functions

Intelligent Part Number (IPN)

The Intelligent Part Number (IPN) specifies the Innovation Series product and the basic configuration of the product. The IPN is the catalog number for the Innovation Series product. It can be found on the inside of the cabinet door.

The IPN for the Innovation Series medium voltage drive with general industrial application pattern takes the following form:

ACMVAC2-G-FRAM-VOLT-AMPS-xxxxxxxxx-xxx-xx

The IPN contains eight fields separated by dashes. The fields shown in italics are user configurable.

Product field

The product field is designated by the characters ACMVAC2. The characters have the following meaning:

AC	AC inverter drive
MV	Medium voltage
AC	AC fed
2	2300 volt

Pattern field

The pattern field is designated by the character G. The character has the following meaning:

G	General industrial application firmware pattern

Frame size field

The frame size field is designated by the characters *FRAM*. The designation has the following meaning:

FRAM	Bridge frame size

The following medium voltage drive frame sizes are supported:

0700 (Eupec IGBTs)

0701 (Powerex IGBTs)

System voltage field

The system voltage field is designated by the characters *VOLT*. The designation has the following meaning:

VOLT	Maximum lineup output AC voltage

The medium voltage drive supports the following system voltages:

2300

Shunt rating field

The shunt rating field is designated by the characters *AMPS*. The designation has the following meaning:

AMPS	Total shunt amp rating per phase

The medium voltage drive supports the following shunt ratings:

0300, 0500, 0600, 0800, 1000

Primary Motor & Application Data

User entered parameters

Eight primary values define the motor load for the Innovation Series general industrial application (GIA) pattern drive. The primary values include motor nameplate data and application data. They are user-entered parameters that are generally specified within the *Drive Commissioning* wizard. The primary values are used to determine control and protective settings for the drive.

The following table lists the user-entered parameters that specify the primary motor and application data:

Parameter	Description
Motor rated current	Motor nameplate current. Amps
Motor rated voltage	Motor nameplate voltage. Volts
Crossover Voltage	Voltage at which field weakening begins. RMS volts
Motor rated power	Motor nameplate power. Kilowatts or Horsepower
Motor rated freq	Motor nameplate frequency. Hertz
Motor rated rpm	Motor nameplate speed. RPM
Motor poles	The number of magnetic poles in the motor. If this parameter is left blank, the control determines the number of poles from parameters Motor rated freq and Motor rated rpm. In the case of some lower speed motors (less than 900 rpm at 60 hz) with high slip, this determination may not be accurate and parameter Motor poles must have the correct value entered. Unitless. Must be an even whole number.
Applied top RPM	Top application speed. RPM

Reflected indication variables

The Innovation Series drive contains a variable copy of some of the primary motor and application parameters. The following table lists the variable reflections of the primary value parameters:

Variable	Description
100% Motor current	Motor nameplate current. RMS amps
100% Motor voltage	Voltage at which field weakening begins. RMS volts
100% Motor power	Motor nameplate power. Kilowatts or Horsepower
100% Applied RPM	Top application speed used in overspeed fault protection and other areas of motor control. RPM

Calculated control variables

The Innovation Series drive contains a set of variables that are calculated from the primary motor parameters but are not exact reflections of the primary parameters. These calculated variables are used in motor control and protective functions. The values of the variables are calculated at drive initialization after power up or a hard reset.

The following table lists the variables calculated from the primary value parameters:

Parameter	Description
100% Motor torque	Motor torque at motor nameplate conditions. Newton-meters or Pound-feet
100% Flux	Motor flux at motor nameplate conditions. Volts/hertz
100% Torque current	Motor torque current at motor nameplate conditions. RMS amps
100% Flux current	Motor flux current at motor nameplate conditions. RMS amps
100% Slip	Motor slip at motor nameplate conditions. Radians/second

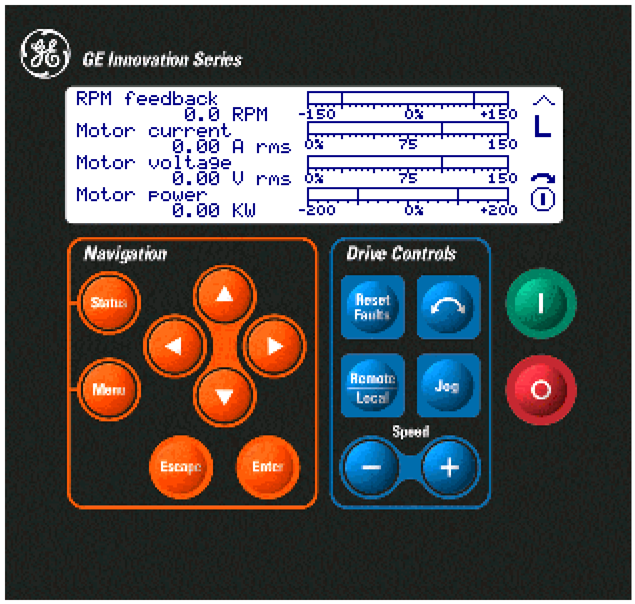
Display meter scaling parameters

The Innovation Series drive contains a set of parameters that specify the scaling for the DDI and toolbox display meters. These parameters are calculated from the primary motor and application parameters. They are calculated within the *Drive Commissioning* wizard or the *Per Unit Setup* wizard. If any of the primary data parameters is modified outside the *Drive Commissioning* wizard, the *Per Unit Setup* wizard should be performed to update the display meter scaling parameters.

General Setup Functions

Keypad Overview

The Drive Diagnostic Interface (DDI; also known as the keypad) is mounted on the door of an Innovation Series drive. The DDI provides a simple, easily accessible means for a user to set, monitor, and maintain the drive locally.



The DDI provides both analog and digital representations of drive functions and values. Its keypad is logically organized into two functional groups: navigation keys and drive control keys. The Run and Stop keys are set to the side for easy access.

The operator can use the DDI to perform the following common tasks:

- Monitor speed / current / voltage / power
- Start/Stop the drive
- Adjust a configuration parameter
- Reset a fault condition
- Commission the drive through a wizard

Each drive has its own DDI for local control.

Related functions

Following are the DDI functions that can be modified from the toolbox:

- Keypad Contrast Adjustment
- Keypad Meter Configuration
- Keypad Security Configuration
- Language Display

Keypad Contrast Adjustment

Normally the LCD contrast of the Drive Diagnostic Interface (DDI) should be adjusted at the DDI or keypad. The user can modify the *Keypad contrast adj* parameter under the General Setup -> Keypad -> Keypad Functions menu.

A special keypad key sequence is also available to make this adjustment and is especially useful when the contrast is too light or too dark to navigate the menus. The sequence is to hold down the Menu key and press either the up (darker) or down (lighter) arrow keys until the contrast is acceptable.

If your DDI firmware version is prior to V02.01.03C and the DDI contrast is too light or too dark to navigate through the menus you will need to use Toolbox to find the *Keypad contrast adj* parameter and make the adjustment.

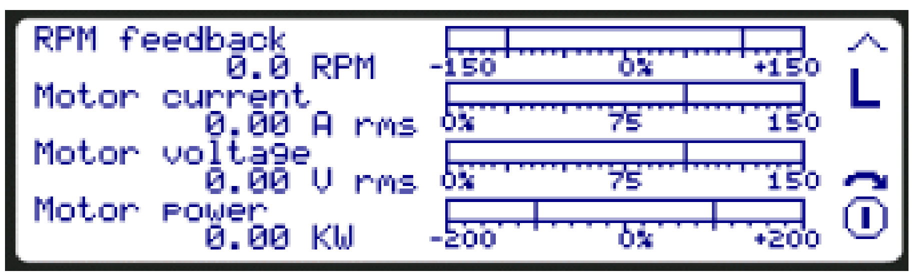
Function configuration

Parameter	Description
Keypad contrast adj	Adjusts the contrast of the DDI LCD screen. Values are from 0 to 63 where 63 is the darkest contrast. Setting Keypad contrast adj to 0 will cause the DDI to adjust the contrast to a middle value.

Note Once Keypad contrast adj has been modified in the toolbox and then saved in the drive, a hard reset must be performed for the user to see their modification to the contrast reflected in the DDI.

Keypad Meter Configuration

The DDI Status screen has four animated meters and associated text that display drive performance information.



The variables displayed by the meters and the meter ranges can be modified by configuring the following parameters:

Function configuration

Parameter	Description
Keypad meter 1 sel	Selects a floating-point variable that is displayed in Meter #1 on the DDI Status screen.
Keypad meter 2 sel	Selects a floating-point variable that is displayed in Meter #2 on the DDI Status screen.
Keypad meter 3 sel	Selects a floating-point variable that is displayed in Meter #3 on the DDI Status screen.
Keypad meter 4 sel	Selects a floating-point variable that is displayed in Meter #4 on the DDI Status screen.
Keypad meter 1 range	Selects the bar graph meter scaling for Meter #1. Possible values are as follows (note that all bar graphs are scaled in percent (%)): 0 to +100 -100 to +100 0 to +150 -150 to +150 0 to +200 -200 to +200 0 to +300 -300 to +300
Keypad meter 2 range	Selects the bar graph meter scaling for Meter #2. See *Keypad meter 1 range* for possible values.
Keypad meter 3 range	Selects the bar graph meter scaling for Meter #3. See *Keypad meter 1 range* for possible values.
Keypad meter 4 range	Selects the bar graph meter scaling for Meter #4. See *Keypad meter 1 range* for possible values.
Keypad meter 1 ref	Selects an optional reference display for Meter #1. If selected, the bar graph for this reference signal will be displayed just above the bar graph for the feedback signal. Both graphs will be displayed in the Meter #1 area as a split screen. The reference signal will only be displayed if local mode is enabled. *Keypad meter 1 ref* can be disabled from the pick list.

Note When changing DDI meter configuration from the toolbox, first save the modified parameters to the drive. Press the Menu button and then the Status button on the DDI. This will cause the meters on the Status screen to update.

Keypad Security Configuration

The DDI contains security controls to keep unauthorized personnel from operating or reconfiguring the drive. These security controls can be modified from the toolbox or from the DDI. The controls are password protected in the DDI.

Function configuration

Parameter	Description
Keypad privilege	Selects the privilege level in the DDI. Possible levels are: *Read only* - Disables both drive controls and configuration functions. Allows user to view but not edit parameters. *Operate & read only* – Enables drive controls, but disables configuration functions. Allows user to view but not edit parameters. *Configure & operate* - Enables both drive controls and configuration functions. See below for full list of enabled functions for each level.
Keypad password	Sets the 5-digit password value for the DDI. When a user attempts to modify the Keypad security configuration from the DDI, he will be prompted to enter a password. If the entered password does not match the value in *Keypad password*, the user will not be permitted to modify the security configuration (*Keypad privilege* and *Keypad password*).

Function description

The following table displays a list of all DDI functions. Available functions for each privilege level are marked with a check mark (✓).

Keypad Function	Privilege Level Read Only	Operate & read only	Cofigure & operate
Drive control functions			
Stop	✓	✓	✓
Start		✓	✓
Reset faults	✓	✓	✓
Change direction		✓	✓
Remote/Local		✓	✓
Jog		✓	✓
Speed Increment		✓	✓
Speed Decrement		✓	✓
Menu functions			
Status button	✓	✓	✓
Menu button	✓	✓	✓
Navigation buttons (Arrows, Esc, Enter)	✓	✓	✓
Display Active Faults	✓	✓	✓
Display Fault History	✓	✓	✓
View Parameters	✓	✓	✓
Edit Parameters			✓
View Variables	✓	✓	✓
Wizards			✓
Adjust Screen Contrast	✓	✓	✓
Display Firmware Version	✓	✓	✓
Display Hardware Information	✓	✓	✓
Save Parameters to Backup			✓
Restore Parameters from Backup			✓
Compare Current Parameters to Backup	✓	✓	✓
View Overrides	✓	✓	✓

Note When changing DDI security configuration from the toolbox, first save the modified parameters to the drive. Then switch between the Menu and Status screens for the password and privilege level to update.

Language and Units Presentation

The presentation of the Innovation Series product in the Control System Toolbox and DDI (keypad) can be customized. The presentation can be configured using the following parameters:

- Language
- Display units

In regions in which English is not the primary language, the Innovation Series product provides a choice of two languages: English and the indigenous language. The presentation is in English if parameter *Language* is set to *English*. The presentation is in the indigenous language if *Language* is set to *Native*.Parameters and variables in the Innovation Series product can be displayed in different unit systems. The display units are chosen by parameter *Display units*.

Three different unit systems are available:

- Imperial (English)
- Metric (SI)
- Native (Platform)

If *Display units* is set to *Native (Platform)*, then values are displayed in the same units that the internal control uses. The following table specifies some of the unit system differences.

Display units	Length	Power	Torque	Flux
Imperial (English)	Feet	Horsepower	Foot-pounds	Volts/hertz
Metric (SI)	Meters	Kilowatts	Newton-meters	Volts/hertz
Native (Platform)	Meters	Watts	Newton-meters	Webers

Language Display

As long as the keypad has been configured correctly, the DDI can display its menu and status information in an alternate language.

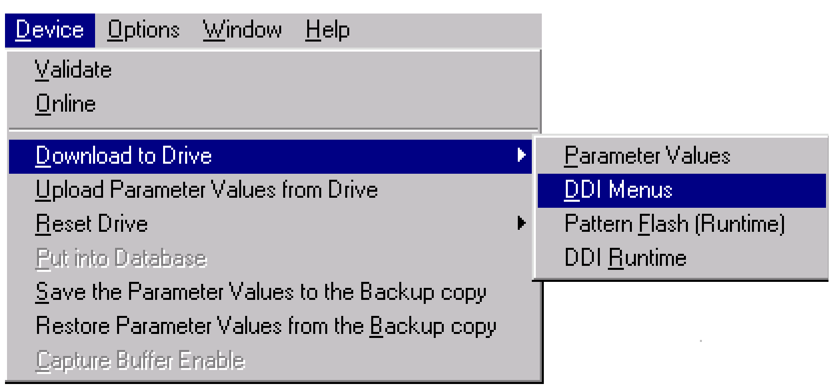
Note Presently this function is not yet operational.

Function configuration

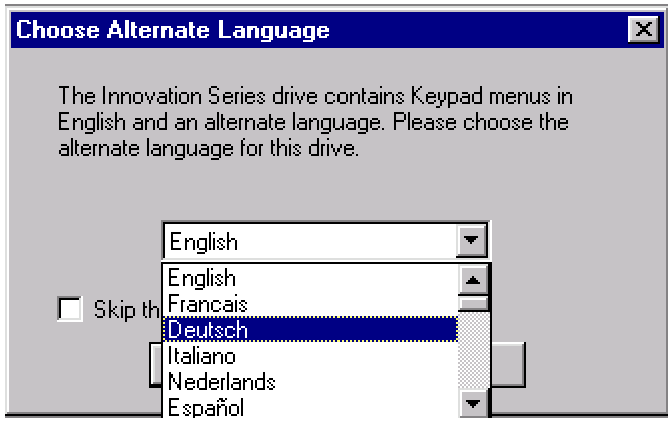
Parameter	Description
Language	Selects the language in which to display all information in the DDI. Possible selections are: *English* - Displays DDI text in English. *Native* - Displays DDI text in the native language that is specified when DDI Menus are downloaded from the toolbox (see below).

Function description

To display the DDI text in a non-English language, the user must first download the appropriate DDI Menus. The user can perform this operation from the toolbox by selecting from the menu bar: Device > Download > DDI Menus.



The user will then be prompted to select an alternate language to download to the DDI.



The toolbox will then build the DDI Menu file and can be downloaded to the DDI.

Once the download is completed, the user can then modify the *Language* parameter to the desired value. The DDI will display its text in the selected language the next time its screen is updated

I/O Functions

Analog and Digital I/O Testing

The *Analog and Digital I/O Testing* function is intended for factory use only.

Function configuration

The following table specifies the configuration parameters for the *Analog and Digital I/O Testing* function.

Parameter	Description
I/O test mode req	Hardware I/O test request.
Simulate mode	Simulator mode request.

Both *I/O test mode req* and *Simulate mode* must be True for the *Analog and Digital I/O Testing* function to be active. *I/O test mode* is True when the function is active.

Analog inputs

The following table specifies the signals available for testing the analog inputs.

Variable	Description
Analog input 1 volts	Voltage of analog input 1 source. DC volts
Analog input 2 volts	Voltage of analog input 2 source. DC volts

Digital inputs

The following table specifies the signals available for testing the digital inputs.

Variable	Description
Digital input 1 test	Unfiltered value of digital input 1.
Digital input 2 test	Unfiltered value of digital input 2.
Digital input 3 test	Unfiltered value of digital input 3.
Digital input 4 test	Unfiltered value of digital input 4.
Digital input 5 test	Unfiltered value of digital input 5.
Digital input 6 test	Unfiltered value of digital input 6.

Hi-fi counters

The following table specifies the signals available for testing the high fidelity VCO counters.

Variable	Description
VCO 1 unfiltered	VCO 1 counter value.
VCO 2 unfiltered	VCO 1 counter value.
VCO 3 unfiltered	VCO 1 counter value.

Local and system fault strings

The following table specifies the signals available for testing the local and system fault strings.

Variable	Description
Local fault test	Unfiltered value of local fault string.
System fault test	Unfiltered value of system fault string.

Contactor status

The following table specifies the signals available for testing the main contactor status input.

Variable	Description
MA cont test mode	Unfiltered value of main contactor status.

DAC and meter outputs

The following table specifies the parameters that configure the analog output (DAC) and meter output tests.

Parameter	Description
Analog out 1 test	DAC 1 output voltage. DC volts
Analog out 1 test	DAC 2 output voltage. DC volts
Analog out 1 test	DAC 3 / Meter 1 output voltage. DC volts
Analog out 1 test	DAC 4 / Meter 2 output voltage. DC volts
Analog meter 3 test	Meter 3 output voltage. DC volts
Analog meter 4 test	Meter 4 output voltage. DC volts

Relay outputs

The following table specifies the parameters that configure the relay output test.

Parameter	Description
Relay 1 test	Relay 1 output.
Relay 2 test	Relay 2 output.
Relay 3 test	Relay 3 output.
SS relay driver test	Relay 4 output.

Related diagrams

- Analog and Digital I/O Testing (HWIO_Tst)

Analog Inputs/Outputs and Mapping

Analog Inputs

Two bipolar (±10 volts) analog inputs are available at the terminal board (ATB). Jumpers on the BAIA board connect a burden resistor that allow these inputs to be used for 4-20 ma references.

Analog in 1 offset and *Analog in 2 offset* provide a voltage offset adjustment. *Analog in 1 gain* and *Analog in 2 gain* can be used to scale the inputs from volts to appropriate application units. *Analog in 1 filter* and *Analog in 2 filter* provide first-order signal softening at *Analog input 1* and *Analog input 2*.

Loss of 4-20 ma signal can be configured by selecting a lower threshold *Analog in 1 flt lev* and *Analog in 2 flt lev* and then selecting the appropriate fault type, *Analog in 1 flt mode* and *Analog in 2 flt mode*.

Analog Outputs

Two bipolar (±10 volts) DAC outputs are available at the terminal board (ATB). The signal to be output is selected by *Analog out 1 select*. This signal can be offset by *Analog out 1 offset* using the same units as the signal to be output. The signal is scaled for output by setting *Analog out 1 scale* to the value that will produce +10 volts. The second DAC is configured in a similar manner.

Meters

Four bipolar (±10 volts) meter drivers are available for use with the optional meter assembly. This assembly is connected to the drive at connector J8 on the backplane.

The signal to be metered is selected by *Analog meter 1 sel*. This signal can be offset by *Meter 1 offset* using the same units as the signal to be metered. The signal is scaled for output by setting *Analog meter 1 scale* to the value which shall produce +10 volts. *Meter 1 mode* is used to accommodate both 0 - +10 volt meters and -10 - +10 volt meters. *Analog meter 1 scale* is unaffected by *Meter 1 mode*. The remaining three meters are configured similarly.

Related diagrams

- Analog Inputs / Outputs & Mapping (HWIO_Ana)

Digital Inputs/Outputs and Mapping

Digital inputs and outputs provide an interface between the outside world and the control. The ATB (terminal board) provides six general purpose digital inputs. Three dry contact relays and one solid state relay driver are provided as outputs. System and Local fault strings provide start and trip interlocks to the control.

Isolated digital inputs are listed with their associated terminal board points. A filter debounces a noisy input signal. The filter should be set to zero in most instances, since the hardware provides a level of debounce conditioning. The variables *Digital input 1* through *Digital input 6* indicate the logical state of each digital input and are used to interface to functions in the drive that require a Boolean signal.

Each relay output may be used by setting the parameters *Relay 1 select* through *Relay 3 select* to the variables whose logical states are desired to drive the corresponding relay. The associated terminal board points are shown for output terminals of each relay. The variables *Relay 1 state*, *Relay 2 state*, and *Relay 3 state* indicates whether the relay coils are energized.

Relay four is a solid-state relay driver that should be used for driving a 24 V dc, 10 mA relay. The relay driver output may be used by setting the parameter *SS relay driver sel* to the variable whose logical state is desired to drive the relay. *Solid state relay* indicates the status of the relay driver.

In addition to the four programmable outputs available on ATB, the drive provides 3 additional application outputs through the CTBC terminal board. The CTBC outputs are not programmable but instead are mapped to some commonly used signals in the drive. CTBC outputs are solid-state relay drivers that can be used for driving 24 V dc, 10 mA relays. Signals available on CTBC are as follows:

CTBC Output	Pre-programmed function
D08 (pins 33 & 35)	Closed when *No trip fault* is True
D07 (pins 29 & 31)	Closed when *Running* is True
D06 (pins 25 & 27)	Closed when *No faults active* is True

A pilot relay controls a main contactor. Most applications do not require a contactor (see *MA contactor absent*). This contactor is normally controlled through drive sequencing, but it may be controlled alternately by *MA close req sel*. The contactor cannot be energized if either the Local Fault String or the System Fault String are open. If the contactor is closed and the Local Fault String or the System Fault String open, the contactor will be de-energized.

Contactor status feedback is available (*MA contactor closed*). *MA contactor fbk* determines if the drive sequencer requires *MA contactor closed* to be active in response to a contactor close command.

Related diagrams

- Digital Inputs / Outputs & Mapping (HWIO_Dig)

LAN Functions

LAN Overview

Information is available for the following LAN topics:

- Frame Phaselock Loop
- LAN Configuration and Health
- LAN Signal Map

Frame Phaselock Loop

The *Frame Phaselock Loop* function can synchronize the execution of the Innovation Series drive control firmware with the communication frame of the product application interface. This feature is available only for those interface which support synchronous communications, such as ISBus.

Function outputs

The following table specifies the published output variables of the *Frame Phaselock Loop* function.

Variable	Description
Frame PLL OK status	Boolean signal indicating the lock status of the *Frame Phaselock Loop*.
FPLL Phase error	Phase error signal for the *Frame Phaselock Loop*. Scaling is per-unitized such that unity corresponds to the full frame period; signal values range from minus one-half to plus one-half.
FPLL Freq Output	Frequency adjustment output signal for the *Frame Phaselock Loop*. Scaling is per-unitized such that unity corresponds to the full frame period; signal values range from minus output limit to plus output limit.

Function configuration

The following table specifies configuration parameters related to the *Frame Phaselock Loop* function.

Parameter	Description
Network interface	Network interface type. Specifies one of the following interface types: No interface ACL dual port memory (synchronous operation supported) ISBus (synchronous operation supported) DRIVENET - Optional LAN modules such as Genius & Profibus
LAN frame time	Expected communication frame period. Allowed frame periods are 1, 2, 4, and 8 milliseconds.

Function description

The product completely handles configuration of the *Frame Phaselock Loop* function. Appropriate user selections of *Network interface* activate the function, and user specification of *LAN frame time* sets the nominal period.

The Boolean variable *Frame PLL OK status* indicates the status of the *Frame Phaselock Loop*. The asserted state indicates that the function has been activated and that lock status has been validated. The unasserted state indicates that the function is not activated or that lock status is not validated.

The *FPLL Phase error* signal reflects the phase error when valid phase information has been extracted from the interface. A signal value of zero indicates either zero phase error or invalid phase information. Scaling is such that one per-unit phase error represents a full communication frame period.

The *FPLL Freq Output* signal is the frequency adjustment output of the function; the authority of the function to modify away from nominal frequency is strictly limited. When the function is not activated, the *FPLL Freq Output* signal is zero. When the function is activated but no valid phase information is detected, then *FPLL Freq Output* maintains its last valid calculated value.

When phaselock is achieved, *Frame PLL OK status* is asserted, *FPLL Phase error* is at a zero-mean steady-state value, and *FPLL Freq Output* is at a non-zero, but very small, steady-state value. When the *Frame Phaselock Loop* has been requested by configuration but phaselock is not achieved, then *Frame PLL not OK* is shown.

LAN Configuration and Health

The following information describes the configuration of the primary signal interface between the Innovation Series device and the application layer interface. The application layer may consist of an embedded ACL card, a direct LAN interface card, or an application-level ISBus serial bus.

Configuration parameters

The following table specifies the configuration parameters of the *LAN Configuration and Health* function.

Parameter	Description
Network interface	Network interface type. Specifies one of the following interface types: No interface ACL dual port memory ISBus DRIVENET - Other optional LAN modules such as Genius and Profibus
LAN frame time	Expected communication frame period. Allowed frame periods are 1, 2, 4, and 8 milliseconds.
LAN fbk avg time	Period over which feedback signals are sequentially averaged. The *LAN Signal Map* help topic describes which feedback signals are averaged. If *LAN fbk avg time* is zero, no averaging occurs.
LAN cmds inhibit	Disables LAN references, forcing the signal interface to operate in feedback-only mode. Local images of reference signals are set to zero (0.0) or False.
LAN trips inhibit	Disables LAN heartbeat trip fault (*LAN heartbeat trip*), and enable the corresponding alarm (*LAN heartbeat alarm*).
LAN heartbeat time	Period within which transition must be detected in the LAN heartbeat signal (*Heartbeat ref, lan*) to satisfy the local heartbeat timeout check.
Sys ISBus node #	ISBus node for the Innovation Series Drive device. Each device on the ISBus bus should be assigned a unique node between 1 and 31.
LAN parameter 1 through LAN parameter 16	These parameters are used only by optional LAN modules and are specific to those modules. Such items as baud rate and device number are configured via these parameters. Please see the documentation for the specific LAN module for detailed information.

Diagnostic variables

The following table specifies variables that indicate the LAN health and status for the *LAN Configuration and Health* function.

Variable	Description
LAN connection ok	Indicates that the health of the LAN connection is good, such that the LAN watchdog function is satisfied.
LAN commands OK	Indicates that the health of the LAN references is good, based upon detection of two successive *LAN connection ok* indications.
Heartbeat ref, lan	LAN heartbeat signal that proceeds from the application layer to the local device, used locally for *LAN heartbeat trip*) and *LAN heartbeat alarm*) detection, and as the source of the reflected *Heartbeat fbk, lan* signal.
Heartbeat fbk, lan	Local device reflection of the *Heartbeat ref, lan* signal that is sent back to the application layer.
Sys ISBus error cnt	Counter signal which provides an indication of the rate of occurrence of ISBus fault conditions.
Sys ISBus error reg	Bit-coded value of the last ISBus fault detected; each bit indicates a particular ISBus fault seen by the control.
Frame PLL OK status	Boolean signal indicating the lock status of the *Frame Phaselock Loop*.
FPLL Phase error	Phase error signal for the *Frame Phaselock Loop*. Scaling is per-unitized such that unity corresponds to the full frame period; signal values range from minus one-half to plus one-half.
FPLL Freq Output	Frequency adjustment output signal for the *Frame Phaselock Loop*. Scaling is per-unitized such that unity corresponds to the full frame period; signal values range from minus output limit to plus output limit.

Function description

Determining the integrity of the LAN interface involves several communication layers, and may vary depending upon the specific communication options in use. The Innovation Series Drive has two levels of validation available: LAN watchdog and LAN heartbeat. Status information is conveyed to the user and/or application by status signals and fault declarations.

The LAN watchdog function describes the set of mechanisms the drive uses to determine the status of the connection between DSPX and the module immediately "above" the drive in the LAN hierarchy. For Dual-Port RAM interfaces, such as that used for an embedded ACLA controller and for a direct LAN interface, the watchdog takes the form of a handshake protocol. In this handshake protocol, the drive determines the presence of a minimum level of intelligence on the host on the LAN side of the shared memory. For ISBus interfaces, such as that used by a remote or embedded ACLA controller, the watchdog reflects the reception of ISBus frame synchronization codes. The watchdog function's immediate authority is limited to alarms and status variables, although the status information does play a functional role in the interface management. Note that the watchdog does not offer information about the LAN connection's status which may be supported beyond the immediate interface to DSPX. In fact, many device networks offer no means of determining basic network health.

The LAN heartbeat function is visible to the user. The heartbeat function uses published signal map channels, and is available for use by the application. It provides a means to "loop back" a signal between the drive and any level in the LAN hierarchy so a higher-level controller can validate the entire connection pathway, including the drive itself. Locally, the drive can be configured to trigger a trip or alarm if the heartbeat reference signal fails to transition within a configurable period of time. The heartbeat offers the most robust validation options from a system perspective, although it offers the least information about the detected problem's location.

The *System ISBus error* alarm occurs when an ISBus fault is detected in the DSPX control. The variable *Sys ISBus error reg* contains the bit-coded value of the last ISBus fault detected; each bit indicates a particular ISBus fault seen by the control. The variable *Sys ISBus error cnt* increments upon fault detection. When initializing the interface, the user should expect the alarm to signal intermittently.

The *Frame PLL not OK* alarm occurs when phase-lock between the DSPX control and the System ISBus or (local ACL) is not assured. Detection of the fault is enabled when the parameter *Network interface* is configured to select an interface for which synchronized operation is supported. This alarm indicates that data coherency is compromised. Status of the *Frame Phaselock Loop* function can be observed via the signals *Frame PLL OK status*, *FPLL Phase error*, and *FPLL Freq Output*.

LAN Signal Map

The following information describes the primary signal interface between the Innovation Series Drive and the product application layer interface. The application layer may consist of an embedded ACL card, a direct LAN interface card, or an application-level ISBus serial bus.

The *LAN Signal Map* is a fixed signal map that defines dedicated registered communication channels for specific signals. It is defined in terms of paired reference and feedback pages that are the same size physically. The internal data organization of the reference and feedback pages may differ. The standard Innovation Series signal map page consists of eight 32-bit elements.

Each 32-bit element in the *LAN Signal Map* is assigned a data type. The following data types are used.

- Single precision floating point, IEEE 754 format (23-bit mantissa, 8-bit exponent, 1-bit sign).
- Two's complement integer.
- Individual 1-bit Boolean signals.

LAN References

The following table specifies the *LAN Signal Map* reference signals.

Page &	Element	Signal	Data Type	Description
1	1		Boolean bits	Boolean requests. See table below for definition of request bits.
1	2	Auto speed ref, lan	Floating point	Auto speed reference that can be used in the *Speed Reference Generation* function. RPM
1	3	Spd ref offset, lan	Floating point	Speed reference offset that can be used prior to the *Speed/Torque Regulator* function. RPM
1	4	Torque ref, lan	Floating point	Torque reference that can be used in the *Speed/Torque Regulator* function. Newton-meters or Pound-feet
1	5	Unused		
1	6	Unused		
1	7	GP lan ref 1	Floating point	General purpose reference that can be used by a number of functions.
1	8	GP lan ref 2	Floating point	General purpose reference that can be used by a number of functions.
2	1	Torque fdfwd, lan	Floating point	Torque feed forward reference that can be used in the *Speed/Torque Regulator* function. Newton-meters or Pound-feet
2	2	Flux reference, lan	Floating point	Flux scale that can be used in the *Motor Control Interface* function.
2	3	Droop comp ref, lan	Floating point	Droop compensation reference that can be used in the *Droop* function. Per unit torque
2	4	Unused		
2	5	Unused		
2	6	Unused		
2	7	GP lan ref 3	Floating point	General purpose reference that can be used by a number of functions.
2	8	GP lan ref 4	Floating point	General purpose reference that can be used by a number of functions.

The following table specifies the *LAN Signal Map* request bits that appear in Page 1, Element 1 of the reference signal map.

Bit	Signal	Description
0	Heartbeat ref, lan	Heartbeat signal to validate LAN health.
1	Fault reset req, lan	Request to reset drive faults. Functionality is always enabled.
2	Trip request, lan	Request to trip the drive. Functionality is always enabled.
3	Alarm request, lan	Request to declare an alarm in the drive. Functionality is always enabled.
4-7	Unused	
8	Run request, lan	Request to run the drive. Functionality is always enabled.
9	Jog request, lan	Request to jog the drive. Functionality is always enabled.
10	X stop request, lan	Request to perform an X stop in the drive. Functionality is always enabled.
11	Full flux req, lan	Request to flux the drive. Functionality is always enabled.
12	Rev mode req, lan	Request to reverse the direction of rotation that can be used in the *Speed Reference Generation* function.
13	Torque mode req, lan	Request to enable torque mode that can be used in the *Speed/Torque Regulator* function.
14	Droop disab req, lan	Request to inhibit droop functionality that can be used in the *Droop* function.
15	Trq lim 2 sel, lan	Request to choose between torque limits that can be used in the *Motor Control Interface* function.
16	Ramp rate 2 sel, lan	Request to choose between ramp rates that can be used in the *Speed Reference Ramp* function.
17	Unused	
18	Auto mode req, lan	Request to enable auto reference mode that can be used in the *Speed Reference Generation* function.
19-23	Unused	
24	GP lan req bit 1	General purpose request that can be used by a number of functions.
25	GP lan req bit 2	General purpose request that can be used by a number of functions.
26	GP lan req bit 3	General purpose request that can be used by a number of functions.
27	GP lan req bit 4	General purpose request that can be used by a number of functions.
28	GP lan req bit 5	General purpose request that can be used by a number of functions.
29	GP lan req bit 6	General purpose request that can be used by a number of functions.
30	GP lan req bit 7	General purpose request that can be used by a number of functions.
31	GP lan req bit 8	General purpose request that can be used by a number of functions.

LAN Feedbacks

Several LAN feedback signals are averaged versions of internal drive signals. The signals that fall in this category appear in dedicated floating point feedback channels. The averaging is sequential (not rolling), and the averaging time is specified by parameter *LAN fbk avg time*.

The following table specifies the *LAN Signal Map* feedback signals.

Page & Element		Signal	Data Type	Description
1	1		Boolean bits	Boolean feedbacks. See table below for definition of feedback bits.
1	2	Fault number	Integer	Number of active fault. Priority is given to trip faults over alarms, and to the earliest detected fault.
1	3	Speed feedback, lan	Floating point	Averaged *Speed reg fbk*. RPM
1	4	Motor torque, lan	Floating point	Averaged *Torque calced, unfil*. Newton-meters or Pound-feet
1	5	Motor current, lan	Floating point	Averaged *Motor current, unfil* x $\sqrt{2}$. RMS amps
1	6	Unused		
1	7	GP lan fbk reg 1	Floating point	General purpose feedback selected by *GP lan fbk reg 1 sel*.
1	8	GP lan fbk reg 2	Floating point	General purpose feedback selected by *GP lan fbk reg 2 sel*.
2	1	Motor power, lan	Floating point	Averaged motor output power. Kilowatts or Horsepower
2	2	Motor voltage, lan	Floating point	Averaged motor voltage. RMS volts
2	3-6	Unused		
2	7	GP lan fbk reg 3	Floating point	General purpose feedback selected by *GP lan fbk reg 3 sel*.
2	8	GP lan fbk reg 4	Floating point	General purpose feedback selected by *GP lan fbk reg 4 sel*.

The general purpose feedback signals *GP lan fbk reg 1*, …, *GP lan fbk reg 4* are not averaged. The following parameters are used to select the general purpose feedbacks.

- GP lan fbk reg 1 sel
- GP lan fbk reg 2 sel
- GP lan fbk reg 3 sel
- GP lan fbk reg 4 sel

The following table specifies the *LAN Signal Map* feedback bits that appear in Page 1, Element 1 of the feedback signal map.

Bit	Signal	Description
0	Heartbeat fbk, lan	Heartbeat signal to validate LAN health.
1	No faults active	No trip faults or alarms are active in the drive.
2	Trip fault active	Trip fault is active in the drive.
3	Local fault string	Local hardware permissive fault is active in the drive.
4	System fault string	System hardware permissive fault is active in the drive.
5	Ready to run	Drive is ready and will respond to a run request.
6	Bridge is on	Bridge power is enabled.
7	Running	Drive is running: References and regulators are enabled.
8	Run active	Drive is running in response to a run request.
9	Jog active	Drive is running in response to a jog request.
10	X stop active	Result of X stop requests.
11	Flux enable status	Net commanded flux is established.
12	Reverse mode active	Result of reverse mode requests.
13	Torque mode active	*Speed/Torque Regulator* function is regulating torque.
14	Speed mode active	*Speed/Torque Regulator* function is regulating speed.
15	In cur or trq limit	Inner torque regulator is in limit.
16	Unused	
17	MA cont enable stat	Real or modeled contactor status.
18	Auto mode active	Speed reference source is auto reference.
19	Zero speed active	Speed feedback (*Speed reg fbk*) is below zero speed level (*Zero speed level*).
20-22	Unused	
23	Lan diag fbk bit 1	Drive has diagnostic information for the diagnostic master.
24	GP lan fbk bit 1	General purpose feedback selected by *GP lan fbk bit 1 sel*.
25	GP lan fbk bit 2	General purpose feedback selected by *GP lan fbk bit 2 sel*.
26	GP lan fbk bit 3	General purpose feedback selected by *GP lan fbk bit 3 sel*.
27	GP lan fbk bit 4	General purpose feedback selected by *GP lan fbk bit 4 sel*.
28	GP lan fbk bit 5	General purpose feedback selected by *GP lan fbk bit 5 sel*.
29	GP lan fbk bit 6	General purpose feedback selected by *GP lan fbk bit 6 sel*.
30	GP lan fbk bit 7	General purpose feedback selected by *GP lan fbk bit 7 sel*.
31	GP lan fbk bit 8	General purpose feedback selected by *GP lan fbk bit 8 sel*.

The following parameters are used to select the general purpose feedback bits.

- GP lan fbk bit 1 sel
- GP lan fbk bit 2 sel
- GP lan fbk bit 3 sel
- GP lan fbk bit 4 sel
- GP lan fbk bit 5 sel
- GP lan fbk bit 6 sel
- GP lan fbk bit 7 sel
- GP lan fbk bit 8 sel

Related diagrams

- Drive LAN Signal Map (SigMap_LAN)
- Drive LAN Boolean Signals (bits 0-15) (SigMap_Bit1)
- Drive LAN Boolean Signals (bits 16-31) (SigMap_Bit2)

Motor Control Functions

Motor Control Overview

The Innovation Induction motor control algorithm utilizes a Flux-Vector control strategy. The motor control features include the following:

- Motor torque, flux and thermal models
- Online motor parameters adaptation
- Voltage and current regulators
- Voltage feedback offset correction
- Power-Dip ride through control
- Tach and Tachless mode operation
- Tach loss detection
- Current limit and Motor pull-out limit
- Automatic field-weakening control
- Torque Compensation
- Cross-over voltage control

Motor Equivalent Circuit parameter information is required for the motor controller. These parameters can be obtained by running the *Motor Control Tuneup* wizard during commissioning of the drive. The motor parameters will change due to motor temperature variations; because of this, on-line parameter adaptation, motor thermal model and torque compensation schemes (shown in diagram, Motor Control (Ovr_MCtrl) are incorporated in the motor control to enable accurate tracking of torque, flux and calculated speed.

Motor electrical models are used to form feedforward models, feedback torque, flux and speed calculations.

The induction motor controller can be used with or without tachometer. It can also be configured to operate in tachometer control mode with automatic switch over to Tachless control upon detection of a Tach-loss situation (comparison between model calculated speed and actual speed feedback signal).

Field flux control can be manipulated by *Flux ref ratio* (inputs to motor control shown in the diagram, Motor Control (Ovr_MCtrl). However, if the inverter output voltage approaches its limit (*Crossover Voltage*) by increasing speed, an automatic field-weakening control will take action to limit the output voltage (by reducing flux command) to the *Crossover Voltage* level.

Current limits in the drive are affected by motor Pull-out torque capability, *Power Dip Protection* control, and user current limit setting (as shown in diagram Motor Control Interface (Core)). Motor pullout limit normally occurs when a large torque is demanded in deep field-weakening operating region.

Related diagrams

- Motor Control Interface (Core)
- Motor Control (Ovr_MCtrl)

Flux Curve

The *Flux Curve* describes the relationship between the induction motor voltage and current. Specifically, each point of the curve specifies the voltage that is measured at the motor terminals for a particular excitation current, under no load conditions at the nameplate frequency.

Function configuration

The *Flux Curve* consists of five voltage and current points. Two parameters are associated with each point. The following table lists the parameters that configure the *Flux Curve*.

Parameter	Description
Flux curve voltage 1	No load voltage for data point 1. RMS volts
Flux curve voltage 2	No load voltage for data point 2. RMS volts
Flux curve voltage 3	No load voltage for data point 3. RMS volts
Flux curve voltage 4	No load voltage for data point 4. RMS volts
Flux curve voltage 5	No load voltage for data point 5. RMS volts
Flux curve amps 1	No load current for data point 1. RMS amps
Flux curve amps 2	No load current for data point 2. RMS amps
Flux curve amps 3	No load current for data point 3. RMS amps
Flux curve amps 4	No load current for data point 4. RMS amps
Flux curve amps 5	No load current for data point 5. RMS amps

The parameters listed above specify the curve if they contain meaningful values. If all the parameters are set to <No Value>, then the control uses the curve measured during *Motor Control Tuneup*.

Function description

Often the motor data sheet contains four or five voltage and current measurements that specify the *Flux Curve*. The voltage points are generally labeled "VNL" and the current points "INL".

If five data points are available on the motor data sheet, they can be entered directly into the configuration parameters. *Flux curve voltage 1* and *Flux curve amps 1* represent the smallest voltage and current, and *Flux curve voltage 5* and *Flux curve amps 5* represent the largest voltage and current.

If fewer than five data points are available on the motor data sheet, the highest data points should contain meaningful values and the lowest data points should be set to <No Value>. To reset one of the parameters to <No Value>, highlight the value and press the Delete key.

If the curve data is not available, all the configuration parameters should be set to <No Value>, and the *Flux Curve* should be determined using the *Motor Control Tuneup*.

Leakage Inductance Curve

The *Leakage Inductance Curve* describes the relationship between motor leakage flux and torque current. The motor data sheet does not provide *Leakage Inductance Curve* information. The characteristics of the curve can be obtained experimentally or by running the *Motor Control Tuneup*.

Line Transfer

The *Line Transfer* function transfers a motor from the drive to the utility line and captures a motor from the utility line to return control to the drive. In addition to the parameters and variables documented here the *Line Transfer Tuneup* wizard is provided to simplify and automate many of the tasks required to correctly commission this function. To use this function you must have the necessary contactors and operator interfaces as described in the "Innovation Series Line Transfer Application Guide". The following figure summarizes the power one-line of a basic line transfer application.

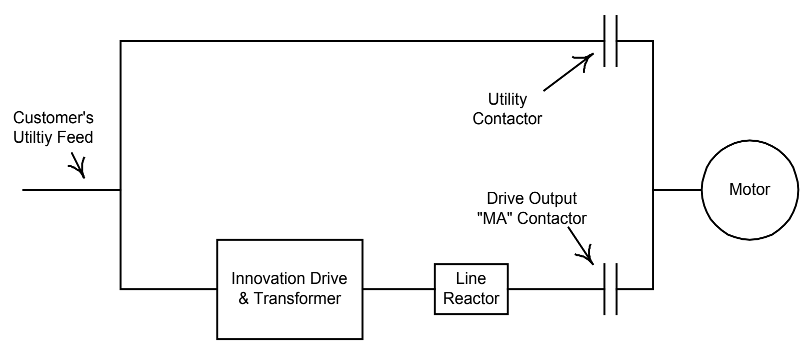


Figure 1

General operation

The following table specifies the general configuration parameters for this function.

Parameter	Description
Line reference	Selects the source of the utility line reference. The use of the internal line reference (ILR) is encouraged unless conditions exist such that it is not possible to accurately predict the utility phase and magnitude at the motor from the source voltage applied to the drive. See the "Innovation Series Line Transfer Application Guide" for a complete discussion of issues related to line reference selection.

The following table specifies the general status variables for this function.

Variable	Description
Line xfer enabled	Indicates that the line transfer function is enabled.
Transfer MA request	Indicates that the transfer/capture sequence has requested the MA contactor to close.

Motor transfer functionality

The following table specifies parameters relating to the motor transfer function.

Parameter	Description
Transfer mtr req sel	Selects the source of motor transfer requests.

The following table specifies variables relating to the motor transfer function.

Variable	Description
Transfer motor req	Indicates that the user has requested a motor transfer.
Transfer motor cmd	Indicates that the internal sequencer has acknowledged the user motor transfer request and commanded the transfer to proceed.
Transfer MA request	Indicates that the transfer/capture sequence has requested the MA contactor to close.
Utility close cmd	Indicates that the transfer sequence has requested the utility switchgear to close.
Utility close status	Indicates that the utility switchgear has been detected closed.

Motor capture functionality

The following table specifies parameters related to the motor capture function.

Parameter	Description
Capture mtr req sel	Selects the source of motor capture requests.
Anticipated torque	Specifies the expected motor torque at the time of motor capture. While not extremely critical, this value assists in smoothing the motor capture. Observe the motor torque at full speed operation and enter that number in PU here. If you do not know the motor torque use the default value.

The following table specifies variables related to the motor capture function.

Variable	Description
Capture trq feed fwd	Torque feedforward to speed regulator at the time of motor capture.
Capture motor req	Indicates that the user has requested a motor capture.
Capture motor cmd	Indicates that the internal sequencer has acknowledged the user motor capture request and commanded the capture to proceed.
Utility open command	Indicates that the capture sequence has requested the utility switchgear to open.
Utility open status	Indicates that the utility switchgear has been detected open.

External line reference functionality

The use of an ELR is recommended when the phase angle and magnitude of the utility feed the drive is expected to transfer the motor to cannot be accurately predicted from the phase angle and magnitude of the ILR. Such situations can arise when transferring the motor to a generator, to a utility feed separate from the one supplying the drive or in certain plants where multiple transformers with varying loads are involved. See the "Innovation Series Line Transfer Application Guide" for a complete discussion of issues related to line reference selection.

The following table specifies variables related to the external line reference functionality.

Variable	Description
Ext ref phase AB	External line reference analog input voltage.
Ext ref feedback	External line reference scaled to represent actual line voltage.

Motor Equivalent Circuit

The *Motor Equivalent Circuit* function implements the equivalent circuit of the motor.

Function configuration

The following table lists the configuration parameters for the *Motor Equivalent Circuit*.

Parameter	Description
Stator hot res R1	Stator hot resistance. Ohms
Stator cold res R1	Stator cold resistance. Ohms
Rotor hot res R2	Rotor hot resistance. Ohms
Rotor cold res R2	Rotor cold resistance. Ohms
Magnetizing react Xm	Magnetizing reactance. Ohms
Stator lkg react X1	Stator leakage reactance. Ohms
Rotor lkg react X2	Rotor leakage reactance. Ohms
Starting react Xst	Starting reactance. Ohms
Rated rotor temp	Rated rotor temperature. Degrees C or Degrees F
Motor ambient temp	Motor ambient temperature. Degrees C or Degrees F

Motor Temperature Estimation

The *Motor Temperature Estimation* function estimates the rotor and stator temperatures.

Function inputs

The *Motor Temperature Estimation* uses the following information to calculate the rotor and stator temperatures:

- Estimated rotor and stator resistances
- Thermal properties of the stator and rotor winding materials
- Motor ambient temperature

The estimated rotor and stator temperatures are calculated using online parameter estimation. The thermal properties of the winding materials and the motor ambient temperature are internal drive constants.

Function outputs

The following table specifies the outputs of the *Motor Temperature Estimation*.

Variable	Description
Rotor temp	Estimated rotor temperature. Degrees C or Degrees F
Stator temp	Estimated stator temperature. Degrees C or Degrees F

Power Dip Protection

The *Power Dip Protection* function sustains DC link voltage when a low voltage condition is detected.

Function inputs

The following table specifies the input variables of the *Power Dip Protection* function.

Variable	Description
DC bus feedback	DC link voltage. DC volts

Function configuration

The following table specifies the configuration parameters for the *Power Dip Protection* function.

Parameter	Description
Power dip control	Specifies one of three functional modes: Disabled Enabled with standard operation Enabled with custom operation
Custom pwr dip time	Length of time that the function attempts to sustain the DC link in custom mode. Seconds

Faults and alarms

The following table specifies the faults and alarms that the *Power Dip Protection* function declares.

Fault	Description
Power dip	Trip fault that occurs when the DC link voltage remains below the power dip activation level for a specified period of time. Causes drive to stop running.

Function description

The *Power Dip Protection* function is activated when the drive determines that the DC link voltage is low. The power dip voltage level is defined as

80% x 1.357 x *IPN volt rating*.

IPN volt rating is specified during the drive commissioning process and should not be changed to alter the behavior of the *Power Dip Protection* function.

When a DC link low voltage condition is detected, the *Power Dip Protection* function begins a timer. The function uses motor rotational energy to keep the DC link at the power dip voltage level until the timer expires. The expiration time for the timer depends on the parameters *Power dip control* and *Custom pwr dip time*. The following table specifies how the expiration time is determined:

Value of Power dip control	Expiration time
0.008 sec (Disable)	0.008 seconds
0.500 sec (Enable)	0.5 seconds
Custom: Specify time	User specified value of *Custom pwr dip time*

The timer does not reset to zero if the DC link rises above the power dip voltage level. Instead, the timer contains the difference between the amount of time the DC link feedback spends below and the amount of time it spends above the power dip voltage level. As a result, the timer may expire even if the DC link voltage is not continuously below the power dip voltage level. If the timer expires, the *Power dip* trip fault is declared.

The *Power Dip Protection* function does not try to regulate the DC link when the absolute speed of the motor (variable *Speed reg fbk*) is less than 5% of the rated motor nameplate speed (parameter *Motor rated rpm*).

The maximum time the bridge can actually ride through a power loss without a fault is dependent on the amount of inertial energy available in the load and the ride through capacity of the power supplies that are feeding the control AND cooling systems. The control rack itself can ride through power dips up to 100ms long. An optional ride through device is available to extend this time up to 500ms. If the customer can supply power from an interruptible source then much longer times can be achieved and a custom power dip timeout should be specified.

Tach Loss Detection

The *Tach Loss Detection* function controls the response of the drive to the loss of the tachometer feedback signal.

Function inputs

The following table specifies the input variables of the *Tach Loss Detection* function.

Variable	Description
Output freq, unfil	Motor electrical frequency. Hertz
Tach speed, instr.	Tachometer speed feedback. Radians/second

Function configuration

The following table specifies the configuration parameters for the *Tach Loss Detection* function.

Parameter	Description
Tach loss fault mode	Specifies whether the drive reports a trip fault or an alarm in response to the loss of tachometer feedback.

Faults and alarms

The following table specifies the faults and alarms that the *Tach Loss Detection* function gives.

Fault	Description
Tach loss alarm	Alarm that occurs when a loss of tachometer feedback is detected. Drive will continue run in tachless control mode.
Tach loss trip	Trip fault that occurs when a loss of tachometer feedback is detected. Causes the drive to coast stop.

Function description

The *Tach Loss Detection* function is not active when the parameter *Motor ctrl alg sel* is set to *Tachless control* (that is, the drive is configured to perform motor control and speed feedback acquisition without a tachometer). The *Tach Loss Detection* is active for other values of *Motor ctrl alg sel*.

The *Tach Loss Detection* function compares the tachometer speed feedback to the estimated motor speed to determine whether the tachometer feedback is valid.

If the tachometer feedback is invalid, the function takes one of two actions based on the value of parameter *Tach loss fault mode*. If *Tach loss fault mode* is set to *Alarm*, then *Tach loss alarm* is declared and the drive transitions to tachless mode. If *Tach loss fault mode* is set to *Trip*, then *Tach loss trip* is declared and the drive stops running.

Tach loss alarm cannot be cleared until the drive is stopped. When the alarm is cleared, the drive returns to tachometer control mode.

The tachometer feedback may be lost for the following reasons:

- The tachometer is malfunctioning.
- The tachometer feedback is noisy, possibly because of bad cable shielding.
- The estimated speed is incorrect because of errors in motor parameters that are used for estimated speed calculation. These parameters include rotor resistance and saturation curve parameters.

Protective Functions

Custom User Faults

Each Innovation Series product provides the capability to configure two fault circuits. The trip faults *Customer use NC flt* and *Customer use NO flt* trigger on input signals that are the states of the fault circuits. *Customer use NC flt* occurs when the normally closed circuit is open. *Customer use NO flt* occurs when the normally open circuit is closed.

Function inputs

The following table specifies the input parameters of the *Custom User Faults* function.

Parameter	Description
User NC fault sel	Selects the source of the normally closed circuit input.
User NO fault sel	Selects the source of the normally open circuit input.

Faults and alarms

The following table specifies the faults and alarms declared by the *Custom User Faults* function.

Fault/Alarm	Description
Customer use NC flt	Trip fault that occurs when the normally closed circuit input is False, indicating that the circuit is open
Customer use NO flt	Trip fault the occurs when the normally open circuit input is True, indicating that the circuit is closed

Function description

The parameters *User NC fault sel* and *User NO fault sel* generally select digital inputs (variables *Digital input 1*, …, *Digital input 6*) or general purpose LAN requests (variables *GP lan req bit 1*, …, *GP lan req bit 8*). The custom user faults may be disabled by selecting Unused for the input parameters.

DC Link Protection

The drive contains several diagnostic and protective features involving the *DC Link Protection*.

Diagnostic variables

The following table specifies the *DC Link Protection* diagnostic variables.

Variable	Description
DC bus feedback	Unfiltered DC link voltage. DC volts
DC bus voltage	Filtered DC link voltage. DC volts
DC bus charged	Indicates whether the DC link voltage is high enough to allow the drive to run.
DC bus excursion	Departure of DC link from user specified region. DC volts

Function configuration

The following table specifies the *DC Link Protection* configuration parameters.

Parameter	Description
DC bus region max	High boundary of user specified DC link voltage region. DC volts
DC bus region min	Low boundary of user specified DC link voltage region. DC volts

Faults and alarms

The following table specifies the faults and alarms associated with the *DC Link Protection*.

Fault/Alarm	Description
DC bus over voltage	Trip fault that occurs when the DC link voltage is too high.
DC bus under voltage	Trip fault that occurs when the DC link voltage is too low.
DC bus voltage low	Alarm that occurs when the DC link voltage is too low.

Function description

The signal *DC bus feedback* is an unfiltered representation of the DC link voltage. *DC bus voltage* is a filtered version of the DC link voltage. The default filter frequency is 90 rad/sec.

The *DC bus over voltage* trip fault occurs when the DC link voltage exceeds a maximum safe operating voltage defined as

$$123\% \times \sqrt{2} \times 2300 \text{ Volts.}$$

The *DC bus under voltage* trip fault occurs when the drive is running and the DC link voltage falls below a minimum operating voltage. The *DC bus voltage low* alarm occurs when the drive is stopped and the DC link voltage falls below a minimum operating voltage. In both cases the minimum voltage is defined as

$$50\% \times \sqrt{2} \times 2300 \text{ Volts.}$$

The *DC bus voltage low* alarm clears when the DC link voltage rises again to an acceptable operating level.

The user has the opportunity to specify a desired operating region for the DC link voltage. Parameters *DC bus region max* and *DC bus region min* define the high and low boundaries of the region, respectively. The diagnostic variable *DC bus excursion* indicates whether the DC link voltage lies within the region, and if not, how far outside the region it falls.

If *DC bus region min* <= *DC bus feedback* <= *DC bus region max*,

DC bus excursion = 0.

If *DC bus feedback* < *DC bus region min*,

DC bus excursion = *DC bus feedback* - *DC bus region min*.

If *DC bus feedback* > *DC bus region max*,

DC bus excursion = *DC bus feedback* - *DC bus region max*.

Notice that if the DC link voltage falls below the user specified region, *DC bus excursion* is negative; if the DC link voltage falls above the region, *DC bus excursion* is positive.

Ground Fault Protection (Fast)

The *Ground Fault Protection (Fast)* tests the phase currents to verify that there is no ground current in the system.

Function inputs

The following table specifies the input parameters of the *Ground Fault Protection (Fast)* function.

Parameter	Description
Phase A current	Phase A current feedback. Amps
Phase B current	Phase B current feedback. Amps
Phase C current	Phase C current feedback. Amps

Function outputs

The following table specifies the output variables of the *Ground Fault Protection (Fast)* function.

Variable	Description
Gnd current, coarse	Ground current, filtered. Amps

Function configuration

The following table specifies the configuration parameters for the *Ground Fault Protection (Fast)* function.

Parameter	Description
Gnd flt coarse trip	Current level at which the *Gnd flt, coarse* trip fault occurs. Amps

Faults and alarms

The following faults and alarms are declared by the *Ground Fault Protection (Fast)* function.

Fault / Alarm	Description
Gnd flt, coarse	Occurs when *Gnd current, coarse* > *Gnd flt coarse trip*.

Function description

Gnd current, coarse is determined by summing and filtering the three phase currents *Phase A current*, *Phase B current*, and *Phase C current*.

The configuration parameter *Gnd flt coarse trip* can be set to a default value by running the *Ground Fault Setup*.

Hardware Fault Strings

Each Innovation Series product provides a hardwired, fail-safe circuit to turn off bridge power and to shut down its control. The circuit consists of two independent isolated inputs designated the local and system fault strings. The loss of either input results in the shutdown of the power bridge and control.

Diagnostic variables

The following table specifies the *Hardware Fault Strings* diagnostic variables.

Variable	Description
Local fault string	State of the local fault string circuit.
System fault string	State of the system fault string circuit.

Function configuration

The following table specifies the *Hardware Fault Strings* configuration parameters.

Parameter	Description
Inh sim Loc/Sys flt	Disables the hardware fault string validation in simulation mode only.

Faults and alarms

The following table specifies the faults and alarms associated with the *Hardware Fault Strings*.

Fault/Alarm	Description
Local flt	Trip fault that occurs when the local fault string circuit is open.
System flt	Trip fault that occurs when the system fault string circuit is open.

Function description

The hardware fault string circuits are capable of operating with either 24 volts DC or 115 volts AC. The inputs are isolated so the system and local fault string circuits are not required to operate at the same voltage level. Both circuits must be closed for normal product operation.

The local fault string circuit is closed when the following connections are made through appropriate circuitry:

- Terminal board (ATBA): Connector L115 or L24 to connector LCOM.
- Backplane: Jumper J2 pin 1 to pin 2.

The system fault string circuit is closed when the following connection is made through appropriate circuitry:

- Terminal board (ATBA): Connector S115 or S24 to connector SCOM.
- The local and system fault strings are evaluated by the hardware. If one of the strings opens during product operation, then the hardware implements a controlled shutdown of the power bridge and dropout of the contactors.
- The state of the hardware fault string inputs are reported to the control and contained in variables *Local fault string* and *System fault string*. The variables contain the actual state of the hardware circuits whether or not the product is running. The trip faults associated with the fault strings, *Local flt* and *System flt*, are reported when the fault string opens only when the product is running or commanded to run.

Heatsink Thermal Protection

The *Heatsink Thermal Protection* function measures the power bridge heatsink and ambient temperatures and verifies that they are at a safe operating level.

Function inputs

The inputs to the *Heatsink Thermal Protection* function are hardware thermal sensor connections. The bridge ambient temperature thermal sensor connects to backplane connector J4. The control rack ambient temperature thermal sensor is located on BICM. The heatsink thermal sensors connect to FOSA. The following table summarizes the source of the input signals of the *Heatsink Thermal Protection* function.

Input signal connection	Thermal sensor
Backplane J4 7 & 8	Bridge ambient thermal sensor
Mounted on BICM	Control rack ambient thermal sensor
FOSA TF-A	Heatsink A thermal sensor
FOSA TF-B	Heatsink B thermal sensor
FOSA TF-C	Heatsink C thermal sensor
FOSA TF-DB	Dynamic brake heatsink thermal sensor
FOSA TF-SRC	Diode source heatsink thermal sensor

Function outputs

The following table specifies the output variables of the *Heatsink Thermal Protection* function.

Variable	Description
Heat sink A temp	Measured temperature of heatsink A. Degrees C or Degrees F
Heat sink B temp	Measured temperature of heatsink B. Degrees C or Degrees F
Heat sink C temp	Measured temperature of heatsink C. Degrees C or Degrees F
DB heat sink temp	Measured temperature of dynamic brake heatsink. Degrees C or Degrees F
DS heat sink temp	Measured temperature of diode source heatsink. Degrees C or Degrees F
Bridge ambient temp	Measured bridge ambient temperature. Degrees C or Degrees F
BIC ambient temp	Measured control rack ambient temperature. Degrees C or Degrees F

In simulator mode, the output variables are set to constant values which are the maximum expected operating temperatures.

Related faults and alarms

The following faults and alarms are declared by the *Heatsink Thermal Protection* function. Temperatures are described as "high" and "low", relative to non-adjustable setpoints in the control.

Fault/Alarm	Description
Ambient temp hot	Ambient temperature (variable *Bridge ambient temp*) is high.
Ambient over temp	Ambient temperature (variable *Bridge ambient temp*) is too high.
Ambient temp low	Ambient temperature (variable *Bridge ambient temp*) is too low.
HtSink A temp hot	Heatsink A temperature (variable *Heat sink A temp*) is high.
HtSink A over temp	Heatsink A temperature (variable *Heat sink A temp*) is too high.
HtSink A rise high	Heatsink A temperature (variable *Heat sink A temp*) is too far above ambient temperature (variable *Bridge ambient temp*).
HtSink A temp low	Heatsink A temperature (variable *Heat sink A temp*) is too low.
HtSink B temp hot	Heatsink B temperature (variable *Heat sink B temp*) is high.
HtSink B over temp	Heatsink B temperature (variable *Heat sink B temp*) is too high.
HtSink B rise high	Heatsink B temperature (variable *Heat sink B temp*) is too far above ambient temperature (variable *Bridge ambient temp*).
HtSink B temp low	Heatsink B temperature (variable *Heat sink B temp*) is too low.
HtSink C temp hot	Heatsink C temperature (variable *Heat sink C temp*) is high.
HtSink C over temp	Heatsink C temperature (variable *Heat sink C temp*) is too high.
HtSink C rise high	Heatsink C temperature (variable *Heat sink C temp*) is too far above ambient temperature (variable *Bridge ambient temp*).
HtSink C temp low	Heatsink C temperature (variable *Heat sink C temp*) is too low.
HtSink DB temp hot	Dynamic brake heatsink temperature (variable *DB heat sink temp*) is high.
HtSink DB over temp	Dynamic brake heatsink temperature (variable *DB heat sink temp*) is too high.
HtSink DB rise high	Dynamic brake heatsink temperature (variable *DB heat sink temp*) is too far above ambient temperature (variable *Bridge ambient temp*).
HtSink DB temp low	Dynamic brake heatsink temperature (variable *DB heat sink temp*) is too low.

Fault/Alarm	Description
HtSink DS temp hot	Diode source heatsink temperature (variable *DS heat sink temp*) is high.
HtSink DS over temp	Diode source heatsink temperature (variable *DS heat sink temp*) is too high.
HtSink DS rise high	Diode source heatsink temperature (variable *DS heat sink temp*) is too far above ambient temperature (variable *Bridge ambient temp*).
HtSink DS temp low	Diode source heatsink temperature (variable *DS heat sink temp*) is too low.
HtSink temp imbalanc	Trip fault occurs when any two of the measured heatsink temperatures differ by an amount exceeding heatsink imbalance fault level.
HtSink blower failed	Trip fault occurs if the drive is running and the cooling fans are not operating.
BICM card temp low	Control rack temperature, measured by a sensor on BICM, is too low.
BICM card hot	Control rack temperature, measured by a sensor on BICM, is high.
BICM card over temp	Control rack temperature, measured by a sensor on BICM, is too high.

Line-Line Voltage Protection

The drive contains several diagnostic and protective features involving the *Line-Line Voltage Protection*.

Diagnostic variables

The following table specifies the *Line-Line Voltage Protection* diagnostic variables.

Variable	Description
Output volts, A-B	Filtered A-B line-line voltage. Line-line volts
Output volts, B-C	Filtered B-C line-line voltage. Line-line volts
A-B, Voltage offset	Calculated A-B voltage offset. Line-line volts
B-C, Voltage offset	Calculated B-C voltage offset. Line-line volts

Faults and alarms

The following table specifies the faults and alarms associated with the *Line-Line Voltage Protection*.

Fault/Alarm	Description
A-B voltage offset	Trip fault that occurs when the A-B line-line voltage offset is too high.
B-C voltage offset	Trip fault that occurs when the B-C line-line voltage offset is too high.

Function description

The variables *Output volts, A-B* and *Output volts, B-C* are filtered versions of the measured line-line voltage feedbacks. The default filter frequency is 1000 rad/sec.

When the drive is stopped, it performs an automatic voltage offset calculation. If the drive does not have a contactor, the offset calculation happens continuously. If a contactor is present, the calculation occurs when the contactor closes immediately before the drive begins running. During the calculation the power bridge is turned off and the line-line voltages should be zero. Any appreciable voltage that is detected during the calculation indicates a potential power bridge or feedback circuitry problem. The *A-B voltage offset* and *B-C voltage offset* trip faults are reported when excessive offsets are calculated. The calculated offsets *A-B, Voltage offset* and *B-C, Voltage offset* are used by the control to calculate feedbacks once the drive starts running.

There is a period of time when the line-line voltage offset calculations are considered valid and the calculation does not need to be performed if the drive is stopped and started again. However, if the time expires, the voltage offsets must be recalculated before the drive can run again. The default value for the expiration time is one hour. The variable *Voltage offset valid* indicates whether or not the voltage offset calculations are valid.

Motor Overtemperature Detection

Innovation Series drive products provide the capability to detect a motor overtemperature condition. The *Motor over temp* trip fault and the *Motor temp hot* alarm trigger on a signal that is a drive input from the motor overtemperature fault circuit. When the motor overtemperature circuit is open, the fault or alarm occurs.

Function inputs

The following table specifies the input parameters of the *Motor Overtemperature Detection* function.

Parameter	Description
Motor OT fault sel	Selects the source of the motor overtemperature circuit.

Function configuration

The following table specifies the configuration parameters of the *Motor Overtemperature Detection* function.

Parameter	Description
Motor OT fault mode	Specifies whether the overtemperature condition triggers a fault or an alarm.

Faults and alarms

The following table specifies the faults and alarms that the *Motor Overtemperature Detection* function declares.

Fault/Alarm	Description
Motor over temp	Occurs when the state of the motor overtemperature circuit is *Force False*, indicating that the circuit is open, and parameter *Motor OT fault mode* is set to *Trip flt*
Motor temp hot	Occurs when the state of the motor overtemperature circuit is *Force False*, indicating that the circuit is open, and parameter *Motor OT fault mode* is set to *Alarm fault*

Function description

The parameters *Motor OT fault sel* generally selects digital inputs (variables *Digital input 1*, …, *Digital input 6*). The *Motor Overtemperature Detection* may be disabled by setting *Motor OT fault sel* equal to *Unused*.

Phase Current Protection

The drive contains several diagnostic and protective features involving the *Phase Current Protection*.

Diagnostic variables

The following table specifies the *Phase Current Protection* diagnostic variables.

Variable	Description
Phase A current	Filtered phase A current. Amps
Phase B current	Filtered phase B current. Amps
Phase C current	Filtered phase C current. Amps
Phs A current offset	Calculated phase A current offset. Amps
Phs B current offset	Calculated phase B current offset. Amps
Phs C current offset	Calculated phase C current offset. Amps

Faults and alarms

The following table specifies the faults and alarms associated with the *Phase Current Protection*.

Fault/Alarm	Description
Phase A cur offset	Trip fault that occurs when the phase A current offset is too high.
Phase B cur offset	Trip fault that occurs when the phase B current offset is too high.
Phase C cur offset	Trip fault that occurs when the phase C current offset is too high.

Function description

The variables *Phase A current*, *Phase B current*, and *Phase C current* are filtered versions of the measured phase current feedbacks. The default filter frequency is 1000 rad/sec.

When the drive is stopped, it performs an automatic current offset calculation. During the calculation the power bridge is turned off, and the phase currents should be zero. Any appreciable phase current that is detected during the calculation indicates a potential power bridge or feedback circuitry problem. The *Phase A cur offset*, *Phase B cur offset*, and *Phase C cur offset* trip faults are reported when excessive offsets are calculated. The calculated offsets *Phs A current offset*, *Phs B current offset*, and *Phs C current offset* are used by the control to calculate feedbacks once the drive starts running.

Timed Overcurrent Detection

The *Timed Overcurrent Detection* function protects the motor and wiring against overheating caused by large currents for extended periods of time.

Function inputs

The following table specifies the input variables to the *Timed Overcurrent Detection* function.

Variable	Description
Phase A current	Phase A current. Amps
Phase B current	Phase B current. Amps
Phase C current	Phase C current. Amps

Function outputs

The following table specifies the output variables to the *Timed Overcurrent Detection* function.

Variable	Description
Ia^2 filtered	Squared and filtered phase A current. RMS $amps^2$
Ib^2 filtered	Squared and filtered phase B current. RMS $amps^2$
Ic^2 filtered	Squared and filtered phase C current. RMS $amps^2$

Function configuration

The following table specifies the *Timed Overcurrent Detection* function configuration parameters.

Parameter	Description
Disable TOC profile	Disables the application of the motor cooling profile to the squared phase currents.
Motor protect class	Motor protection class.

Faults and alarms

The following table specifies the faults and alarms associated with the *Timed Overcurrent Detection* function.

Fault/Alarm	Description
Timed over current	Trip fault that occurs when one or more of the squared phase currents is too high for an extended period of time.
TOC pending	Alarm that occurs when one or more of the squared phase currents is too high for an extended period of time.

Function description

The *Timed Overcurrent Detection* function provides overload protection for the motor and wiring. It maintains an independent heating model for each motor phase. The heating is modeled by squaring and filtering the phase currents. The heating model outputs are contained in variables *Ia^2 filtered*, *Ib^2 filtered*, and *Ic^2 filtered*.

The *Timed Overcurrent Detection* function reports the *TOC pending* alarm when any of the heating model outputs is large. It reports the *Timed over current* trip fault when any of the heating model outputs is excessively high. Continued operation during an alarm condition can result in degraded equipment lifetime.

The motor and wiring heating models are independent of the power bridge rating and capability. This independence allows the general application of inverter drives to motors. It also requires that motor wiring comply with NEC standards. The wiring must be capable of withstanding 125% of the motor's rated current.

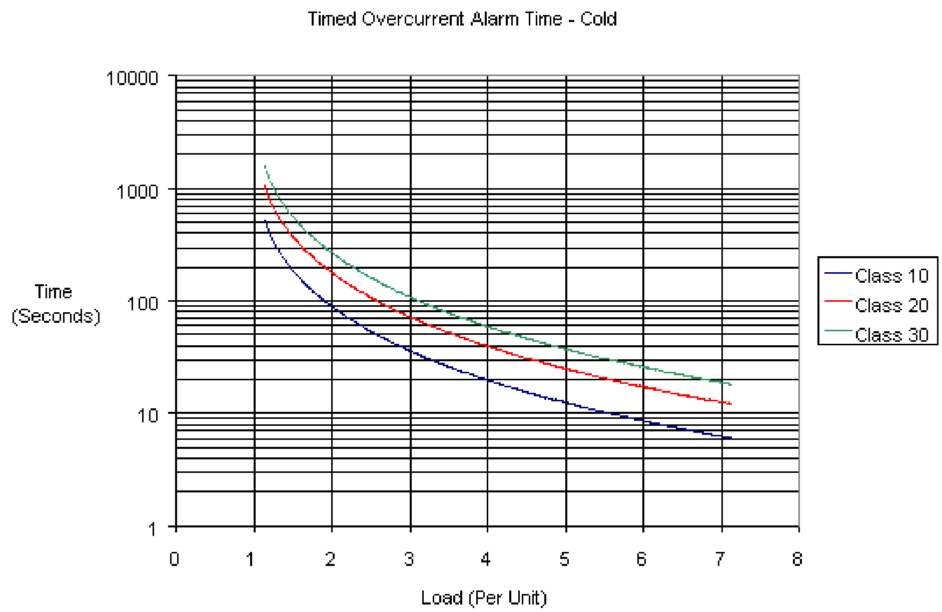
Motor protect class specifies the motor protection class, which indicates the motor's capacity to run under overload conditions. The *Timed Overcurrent Detection* function uses the setting of *Motor protect class* to determine motor thermal characteristics. The thermal characteristics are used to determine current levels at which the drive reports motor overheating.

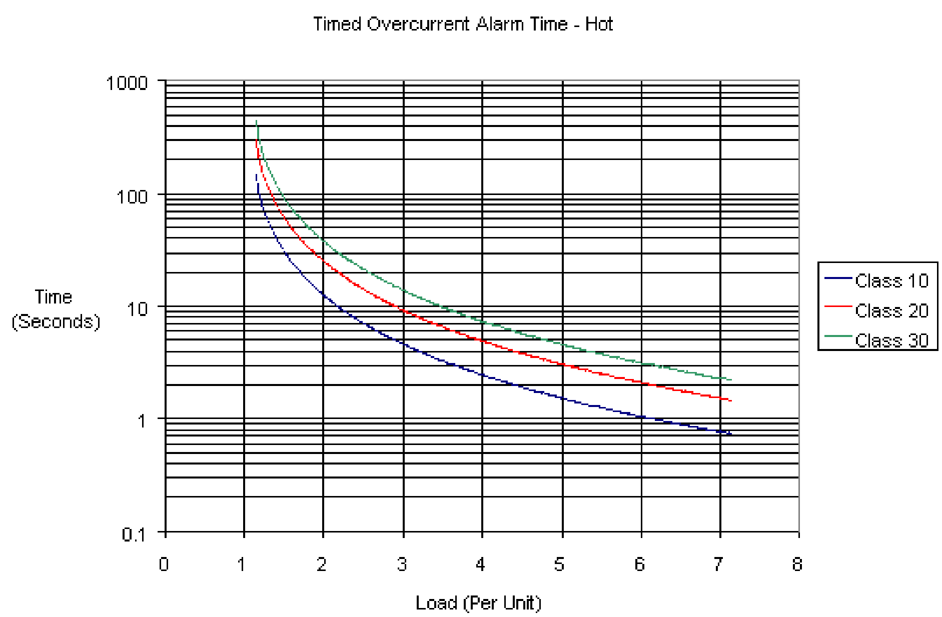
The following values are available for *Motor protect class*:

- *Class10:150%for30sec*: IEC motors. Motor can withstand 150% overload for 30 seconds.
- *Class20:150%for60sec*: US standard motors. Motor can withstand 150% overload for 60 seconds.
- *Class30:150%for90sec*: Specially designed motors. Motor can withstand 150% overload for 90 seconds.

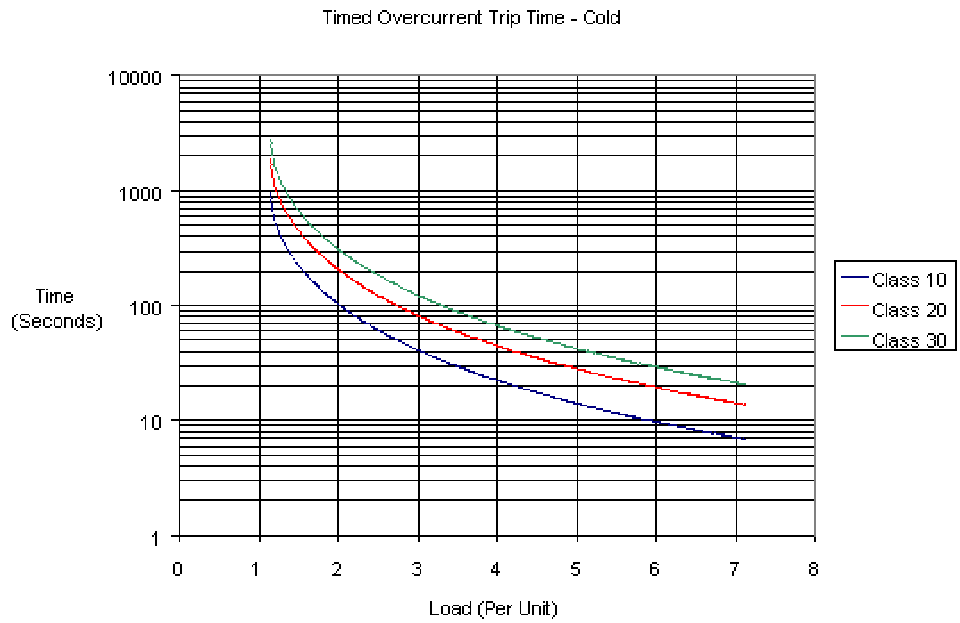
The overload capabilities listed above assume that the motor was running continuously at a rated current prior to the overload condition.

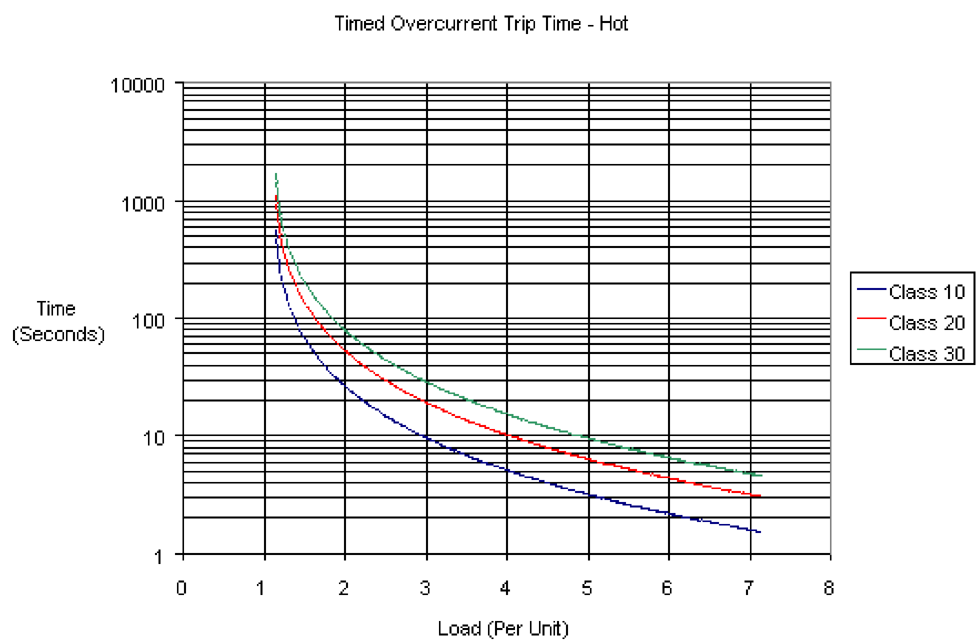
The following graphs show the time a motor of each of the protection classes can operate before reaching alarm conditions. The time is a function of the load applied to the motor. The first graph assumes the motor was not running before the overload condition was applied. The second graph assumes the motor was running continuously at rated current.





The following graphs show the time a motor of each of the protection classes can operate before reaching trip conditions. The time is a function of the load applied to the motor. The first graph assumes the motor was not running before the overload condition was applied. The second graph assumes the motor was running continuously at rated current.





The capability of the drive to produce the overload current depends on the capacity of its power circuit. Especially at higher overload levels, the drive may not be able to sustain the motor's overload current as defined by *Motor protect class*.

The motor heating model has the capability of implementing a speed dependent motor cooling characteristic. The user defined cooling characteristic is activated when *Disable TOC profile* is False. At present, the cooling characteristic functionality is not fully supported. *Disable TOC profile* should not be changed from its default value of True without factory assistance.

Transformer Overtemperature Detection

Those Innovation Series products that are part of a system containing a transformer provide the capability to detect transformer overtemperature condition. The *Xfrmr over temp* trip fault and the *Xfrmr temp hot* alarm trigger on a signal that is a digital input from the transformer overtemperature fault circuit. Either the fault or alarm occurs when the transformer overtemperature circuit is open.

Function inputs

The following table specifies the input parameters of the *Transformer Overtemperature Detection* function.

Parameter	Description
Xfrmr OT fault sel	Selects the source of the transformer overtemperature circuit.

Function configuration

The following table specifies the configuration parameters of the *Transformer Overtemperature Detection* function.

Parameter	Description
Xfrmr OT fault mode	Specifies whether the overtemperature condition triggers a fault or an alarm.

Faults and alarms

The following table specifies the faults and alarms that the *Transformer Overtemperature Detection* function declares.

Fault/Alarm	Description
Xfrmr over temp	Occurs when the state of the transformer overtemperature circuit is False, indicating that the circuit is open, and parameter *Xfrmr OT fault mode* is set to *Trip flt*.
Xfrmr temp hot	Occurs when the state of the transformer overtemperature circuit is False, indicating that the circuit is open, and parameter *Xfrmr OT fault mode* is set to *Alarm fault*.

Function description

The parameter *Xfrmr OT fault sel* generally selects digital inputs (*Digital input 1*, …, *Digital input 6*). The *Transformer Overtemperature Detection* may be disabled by setting *Xfrmr OT fault sel* equal to Unused.

Motor Ground Protection

The *Motor Ground Protection* function detects a ground fault condition in the motor phases. The function is automatically configured by the control; no user configuration is necessary.

Function inputs

The following table specifies the input variables of the *Motor Ground Protection* function.

Variable	Description
DC neut volt mag	Absolute value of the DC bus neutral voltage

Function outputs

The following table specifies the output variables of the *Motor Ground Protection* function.

Variable	Description
Gnd cur signal	Ground current indication (filtered). Note that this value may actually be scaled as the voltage sensed by the BICM, not a current. If *Gnd signal scl* is 1.0, this is the sensed voltage.
Gnd flt warning	This variable is used external to this function to indicate that the alarm, *Ground flt alm, LP* is present.
Gnd flt trip	This variable is used external to this function to indicate that the fault, *Gnd flt trip* is present.
LP fuse stat	This signal, when True, indicates that the value *LP fuse blown sel* points to is True. When *Detector mode* is set to *Disable*, this variable will always be True.

Function configuration

The following table specifies the configuration parameters of the *Motor Ground Protection* function. The control sets these parameters automatically; they should not be changed except in unusual circumstances.

Parameter	Description
Detector mode	When set to *Enable*, the *Motor Ground Protection* function is enabled. The *Ground flt alm, LP* alarm and *Gnd flt trip* trip fault will be annunciated if a ground fault condition occurs. When set to *Disable*, neither the alarm nor fault will occur. The default is *Enable*.
Gnd signal sel	Pointer to the ground fault signal. It points by default to parameter *DC neut volt mag*.
Gnd signal scl	Voltage to current scale factor which is applied to the input analog signal pointed to by *Gnd signal sel*. This parameter is set to 1.0 as default, leaving the scaled signal output as a voltage.
Gnd signal alarm on	The level at which the *Ground flt alm, LP* alarm is present.
Gnd signal alarm off	The level at which the *Ground flt alm, LP* alarm clears.
Gnd signal trip lvl	The level at which the *Gnd flt trip* trip fault occurs.
Gnd signal fil	The bandwidth of the low pass filter (Radians/second) applied to the analog input signal pointed to by *Gnd signal sel*.
LP fuse blown sel	Pointer default setting is *MOV fuse OK status*.

Diagnostic variables

The following table specifies the diagnostic variables of the *Motor Ground Protection* function.

Variable	Description
Gnd flt warning	This variable is for external use to indicate that the alarm, *Ground flt alm, LP* is present.
Gnd flt trip	This variable is for external use to indicate that the fault, *Gnd flt trip* is present.

Faults and alarms

The following table specifies the faults and alarms of the *Motor Ground Protection* function.

Fault/Alarm	Description
Ground flt alm, LP	The alarm is present when *Gnd cur signal* >= *Gnd signal alarm on* and is not present when when *Gnd cur signal* < *Gnd signal alarm off*.
Gnd flt trip	The trip fault occurs if *Gnd cur signal* >= *Gnd signal trip lvl*.

Function description

The VATF-MID voltage feedback board provides a direct measure of the DC bus neutral voltage to the control. This signal is filtered and conditioned to eliminate the effects of bridge modulation and then monitored.

With no motor ground fault condition, the voltage will be nearly zero. With a fault to ground, the voltage will be at a maximum. For a partial ground fault condition, which could be caused by damaged motor insulation, the voltage increases almost linearly between zero and the maximum voltage. The ground fault voltage, variable *Gnd cur signal* is compared to thresholds to create the alarm or trip fault. Variable *Gnd cur signal* is most sensitive at higher motor voltages. When a ground fault condition exists, the alarm may be present at maximum motor voltage but may disappear under other operating conditions.

Phase Imbalance Monitor

The *Phase Imbalance Monitor* function monitors the condition of the phase imbalance on the ac line as well as the status of the phase lock loop.

Function inputs

The following table specifies the input parameters of the *Phase Imbalance Monitor* function.

Variable	Description
PLL error	This is the error signal of the phase lock loop.
X axis line voltage	The demodulated, x-component of the ac line voltage. This variable is also used in the *Phase Lock Loop* function.
AC line magnitude	This is the magnitude of *X axis line voltage* and *Y axis line voltage* (square root of squared sums). It represents the magnitude of the ac line..
Phase imbalance sqr	This signal is basic in the determination of phase imbalance or phase lock loop goodness for the source. It is the filtered sum of two squared signals. The first is *PLL error* and the second is the difference between *X axis line voltage* and *AC line magnitude*.
Phase imbalance ref	This signal represents the allowed amount of imbalance for the source. It has units of volts squared. It includes an allowance for noise and is compensated by the magnitude of the ac line.
Phase imbalance avg	This signal is the amount by which *Phase imbalance sqr* exceeds the allowed threshold, *Phase imbalance ref*.
Phs imbalance limit	Clamp threshold that the integrator
Phs imbalance time	Seconds.

Function outputs

The following table specifies the output variables of the *Phase Imbalance Monitor* function.

Variable	Description
Phase imbalance int	Integrator that accumulates the amount by which the line imbalance (variable *Phase imbalance sqr*) exceeds its allowed threshold (variable *Phase imbalance ref*). This variable drives the *AC line transient* alarm and the *AC line watchdog* trip fault. See Faults and alarms section.
AC line loss	If the ac line drops below 10% of nominal for 5msec, *AC line loss* will be set True, declaring that the ac line has been lost. This variable drives the *AC line transient* alarm.

Diagnostic variables

The following table specifies the diagnostic variables of the *Phase Imbalance Monitor* function.

Variable	Description
PLL proven	This boolean indicates the status of the *Phase Lock Loop* function. The *Phase Imbalance Monitor* function has a direct effect on *PLL proven*.

Faults and alarms

The following table specifies the faults and alarms of the *Phase Imbalance Monitor* function.

Fault/Alarm	Description
AC line transient	This alarm occurs as a result of significant phase lock loop error or significant phase imbalance.
AC line watchdog	This trip fault will occur when the *AC line transient* alarm persists for about one second. Both the trip fault and the alarm are a result of significant phase lock loop error or significant phase imbalance.

Function description

Phase imbalance sqr is fundamental to the *Phase Imbalance Monitor* function. It is the filtered sum of two squared signals. The first is *PLL error* and the second is the difference between *X axis line voltage* and *AC line magnitude*. *Phase imbalance sqr* is a measure of the imbalance of the ac line.

The *Phase Imbalance Monitor* function compares *Phase imbalance sqr* to its allowed threshold (variable *Phase imbalance ref*) to create the delta above the threshold (variable *Phase imbalance avg*). If *Phase imbalance avg* is positive, it accumulates with dt compensation in an integrator (variable *Phase imbalance int*). The integrator is clamped by an upper threshold (variable *Phs imbalance limit*).

If the *Phase imbalance int* integrator exceeds the clamp threshold, the *AC line transient* alarm will occur. If this condition persists for *Phs imbalance time* Seconds, the *AC line watchdog* trip fault will occur.

The *Phase Imbalance Monitor* function has a direct effect on the *Phase Lock Loop* function. The *PLL proven* boolean indicates the status of the *Phase Lock Loop* function. When the control first detects the ac line, a significant, transient error is present until the loop locks. *Phase imbalance avg* will thus be significant, but will begin to decay as the loop locks. After *Phase imbalance int* is less than zero for about 120msec, *PLL proven* will be set true and the phase lock loop will be declared ready for use. In order for *PLL proven* to be set False after it is set True, *AC line loss* must be true for 1 Seconds or *Phase imbalance int* must be non-zero for 1 Seconds.

If the ac line drops below 10% of nominal for 5msec, *AC line loss* will be set True, declaring that the ac line has been lost. This will immediately cause the *AC line transient* alarm. If the condition persists for 1Seconds, the drive will trip if it has not already done so. *AC line loss* will be set False again as soon as the ac line rises back above 15% of nominal.

Related functions

- Phase Lock Loop

Related diagrams

- Line Monitor Overview (Ovr_Lin_Mon)

Line Monitor

The *Line Monitor* function monitors the AC line voltage and frequency and compares them to acceptable limits. Several faults may result. The *Drive Commissioning* wizard automatically configures this function. Run the *Line Protection Setup* wizard to reconfigure this function.

Function inputs

The following table specifies the input parameters of the *Line Monitor* function.

Parameter	Description
Line volt check fil	Filter value for input signal *Line monitor volt*, Radians/second
Line frq check fil	Filter value for input signal *Line monitor frq*, Radians/second

The following table specifies the input variables of the *Line Monitor* function.

Variable	Description
Line monitor volt	AC line voltage magnitude, filtered by *Line volt check fil*
Line monitor frq	AC line frequency, filtered by *Line frq check fil*

Function configuration

The following table specifies the input parameters of the *Line Monitor* function. These parameters are automatically configured by the *Drive Commissioning* wizard but can be reconfigured in the wizard.

Parameter	Description
Line OV fault level	Ac line voltage above which the *AC line over voltage* trip fault occurs
Line OV alarm level	Ac line voltage above which the *AC line voltage high* alarm occurs
Line OV alarm clear	Ac line voltage below which the *AC line voltage high* alarm goes away
Line UV fault level	Ac line voltage below which the *AC line under volt* trip fault occurs
Line UV alarm level	Ac line voltage below which the *AC line volts low* alarm occurs
Line UV alarm clear	Ac line voltage above which the *AC line volts low* alarm goes away
Over freq flt level	Ac line frequency above which the *AC line over freq* trip fault occurs
Over freq alm level	Ac line frequency above which the *AC line freq high* alarm occurs
Over freq alm clear	Ac line frequency below which the *AC line freq high* alarm goes away
Under freq flt level	Ac line frequency below which the *AC line under freq* trip fault occurs
Under freq alm level	Ac line frequency below which the *AC line freq low* alarm occurs
Under freq alarm clr	Ac line frequency above which the *AC line freq low* alarm goes away

Parameter	Description
Utility feed	Determines the bandwidth of the *Phase Lock Loop* function. If set to *True*, the bandwidth is set to obtain an amount of "sluggishness" appropriate for a utility feed. The pll will be more robust and less sensitive to unreal disturbances. It should be set to *True* only if the line is a diesel-generator or other spongy line source. The bandwidth ratio of *True* versus *True* is 4:1. The default setting is *True* to assume a utility feed.
Phase rotation req	Determines the phase sequence the *Phase Lock Loop* function expects. The *Phase Lock Loop* function can lock to either "forward-ABC" or reverse phase sequence. The fault, *AC line rev phs seq* will occur if the wrong sequence is seen by the control. The default setting is *Forward sequence*.

Faults and alarms

The *Line Monitor* function generates the 12 faults and alarms mentioned above in the function configuration section.

Function description

The *Line Monitor* function monitors the filtered ac line voltage (variable *Line monitor volt*) for overvoltage and undervoltage conditions. The function also monitors filtered ac line frequency (variable *Line monitor frq*) for overfrequency and underfrequency conditions. If *Line monitor volt* or *Line monitor frq* surpasses a threshold, the appropriate alarm or trip fault occurs. The thresholds are configured when the *Drive Commissioning* wizard runs and can be changed later by the *Line Protection Setup* wizard. See the above function configuration section for an explanation of the thresholds.

Related functions

- Phase Imbalance Monitor
- Phase Lock Loop

Related diagrams

- Line Monitor Overview (Ovr_Lin_Mon)

Phase Lock Loop

The *Phase Lock Loop* function outputs magnitude, frequency, and phase information to the rest of the control, including the *Line Monitor*. A few configuration parameters are critical. See the parameters in the function configuration section.

Function inputs

The following table specifies the input variables of the *Phase Lock Loop* function.

Variable	Description
Y axis line voltage	The feedback for the phase lock loop regulator. The reference is zero, since the phase lock loop is attempting to regulate the y-component of the line voltage to zero. This variable is also used with *X axis line voltage* to calculate the AC line magnitude (variable *AC line voltage mag*).
X axis line voltage	The demodulated x-axis component of the ac line voltage. It is not used in the actual phase lock loop regulator, but is used with *Y axis line voltage* to calculate the AC line magnitude, *AC line voltage mag*.
PLL error	The phase lock loop regulator error.
PLL prop gain	The phase lock loop proportional gain. This gain is dynamic. It very hot before the pll is locked and then changes to a more sluggish gain.
PLL integral gain	The phase lock loop integral gain. This gain is dynamic. It is very hot before the pll is locked and then changes to a more sluggish gain.
PLL max frequency	Maximum frequency allowed by phase lock loop regulator. This is function of the nominal input frequency.
PLL min frequency	Minimum frequency allowed by phase lock loop regulator. This is function of the nominal input frequency. It is also dynamic. When the pll is not locked, this variable is set to the negative of *PLL max frequency*.

Function outputs

The following table specifies the output variables of the *Phase Lock Loop* function.

Variable	Description
Line monitor frq	A low-pass filtered version of the phase lock loop frequency (variable *PLL frequency*). It is used for frequency fault checking.
PLL frequency	The main un-filtered ac line frequency, as determined by the phase lock loop regulator. This value is used throughout the control's regulators.
Elect angle command	This is the angle of the ac line as determined by the phase lock loop regulator. It is the angle used to determine the phase of the up/down commands to the bridge gating interface.
Electric angle fbk	This is the angle of the ac line as determined by the phase lock loop regulator. It is the angle used to demodulate the voltage and current feedbacks at the beginning of each fast execution task.

Variable	Description
PLL proven	This boolean indicates whether the pll is locked. It is used throughout the control as a permissive to run or check various protections.
Line monitor volt	The filtered AC line voltage magnitude which is used by the *Line Monitor* function to protect the drive from overvoltage and undervoltage conditions. It is calculated as the square root of the sum of the squares of variables *Y axis line voltage* and *X axis line voltage*.

Function configuration

The following table specifies the configuration parameters of the *Phase Lock Loop* function.

Parameter	Description
Utility feed	Determines the bandwidth of the phase lock loop. If set to *True*, the bandwidth is set to obtain an amount of "sluggishness" appropriate for a utility feed. The pll will be more robust and less sensitive to unreal disturbances. It should be set to *True* only if the line is a diesel-generator or other spongy line source. The bandwidth ratio of *True* versus *True* is 4:1. The default setting is *True* to assume a utility feed.
Phase rotation req	The *Phase Lock Loop* function can lock to either "forward-ABC" or reverse phase sequence. The fault, *AC line rev phs seq* will occur if the wrong sequence is seen by the control. The default setting is *Forward sequence*.
AC grid frequency	The phase lock loop regulator clamp settings are determined by this input. Run the *Drive Commissioning* wizard to set this parameter.

Related functions

- Phase Imbalance Monitor

Related diagrams

- Phase Lock Loop Regulator (Ovr_PLL)

Sequencer Functions

Sequencer Overview

Sequencing is a key function of the Innovation Series drive. The sequencer oversees the starting and stopping of the drive. It keeps the drive from mis-operating during fault or diagnostic conditions. The sequencer also provides drive status information that can be used by various drive and application functions.

The Innovation Series drive sequencer can be described by the following functions:

- Fault Reset Logic
- Sequencer Permissives
- Stopping Commands and Modes
- Sequencer Commands
- Sequencer Status
- Main Contactor Configuration

Related diagrams

- Sequencing Overview (Ovr_Seq)

Fault Reset Logic

The sequencer oversees the shutdown of a drive under a fault condition. It makes sure the contactor (if present) is opened and that the regulators and speed references are disabled in a timely manner.

Faults can be reset in several different ways. They can be reset from the Drive Diagnostic Interface (DDI), also called the keypad. They can be reset by a selected variable or through the LAN (if enabled).

Function inputs

Parameter	Description
Fault reset select	Specifies a Boolean variable that requests a fault reset, when the variable transitions from a 0 to a 1 (Positive edge detected).
Variable	**Description**
Fault reset req, lan	Requests a fault reset when the LAN is active and variable transitions from a 0 to a 1 (positive edge detected). Refer to *LAN Signal Map*. This variable must be selected in *Fault reset select* to be active.
DDI “Reset Faults” Push Button	Requests a fault reset when pressed.

Function outputs

Variable	Description
Trip fault active	Indicates when a Trip fault is present. *Trip fault active* is True when a Trip fault exists. It is a NC contact in the *Ready to run* permissive string. Refer to *Sequencer Permissives*.
No trip fault	Indicates when a Trip fault is NOT present. Is True when there is no Trip fault. (Alarm may exist).
No faults active	Indicates when no Trip faults or Alarms are present. Is True when no faults or alarms exist in the drive.

Function description

When the drive is running and a Trip fault is generated, the sequencer will perform the following actions in order:

- Disables the drive flux, *Flux enable status* and the bridge power enable, *Bridge is on*.
- Disables the drive torque, *Torque reg enabled.*
- Opens the contactor, if present. The contactor will remain open as long as a Trip fault exists. See *Main Contactor Configuration*.
- Disables the speed regulator, *Sreg enable status*.
- Disables the speed reference, *Speed ref enabled.*

The sequencer also removes any type of run request to the drive because the *Ready to run* permissive string drops out due to the Trip fault. This will also keep the drive from trying to run while a Trip fault is present.

Because the bridge is turned off during a Trip fault, the sequencer essentially performs a coast stop. A coast stop occurs when the power to the motor is removed and the motor coasts to a stop.

To reset a Trip fault or Alarm, request a Fault reset using one of the Function inputs described above.

Note Performing a Fault reset may not clear the fault if the fault condition still exists, or if the fault is Locked.

Related diagrams

- General Sequencing #1 (GenSeq_1)

Sequencer Permissives

Sequencer permissives are used to prevent or allow the drive to run if the permissive condition exists in the drive. Two types of permissives exist: internal permissives and application permissives.

Internal permissives are internal drive conditions that must be satisfied before the drive will run (for example, *DC bus charged* must be True before the drive can run**.**)

Application permissives allow the user to connect application specific permissive logic that must be satisfied before the drive will run.

The main permissive string used by the sequencer is *Ready to run*. This permissive must be True for the drive to run, and the details of this permissive are displayed in the Sequencing diagrams in the drive.

Function inputs

Application Permissive Inputs

Parameter	Description
Run permissive sel	When used, this parameter selects a variable that populates *Run permissive*. When unused, *Run permissive* is always set to True.
Start permissive sel	When used, this parameter selects a variable that populates *Start permissive* when the drive is stopped. When unused, *Start permissive* is always set to True
Variable	**Description**
Run permissive	If False, this permissive will prevent the drive from starting or stop the drive if it is running. An alarm, *Run permissive lost*, is generated when the permissive is False.
Start permissive	If False, this permissive will prevent the drive from starting, but will not stop the drive if it is running. An alarm, *Start permissive bad*, is generated when the permissive is False.
X stop active	If True, this permissive will prevent the drive from starting or will perform an X-Stop if the drive is running. A Trip fault, *Run req & xstop open*, is generated when this permissive is True, the drive is stopped, and a run is requested. (For more information on *X stop active*, please refer to *Stopping Commands and Modes*.)

Internal Permissive Inputs

Variable	Description
Local fault string	Local hardware permissive. When *Local fault string* is True, it will prevent the drive from starting or running. If a run is requested while *Local fault string* is True, a Trip fault, *Local flt*, will be generated.
System fault string	System hardware permissive. When *System fault string* is True, it will prevent the drive from starting or running. If a run is requested while *System fault string* is True a Trip fault, *System flt*, will be generated. See also *Hardware Fault Strings*.
Flux decay active	Indicates that that flux has not yet decayed below 2% of *100% Flux* when the drive is in Tachless mode operation. If True, *Flux decay active* will prevent the drive from starting. An alarm, *Run cmd w high flux*, will be generated if this permissive is True when a run is requested.
DC bus charged	Indicates that the DC bus is charged. An alarm, *DC bus voltage low*, is generated when this permissive is False.

Function outputs

Variable	Description
Ready to run	The main run permissive and primary indication that the drive is ready to run. If False, this permissive will cause all run requests and commands to drop out. The drive cannot be started unless *Ready to run* is True.
Run ready and fluxed	Indicates that the drive is fluxed and ready to run. This permissive can be used in coordination with *Full flux request* as a ready to run signal for applications that keep the drive fluxed for fast restarts. Refer to *Sequencer Commands*.

Function configuration

Parameter	Description
Bypass Q/C stop	This parameter removes *Coast stop active* and *Quick stop active* from the *Ready to run* permissive, when they are normally included. *Bypass Q/C stop* should be set to Yes if *Normal stop mode* is set to *Quick stop* or *Coast stop*. (Also see *Stopping Commands and Modes*.)
Flying restart	This parameter has the following possible values: *Enable fly restart*: Allows the drive to restart while the motor speed is above the *Zero speed level*. *Disable fly restart*: The motor speed must be below the *Zero speed level* before the drive can be restarted, otherwise a trip fault, *Flying restrt disabl*, will be generated. *Locked shaft restart*: The application assures that the shaft is locked (by a brake or other means) when the drive is started. This mode may decrease the time that it takes to pre-flux the drive. ***Note*** In this mode, failure to insure that the shaft is locked may cause the drive to misoperate.

Related faults and alarms

The following faults and alarms may be generated when the *Ready to run* permissive is not satisfied.

- Run permissive lost
- Start permissive bad
- Run cmd w high flux
- Local flt
- System flt
- Run before MA closed
- Flying restrt disabl
- Run req & xstop open

Related diagrams

- General Sequencing #2 (GenSeq_2)

Stopping Commands and Modes

The sequencer provides two mechanisms for issuing a controlled stop of the drive: a Normal stop and an X-stop.

A Normal stop can be issued in several ways:

- Removing a run request or jog request
- Pressing the Stop pushbutton on the DDI (also called the keypad)
- Pressing an alternate Stop pushbutton (if configured in the drive)
- Removing the *Run permissive* from the *Ready to run* permissive string

An X-Stop is issued through a dedicated configurable input to the drive.

A third mechanism for stopping the drive is to generate a Trip fault. In a Trip fault, since the power to the motor is quickly removed, the drive does not stop the motor in a controlled manner.

Related diagrams

- General Sequencing #1 (GenSeq_1)
- General Sequencing #2 (GenSeq_2)

Normal Stop

The Normal stop is the typical way to stop the drive in a controlled manner. A Normal stop can be configured as Ramp stop, Coast stop, or Quick stop.

Function inputs

The following parameters drive the function input variables:

Parameter	Description
Run request select	See *Sequencer Commands* for a description of this parameter.
Jog request select	See *Sequencer Commands* for a description of this parameter.
Stop PB select	Selects a variable that is inverted and then used to drive *Stop PB request*. The input variable must go False to issue a Normal stop (that is, set *Run request* to False). This input is used to create a two-wire Start/Stop pushbutton. When *Stop PB select* is used, the sequencer looks at the + edge of the *Run request select* input to set *Run request* to True and at *Stop PB request* to set *Run request* to False.
Stop PB select, lan	Selects a LAN variable used to drive *Stop PB request* when *LAN commands OK* is True. The input variable must go True to issue a Normal stop (that is, set *Run request* to False). Please note that input has the OPPOSITE behavior of *Stop PB select*. This input is used to create a two-signal Start/Stop pushbutton over the LAN. When *Stop PB select, lan* is used, the sequencer looks at the + edge of *Run request, lan* to set *Run request* to True and at *Stop PB request* to set *Run request* to False.

The following variables are inputs that are used to stop the drive.

Variable	Description
Run request and Jog request	A normal stop is generated when *Run request* and *Jog request* are both False. (See also *Sequencer Commands*.)
Stop PB request	This input is driven by *Stop PB select* or *Stop PB select, lan*. A normal stop is generated when *Stop PB request* is True.
Run permissive	A normal stop is generated when this input is False. (See also *Sequencer Permissives*.)
DDI Stop Pushbutton	A normal stop is generated when the Stop pushbutton is pressed on the DDI.

Function configuration

Parameter	Description
Normal stop mode	Selects the behavior of a normal stop. Possible choices are: Ramp stop Quick stop Coast stop (See below.)
Flux off delay time	Sets a time delay for which the drive remains fluxed after it has stopped. Allows the drive to be quickly re-started after it has stopped, without the delay of pre-fluxing the drive.

Function description

A normal stop can be generated from one of several different inputs, but has 1 of 3 stopping behaviors as configured by the parameter *Normal stop mode*.

Ramp stop	The drive follows a linear speed deceleration ramp down to zero speed as configured by the *Speed Reference Ramp* function. Once the drive detects that *Speed reg fbk* has reached the *Zero speed level*, the sequencer disables the regulators and stops the drive.
Quick stop	The speed reference is stepped to zero so that the speed is brought to zero as quickly as possible (the drive is in current limit). Once the drive detects that *Speed reg fbk* has reached the *Zero speed level*, the sequencer disables the regulators and stops the drive.
Coast stop	The regulators are immediately disabled and power is removed from the motor so that it will coast to a stop. The sequencer will prevent the drive from being re-started until *Speed reg fbk* has reached the *Zero speed level*, unless *Flying restart* is enabled.

Note If *Normal stop mode* is set to *Quick stop* or to *Coast stop*, it is recommended that the parameter *Bypass Q/C stop* be set to Yes.

Otherwise, if the application uses *Full flux request* or has set the *Flux off delay time*, the sequencer will not properly maintain flux on the drive.

Related diagrams

- General Sequencing #2 (GenSeq_2)

X-Stop

The X-stop is an alternate way to stop the drive in a controlled manner. An X-stop can be configured as Ramp stop, Coast stop, Quick stop, Trip fault stop, or Emergency Ramp stop.

Function inputs

Parameter	Description
X stop request sel	Selects the variable that is inverted and then used to drive *X stop active*. The variable selected by *X stop request sel* must be False to initiate an X-stop.
Variable	**Description**
X stop request, lan	Is used to drive *X stop active* from the LAN when *LAN commands OK* is True. *X stop request, lan* must be True to initiate an X-stop. Please note that this is OPPOSITE the behavior of *X stop request sel*. (See also *LAN Signal Map*.)

Function output

Variable	Description
X stop active	Causes drive to perform an X-stop as configured by *X stop mode*. It also drops out the *Ready to run* permissive string.

Function configuration

Parameter	Description	
X stop mode	Selects the behavior of an X-stop. Possible choices are:	
	Nrml (ramp) stop	Trip flt stop
	Quick stop	Emerg ramp stop
	Coast stop	(See below.)

Function description

An X-stop can have 1 of 5 stopping behaviors as configured by the parameter *X stop mode*.

Nrml (ramp) stop	The drive follows a linear speed deceleration ramp down to zero speed as configured by the *Speed Reference Ramp* function. Once the drive detects that *Speed reg fbk* has reached the *Zero speed level*, the sequencer disables the regulators and stops the drive.
Quick stop	The speed reference is stepped to zero so that the speed is brought to zero as quickly as possible (the drive is in current limit). Once the drive detects that *Speed reg fbk* has reached the *Zero speed level*, the sequencer disables the regulators and stops the drive.
Coast stop	The regulators are immediately disabled and power is removed from the motor so that it will coast to a stop. The sequencer will prevent the drive from being re-started until *Speed reg fbk* has reached the *Zero speed level*, unless *Flying restart* is enabled.
Trip flt stop	Behavior is similar to that of a Coast stop, except that a Trip fault, *X stop*, is also generated.
Emerg ramp stop	The drive follows a linear speed deceleration ramp down to zero as configured by the parameter *Emerg ramp rate*. (See also the *Speed Reference Ramp*.) Once the drive detects that *Speed reg fbk* has reached the *Zero speed level*, the sequencer disables the regulators and stops the drive.

Once the drive is stopped, *X stop active* must be set False before the drive is re-started. Otherwise, if any type of run is requested, the sequencer will generate an *Run req & xstop open* trip fault.

Related diagrams

- General Sequencing #1 (GenSeq_1)

Sequencer Commands

A sequencer request is generated from various user inputs to direct the sequencer to run or flux the drive. A sequencer command is the internal "go ahead" to sequencer once the permissive logic has been satisfied (see *Sequencer Permissives*).

The variables *Run request* and *Jog request* are associated with Run Commands. They direct the sequencer to run the drive using the appropriate speed reference.

The variable *Full flux request* is associated with Flux Commands and directs the sequencer to flux the drive. If the drive is already fluxed when a run is requested, the drive will begin running immediately without the delay caused by fluxing the drive.

Related diagrams

- General Sequencing #2 (GenSeq_2)
- General Sequencing #3 (GenSeq_3)

Run Commands

A run command (initiated either by a *Run request* or *Jog request*) will:

- Enable bridge power
- Flux the drive (if it is not already fluxed)
- Enable drive torque
- Enable the speed regulator
- Enable the appropriate speed reference

Function inputs

Parameter	Description
Run request select	Selects the variable that drives *Run request*. This input is only active in "Remote mode" (*Local mode active* is False). The sequencer normally treats the signal as a +/- edge-triggered input to set *Run request*. However, if *Stop PB select* is used, the sequencer looks only at the + edge of the signal to set *Run request*. (See *Stopping Commands and Modes* for more information on *Stop PB select*.)
Jog request select	Selects the variable that drives *Jog request*. This input is only active in "Remote mode." It is treated as a +/- edge-triggered input.
Variable	**Description**
Run request, lan	Drives *Run request* from the LAN if *LAN commands OK* is True. (Also see *LAN Signal Map*.) This input is only active in "Remote mode". The sequencer normally treats the signal as a +/- edge-triggered input to set *Run request*. However, if *Stop PB select, lan* is used, the sequencer looks only at the + edge of the signal to set *Run request*. (See *Stopping Commands and Modes* for more information on *Stop PB select, lan*.)
Jog request, lan	Drives *Jog request* from the LAN if *LAN commands OK* is True. This input is only active in "Remote mode". It is treated as a +/- edge-triggered input. (Also see *LAN Signal Map*.)
DDI Run pushbutton	Sets *Run request* to True if the drive is in Local mode (*Local mode active* is True).
DDI Jog pushbutton	Sets *Jog request* when pressed and clears it when released. Is operational only when the drive is in Local mode (*Local mode active* is True).

Function outputs

Variable	Description
Run request	The request to run the drive. The details of the logic which forms this signal is shown in the sequencer diagrams.
Jog request	The request to run the drive at the appropriate jog reference (see *Local Speed Reference* or *Remote Speed Reference* for details on speed reference). The details of the logic which forms this signal is shown in the sequencer diagrams.
Run command	Internal sequencer command formed from *Run request*, *Jog request* and the *Ready to run* permissive string.
Run active	Drive is running in response to *Run request*.
Jog active	Drive is running in response to *Jog request*.

Related diagrams

- General Sequencing #2 (GenSeq_2)

Flux Commands

A flux command (initiated by *Full flux command* or *Standby command*) will:

- Enable bridge power
- Flux the drive
- Disable the torque reference (if enabled)

Function inputs

Parameter	Description
Full flux req sel	Selects the variable that requests the drive to be pre-fluxed and waiting for a run command. This input is only active in "Remote mode". It is treated as a +/- edge-triggered input. If the drive is using a Tachless mode motor control and *Flying restart* is set to *Locked shaft restart*, this input will request a *Standby command*.
Variable	**Description**
Full flux req, lan	Requests the drive to be pre-fluxed from the LAN if *LAN commands OK* is True. This input is only active in "Remote mode". It is treated as a +/- edge-triggered input. (Also see *LAN Signal Map*.)

Function outputs

Variable	Description
Full flux request	A request to enable the bridge and pre-flux the drive. This signal is the output of *Full flux req sel* and *Full flux req, lan*.
Full flux command	Internal sequencer command to enable the bridge and pre-flux the drive. This output requires that the *Ready to run* permissive string be satisfied. The details of the logic which forms this signal is shown in the sequencer diagrams.
Standby command	Internal sequencer command to enable the bridge, pre-flux the drive and enter an adaptive full flux standby mode. This output requires that the *Ready to run* permissive string be satisfied. This command is generated *only* when the drive is using a Tachless motor control and *Enb adaptv full flx* is set to *Yes* or *Flying restart* is set to *Locked shaft restart*. The standby mode is used to measure the value of motor parameters that are critical to Tachless motor control operation. The details of the logic which forms this signal is shown on the sequencer diagrams.

Function configuration

Parameter	Description
Enb adaptv full flx	This parameter is specific to the Tachless motor control algorithm and is associated with *Full flux request* mode operation. If this parameter is set to *Yes*, the drive control will track motor resistance continuously during *Full flux request* mode. This will ensure optimal low speed control performance and optimal torque per ampere capability when the Tachless control drive resumes normal running condition. The Vector Tachless drive cannot keep the motor energized at zero speed in (*Full flux request* mode) for an extended period of time (measured in 10's of seconds) without malfunction unless the parameter *Enb adaptv full flx* is set to *Yes* (see caution below). Otherwise, the drive must be stopped and restarted when it is desired to move. When the Tachless drive is stopped, there is a requirement to wait for the motor flux to decay (1 to 20 seconds, depending on motor rotor circuit time constant) before restarting the drive. Otherwise, a *Run cmd w high flux* alarm will occur and the drive will be blocked from starting until the flux has decayed to a lower level (2% rated).

Caution

When parameter *Enb adaptv full flx* is set to *Yes*, any externally induced shaft motion (even very slight motion) will cause the drive to malfunction. Please do not activate this function if the motor shaft can be rotated by its load while in Full Flux mode. Please see also other cautions on applying Tachless Control drives as specified under the parameter, *Motor ctrl alg sel*.

Related diagrams

- General Sequencing #3 (GenSeq_3)

Sequencer Status

The sequencer provides drive status information that can be used by various application functions and is also used for internal sequencing functions. The status information is divided into 2 types:

- Drive status variables
- Sequencer status variables

Drive status variables

Drive status variables provide general information about the status of the drive (for example, whether it is running, stopped, and so forth). These variables are used by the toolbox and by the DDI/keypad to provide drive status information to the user. Drive status information is provided to the LAN as well. (See *LAN Signal Map*.)

Variable	Description
Bridge is on	Bridge power is enabled.
Coast stop active	A coast stop is active in the drive, initiated either by a normal or X-stop. (See *Stopping Commands and Modes*.)
No faults active	No faults or alarms exist in the drive.
Quick stop active	A quick stop is active in the drive, initiated either by a normal or X-stop. (See *Stopping Commands and Modes*.)
Ramp ref enabled	Speed reference input to the *Speed Reference Ramp* is enabled. When a stop command is initiated, *Ramp ref enabled* goes False, stepping the ramp input to zero. The *Speed ref, ramped* follows a linear ramp from its present value to zero.
Ready to run	Drive is ready to run and will start if a run is requested. (See *Sequencer Permissives*.)
Run ready and fluxed	Drive is fluxed and ready to run. (See *Sequencer Permissives*.)
Running	The drive is running (that is, the speed regulator and speed references are enabled).
Stopped	The drive is stopped (that is, bridge power is off).
Trip fault active	A Trip fault exists in the drive.
Zero speed active	The speed feedback used by the speed regulator, *Speed reg fbk*, is less than the parameter, *Zero speed level*. Once this condition is met, *Zero speed active* goes True after a delay time set by *Zero speed delay*.

Parameter	Description
Zero speed level	The level below which the drive is considered to be at zero speed as indicated by the variable, *Zero speed active*.
Zero speed delay	Once *Speed reg fbk* is below the *Zero speed level*, this parameter specifies the time for which *Zero speed active* is held off from going True.

Related diagrams

- General Sequencing #2 (GenSeq_2)

Sequencer status variables

Sequencer status variables are used to request and report status of internal regulator sequencing. These variables normally come in pairs of a Request and a Status. The Request is a command to either enable or disable the appropriate function. The Status is a feedback that indicates the command has been successfully executed (that is, enabled or disabled) and the sequencer can proceed to its next state.

Variable	Description
Sequencer state	Internal sequencer state variable that indicates what mode the sequencer is in. Possible values include: Stopped Enable flux Enable torque Enable speed regulator Running Zero speed (waiting for zero speed) Disable torque Standby
MA cont enable req	Request to pick up (drop out) the MA contactor. (See *Main Contactor Configuration*.)
MA cont enable stat	Indicates that the MA contactor has been picked up (dropped out).
Flux enable request	Request to enable (disable) bridge power and the inner regulators and to pre-flux the drive.
Flux enable status	Status that the bridge power and inner regulators are enabled (disabled) and the drive is pre-fluxed.
Torque enable req	Request to enable (disable) the torque reference
Torque reg enabled	Status that the torque reference is enabled (disabled).
Sreg enable request	Request to enable (disable) the speed regulator. (See *Speed/Torque Regulator*).
Sreg enable status	Status that the speed regulator is enabled (disabled).
Ref enable request	Request to enable (disable) the speed reference.
Speed ref enabled	Status that the speed reference is enabled (disabled).
Standby enable req	Request to enable (disable) standby mode (See *Sequencer Commands*.
Standby enable stat	Status that standby mode is enabled (disabled).

Related diagrams

- General Sequencing #4 (GenSeq_4)
- General Sequencing #5 (GenSeq_5)

Main Contactor Configuration

The sequencer normally controls the operation of the main (MA) contactor. The contactor is picked up when the drive is powered up and only drops out when a Trip fault exists in the drive. The contactor may also be independently controlled from an external input.

Function input

Parameter	Description
MA close req sel	Selects the Boolean variable that drives *MA cont enable req* to independently control the contactor. *Note:* If this input is used, the contactor MUST be picked before a run request is sent to the drive, otherwise a trip fault, *Run before MA closed*, will be issued. If *MA close req sel* is set to Unused, the contactor will be automatically driven by the sequencer.

Function output

Variable	Description
MA cont enable req	Request from sequencer to pick-up or drop out the main contactor.
MA cont enable stat	Status to indicate to the sequencer that the main contactor has been picked-up (dropped-out).
MA close command	Internal command to the contactor hardware to pick-up or drop out the contactor.
MA contactor closed	Actual feedback from the contactor indicating that the contactor has been picked-up or dropped out. If connected, then *MA contactor fbk* must be set to True. If the feedback is not connected, then the contactor sequencing uses *MA pickup time* to indicate the contactor status (*MA cont enable stat*).

Function configuration

Parameter	Description
MA contactor absent	Specifies whether a contactor is absent. If this parameter is not set correctly, the contactor sequencing will not work properly.
MA contactor fbk	Enables the sequencing logic to look at contactor feedback to determine if the contactor status meets the request. (See *MA pickup time* below.)
MA pickup time	If *MA contactor fbk* is enabled, then this acts as a time-out delay. If the contactor feedback hasn't met the command within the specified time, the drive will generate a *Cont failed to close* trip fault. If *MA contactor fbk* is disabled, then this acts as the contactor simulated feedback delay, and will update the status to match the request after the specified delay. The maximum delay time is 2 seconds. In simulator mode, the sequencer ignores the contactor feedback even if *MA contactor fbk* is enabled.

Function description

The main (MA) contactor can be either be automatically controlled by the sequencer, or independently controlled by using the parameter, *MA close req sel*. When controlled by the sequencer, the contactor is picked up when the drive is powered up and dropped out only on trip faults. When independently controlled, the contactor must be picked up before a run is requested. The contactor will also drop out on a trip fault regardless of the command.

The contactor will also be dropped out (in hardware) when either the Local or System Fault strings have been opened.

Many drive applications do not require a contactor and should therefore configure the parameter *MA contactor absent* correctly for proper operation.

If the contactor has the feedback wired, then the parameter *MA contactor fbk* should be enabled and *MA pickup time* should be set to a reasonable time-out delay for the contactor that is used.

Related diagrams

- General Sequencing #4 (GenSeq_4)

Speed Reference Functions

Critical Speed Avoidance

The *Critical Speed Avoidance* function prevents the speed reference from entering speed avoidance zones. The user can specify three positive and three negative speed avoidance zones. The *Critical Speed Avoidance* function operates on the pre-ramp speed reference.

Function inputs

The following table specifies the input variables of the *Critical Speed Avoidance* function.

Variable	Description
Speed avd func input	Speed reference which is the output of the *Minimum Speed Limit* function (variable *Min speed output*). RPM

Function outputs

The following table specifies the output variables of the *Critical Speed Avoidance* function.

Variable	Description
Spd avd func output	Speed reference which has been prohibited from entering the speed avoidance zones and which is the input to the *Speed Reference Ramp* function (variable *Speed ref, pre ramp*). RPM

Function configuration

The following table specifies the configuration parameters of the *Critical Speed Avoidance* function.

Parameter	Description
Crit speed avoidance	Enables the *Critical Speed Avoidance* function.
Critical speed 1	Speed at center of speed avoidance zone 1. RPM
Critical speed 2	Speed at center of speed avoidance zone 2. RPM
Critical speed 3	Speed at center of speed avoidance zone 3. RPM
Critical speed hys	Width of speed avoidance zones on either side of center speeds. RPM

Function description

The *Critical Speed Avoidance* function is part of the *Speed Reference Generation* function. It operates on the speed reference after the *Minimum Speed Limit* function and before the *Speed Reference Ramp* function. The *Critical Speed Avoidance* and *Minimum Speed Limit* functions are coordinated so that the output of the *Critical Speed Avoidance* function is outside the boundary imposed by the *Minimum Speed Limit* function.

The *Critical Speed Avoidance* function prevents the speed reference from entering speed avoidance zones. Each speed avoidance zone is defined by a center speed and a hysteresis level. The user can specify three positive and three negative speed avoidance zones.

The table below lists how the parameters define the center speeds of each of the speed avoidance zones.

Speed Avoidance Zone	Center Speed
Positive zone 1	Critical speed 1
Positive zone 2	Critical speed 2
Positive zone 3	Critical speed 3
Negative zone 1	-1 x Critical speed 1
Negative zone 2	-1 x Critical speed 2
Negative zone 3	-1 x Critical speed 3

The hysteresis is the same for all of the speed avoidance zones. For each of the speed avoidance zones, the *Critical Speed Avoidance* function prohibits the speed reference from taking on values between [*Center speed* - *Critical speed hys*] and [*Center speed* + *Critical speed hys*], where *Center speed* is defined by the table above. The total width of each of the speed avoidance zones is 2 times *Critical speed hys*.

Related diagrams

- Critical Speed Avoidance (CrSpdAvd)

Local Speed Reference

The *Local Speed Reference* forms a speed reference signal from the local source (the DDI/keypad).

Function inputs

The following table specifies the input variables to the *Local Speed Reference* function.

Variable	Description
Local inc command	Signal that is True when the DDI speed increment button is pressed.
Local dec command	Signal that is True when the DDI speed decrement button is pressed.
Jog request	Sequencer request to jog the drive.

Function outputs

The output of the *Local Speed Reference* function is a local speed reference. This becomes the speed reference used by the *Speed Reference Generation* function if *Local mode active* is True.

Function configuration

The following table specifies the configuration parameters for the *Local Speed Reference* function.

Parameter	Description
Local speed	Initial value of local speed reference. RPM
Local jog speed	Jog speed that becomes the local speed reference when *Jog request* is True. RPM
Local Inc/Dec rate	Rate of change of the local speed reference. RPM/second

Function description

The *Local Speed Reference* function is part of the *Speed Reference Generation* function. It forms a speed reference signal from the local source (the DDI).

The *Local Speed Reference* function produces a local speed reference. This becomes the speed reference used by the *Speed Reference Generation* function if the drive is in local mode (when *Local mode active* is True). Local mode is enabled using the DDI Remote/Local button.

The local speed reference is formed by adjusting the reference around an initial value. The initial value is specified by *Local speed*. To make the adjustment, press the DDI speed increment (Speed +) and decrement (Speed –) buttons. Using the increment and decrement buttons sets *Local inc command* and *Local dec command* respectively. The speed reference increases when *Local inc command* is True and decreases when *Local dec command* is True. The rate of change is defined by *Local Inc/Dec rate*. The local speed reference is limited to values between zero and *Applied top RPM*.

The calculation of the local speed reference described in the preceding paragraph applies when *Jog request* is False. When *Jog request* is True, the local speed reference is set to the value of *Local jog speed*. More information on *Jog request* is available in the *Sequencer Commands* function help.

Related diagrams

- Speed Reference Generation (Ovr_RfSel)

Minimum Speed Limit

The *Minimum Speed Limit* function prohibits the speed reference from falling below a specified magnitude.

Function inputs

The following table specifies the input variables of the *Minimum Speed Limit* function.

Variable	Description
Minimum speed input	Speed reference which is the possibly reversed local or remote speed reference (variable *Speed reference*). RPM

Function outputs

The following table specifies the output variables of the *Minimum Speed Limit* function.

Variable	Description
Minimum speed output	Speed reference whose magnitude has been clamped to a minimum value and which is the input to the *Critical Speed Avoidance* function (variable *Speed avd func input*). RPM

Function configuration

The following table specifies the configuration parameters of the *Minimum Speed Limit* function.

Parameter	Description
Minimum speed	Minimum speed reference magnitude. RPM

Function description

The *Minimum Speed Limit* function is part of the *Speed Reference Generation* function. It operates on the speed reference after the *Speed Reference Reverse* and before the *Critical Speed Avoidance* function.

The *Minimum Speed Limit* function prevents the speed reference from falling below a specified magnitude. The minimum speed magnitude is defined by parameter *Minimum speed*.

Related diagrams

- Speed Reference Generation (Ovr_RfSel)

Remote Speed Reference

The *Remote Speed Reference* forms a speed reference signal from the remote source, which is typically a system level controller or an adjustable analog input.

Function inputs

The following table specifies the input parameters to the *Remote Speed Reference* function.

Parameter	Description
Auto analog ref sel	Selects the automatic speed reference.
Man analog ref sel	Selects the manual speed reference when *Manual speed ref sel* is False.
Auto mode select	Selects the signal that switches the remote speed reference between the automatic and manual references.

The following table specifies the input variables to the *Remote Speed Reference* function.

Variable	Description
Jog request	Sequencer request to jog the drive.

Function configuration

The following table specifies the configuration parameters for the *Remote Speed Reference* function.

Parameter	Description
Speed setpoint 0	Constant speed that is the manual reference when *Manual speed ref sel* is True. RPM
Manual speed ref sel	Switches between the selectable and constant sources for the manual reference.
Remote jog speed	Jog speed that becomes the local speed reference when *Jog request* is True. RPM

Function description

The *Remote Speed Reference* function is part of the *Speed Reference Generation* function. It forms a speed reference signal from the remote source (typically a system level controller or an adjustable analog input).

The *Remote Speed Reference* function produces a local speed reference that becomes the speed reference used by the *Speed Reference Generation* function if the drive is in remote mode (when *Local mode active* is False). Remote mode is enabled using the DDI Remote/Local button.

The remote speed reference is formed by selecting an automatic or manual reference. The automatic reference is usually a signal from a system level controller. The manual reference is usually an analog input signal or a constant setpoint. The selection of the automatic or manual reference source is determined by *Auto mode select*. If the variable selected by *Auto mode select* is True, then the automatic reference is used. If the variable selected by *Auto mode select* is False, then the manual reference is used.

If the automatic reference is used, then the remote speed reference is set equal to the signal selected by *Auto analog ref sel*.

If the manual speed reference is used, then the remote speed reference is set to either a selectable or a constant value, depending on the value of *Manual speed ref sel*. If *Manual speed ref sel* is False, then the remote reference is set equal to the signal selected by *Man analog ref sel*. If *Manual speed ref sel* is True, then the remote reference is set equal to *Speed setpoint 0*.

The selection of the remote speed reference described in the preceding paragraphs applies when *Jog request* is False. When *Jog request* is True, the remote speed reference is set to the value of *Remote jog speed*. More information on *Jog request* is available in the *Sequencer Commands* function help.

Related diagrams

- Speed Reference Generation (Ovr_RfSel)

Speed Reference Generation

The *Speed Reference Generation* function coordinates the activities involved in selecting and processing the speed reference signal.

Function description

The *Speed Reference Generation* function selects the speed reference signal from a local or remote source. The local source is the DDI/keypad (details on forming the local reference are available in the *Local Speed Reference* function help). The remote source is typically a system level controller or an adjustable analog input. Information on the formation of the remote reference is available in the *Remote Speed Reference* function help.

The *Speed Reference Generation* selects the local reference if *Local mode active* is True. It selects the remote reference if *Local mode active* is False. Select the value of *Local mode active* with the DDI Remote/Local button.

After the speed reference has been selected from the local or remote source, the *Speed Reference Generation* function allows several subordinate functions to operate on the speed reference. The *Speed Reference Reverse* function reverses the speed reference if the user has requested that action. The *Minimum Speed Limit* function makes sure the speed reference magnitude is above a specified level. The *Critical Speed Avoidance* function prohibits the speed reference from entering specified ranges. The *Speed Reference Ramp* function limits the speed reference's rate of change.

The output of the *Speed Reference Ramp* function (*Speed ref, ramped*) is also the output of the *Speed Reference Generation* function. This final speed reference passes to the *Speed/Torque Overview* function for further conditioning before it becomes the reference to the *Speed/Torque Regulator* function.

Related diagrams

- Speed Reference Generation (Ovr_RfSel)

Speed Reference Ramp

The *Speed Reference Ramp* function forces the speed reference to change in a controlled fashion. It limits the rate of change of the speed reference that goes to the *Speed/Torque Overview* function.

Function inputs

The following table specifies the input variables of the *Speed Reference Ramp* function.

Variable	Description
Speed ref, pre ramp	Speed reference that is the output of the *Critical Speed Avoidance* function (variable *Spd avd func output*). RPM
Speed reg fbk	Speed feedback that in some conditions becomes the output of the ramp. RPM
Ramp ref enabled	Enables the speed reference input to the ramp.
Emergency stop act	A *Stopping Commands and Modes* signal that indicates that an emergency stop has been commanded.

Function outputs

The following table specifies the output variables of the *Speed Reference Ramp* function.

Variable	Description
Speed ref, ramped	Speed reference which has been rate limited by the linear ramp. RPM

Function configuration

The following table specifies the general configuration parameters of the *Speed Reference Ramp* function.

Parameter	Description
Ramp bypass	Disables the *Speed Reference Ramp* function.
Ramp rate mode	Specifies whether the speed independent ramp rate mode or the programmed ramp rate mode is active.
Emerg ramp rate	Deceleration ramp rate under emergency stop conditions. RPM/second

The following table specifies the configuration parameters for the speed independent ramp rate mode, which is active when *Ramp rate mode* is set to *Indep accel/decel*.

Parameter	Description
Acceleration rate 1	Ramp rate that is effective when the magnitude of *Speed ref, pre ramp* is increasing and ramp rate set 1 is active. RPM/second
Acceleration rate 2	Ramp rate that is effective when the magnitude of *Speed ref, pre ramp* is increasing and ramp rate set 2 is active. RPM/second
Deceleration rate 1	Ramp rate that is effective when the magnitude of *Speed ref, pre ramp* is decreasing and ramp rate set 1 is active. RPM/second
Deceleration rate 2	Ramp rate that is effective when the magnitude of *Speed ref, pre ramp* is decreasing and ramp rate set 2 is active. RPM/second
Ramp rate 2 select	Selects between ramp rate set 1 and set 2.

The following table specifies the configuration parameters for the programmed ramp rate mode, which is active when *Ramp rate mode* is set to *Prog accel/decel*.

Parameter	Description
Acceleration rate 1	Ramp rate that is effective when the magnitude of *Speed ref, pre ramp* is increasing and less than *Accel break point 1*. RPM/second
Accel break point 1	Speed at which the acceleration ramp rate switches between *Acceleration rate 1* and *Acceleration rate 2*. RPM
Acceleration rate 2	Ramp rate that is effective when the magnitude of *Speed ref, pre ramp* is increasing and between *Accel break point 1* and *Accel break point 2*. RPM/second
Accel break point 2	Speed at which the acceleration ramp rate switches between *Acceleration rate 2* and *Acceleration rate 3*. RPM
Acceleration rate 3	Ramp rate that is effective when the magnitude of *Speed ref, pre ramp* is increasing and greater than *Accel break point 2*. RPM/second
Deceleration rate 1	Ramp rate that is effective when the magnitude of *Speed ref, pre ramp* is decreasing and less than *Decel break point 1*. RPM/second
Decel break point 1	Speed at which the deceleration ramp rate switches between *Deceleration rate 1* and *Deceleration rate 2*. RPM
Deceleration rate 2	Ramp rate that is effective when the magnitude of *Speed ref, pre ramp* is decreasing and between *Decel break point 1* and *Decel break point 2*. RPM/second
Decel break point 2	Speed at which the deceleration ramp rate switches between *Deceleration rate 2* and *Deceleration rate 3*. RPM
Deceleration rate 3	Ramp rate that is effective when the magnitude of *Speed ref, pre ramp* is increasing and greater than *Decel break point 2*. RPM/second

Function description

The *Speed Reference Ramp* function is part of the *Speed Reference Generation* function. It operates on the speed reference after the *Critical Speed Avoidance* function and before its use in the *Speed/Torque Overview* function.

The *Speed Reference Ramp* function limits the rate of change of the speed reference. Its input (*Speed ref, pre ramp*) may experience a step change of large magnitude. Its output (*Speed ref, ramped*) has the rate limit imposed on it. The user can disable the *Speed Reference Ramp* function by setting *Ramp bypass* to True.

The input to the *Speed Reference Ramp* is enabled and equal to *Speed ref, pre ramp* when *Ramp ref enabled* is True. When *Ramp ref enabled* is False, the input to the ramp is set to zero and the ramp output is allowed to decelerate to zero. More information on *Ramp ref enabled* is available in the *Sequencer Status* function help.

If the drive is configured for flying restart (when *Flying restart* is set to *Enable fly restart*), then the ramp output (*Speed ref, ramped*) is set to the speed feedback (*Speed reg fbk*) when the reference input to the *Speed/Torque Regulator* is disabled. The input to the *Speed/Torque Regulator* is disabled when *Speed ref enabled* is False. This feature allows the speed reference to ramp from the speed feedback to the specified ramp input when the *Speed/Torque Regulator* reference input is enabled. More information on *Flying restart* is available in the *Sequencer Permissives* function help. More information on *Speed ref enabled* is available in the *Sequencer Status* function help.

Two ramp modes are available for the *Speed Reference Ramp* function: the speed independent ramp rate mode and the programmed ramp rate mode. The modes differ in the way the ramp rates are implemented. The modes are selected by *Ramp rate mode*. The speed independent ramp rate mode is active when *Ramp rate mode* is set to *Indep accel/decel*. The programmed ramp rate mode is active when *Ramp rate mode* is set to *Prog accel/decel*.

When the speed independent ramp rate mode is active, one acceleration rate and one deceleration rate are implemented for all speeds. The rate of change of the speed reference is limited to the acceleration rate when the magnitude of the speed reference is increasing. The rate of change of the speed reference is limited to the deceleration rate when the magnitude of the speed reference is decreasing. The acceleration and deceleration ramp rates belong to one of two ramp rate sets. Ramp rate set 1 is defined by *Acceleration rate 1* and *Deceleration rate 1* and is active when *Ramp rate 2 select* selects a False value. Ramp rate set 2 is defined by *Acceleration rate 2* and *Deceleration rate 2* and is active when *Ramp rate 2 select* selects a True value.

When the programmed ramp rate mode is active, the acceleration and deceleration rates depend on the magnitude of the speed reference. The following table lists the ramp rates and the regions where they are active.

Ramp rate	Active region
Acceleration rate 1	Abs(Speed ref, pre ramp) <= Accel break point 1
Acceleration rate 2	Accel break point 1 < Abs(Speed ref, pre ramp) <= Accel break point 2
Acceleration rate 3	Accel break point 2 < Abs(Speed ref, pre ramp)
Deceleration rate 1	Abs(Speed ref, pre ramp) <= Decel break point 1
Deceleration rate 2	Decel break point 1 < Abs(Speed ref, pre ramp) <= Decel break point 2
Deceleration rate 3	Decel break point 2 < Abs(Speed ref, pre ramp)

The rate of change of the speed reference is limited to the acceleration rate when the magnitude of the speed reference is increasing. The rate of change of the speed reference is limited to the deceleration rate when the magnitude of the speed reference is decreasing.

When an emergency stop is commanded, the *Speed Reference Ramp* decelerates the speed reference to zero at a rate defined by *Emerg ramp rate*. *Emergency stop act* indicates that an emergency stop has been commanded. More information on *Emergency stop act* is available in the *Stopping Commands and Modes* function help.

Related diagrams

- Speed Reference Ramp (Ramp)

Speed Reference Reverse

The *Speed Reference Reverse* function reverses the speed reference in response to a user request.

Function inputs

The primary input to the *Speed Reference Reverse* function is the speed reference signal from the *Speed Reference Generation* function (which is either the local or remote speed reference). This signal is not available as a drive variable.

The following table specifies the input parameters to the *Speed Reference Reverse* function.

Parameter	Description
Reverse select	Selects the user reverse request when *Local mode active* is False.

The following table specifies the input variables to the *Speed Reference Reverse* function.

Variable	Description
Local rev request	User reverse request when *Local mode active* is True, changes as DDI reverse button is pressed.

Function outputs

The following table specifies the output variables of the *Speed Reference Reverse* function.

Variable	Description
Speed reference	Speed reference which is the local or remote speed reference and which has possibly been reversed. RPM

Diagnostic variables

The following table specifies the *Speed Reference Reverse* diagnostic variables.

Variable	Description
Reverse mode active	Indicates whether the drive recognizes a user reverse request.

Function description

The *Speed Reference Reverse* function is part of the *Speed Reference Generation* function. It reverses the speed reference in response to a user request.

The speed reference input to the *Speed Reference Reverse* originates in the *Local Speed Reference* if *Local mode active* is True, or in the *Remote Speed Reference* if *Local mode active* is False. The value of *Local mode active* is selected with the DDI Remote/Local button.

The user request to reverse the speed reference is reflected in *Reverse mode active*. It depends on the value of *Local mode active*. If *Local mode active* is True, then *Reverse mode active* is set equal to *Local rev request*, which changes between True and False as the DDI reverse button is pressed. If *Local mode active* is False, then *Reverse mode active* is set equal to the signal selected by *Reverse select*.

When *Reverse mode active* is True, then the speed reference input is multiplied by –1 to obtain the speed reference output (*Speed reference*).

Related diagrams

- Speed Reference Generation (Ovr_RfSel)

Speed/Torque Control Functions

Droop

The *Droop* function adjusts the speed reference to compensate for the difference between the desired and actual load torque.

Function inputs

The following table specifies the input parameters of the *Droop* function.

Parameter	Description
Droop comp ref sel	Selects the load torque compensation. Per unit torque

The following table specifies the input variables of the *Droop* function.

Variable	Description
Droop feedback	Averaged, normalized, and filtered version of the actual torque reference (*Torque ref post lim*). Per unit torque

Function outputs

The following table specifies the output variables of the *Droop* function.

Variable	Description
Droop output	Speed reference adjustment. RPM

Function configuration

The following table specifies the configuration parameters of the *Droop* function.

Parameter	Description
Droop feedback fil	Feedback filter bandwidth. Radians/second
Droop deadband, neg	Negative deadband level. Per unit torque
Droop deadband, pos	Positive deadband level. Per unit torque
Droop gain	Scale factor that specifies speed droop for 1 pu torque. Per unit speed / Per unit torque
Droop disable sel	Selects a signal that can disable the droop function output.

Related diagrams

- Droop (Droop)

Motor Control Interface

The *Motor Control Interface* function describes the main signals with which the application layer of drive functionality controls the inner motor control algorithm. The primary interface is represented by *Torque ref pre limit*, which is constrained by limits and transformed into a torque-producing current command *Torque current ref*.

A secondary interface is represented by the *Flux ref ratio* signal, which provides limited capability for advanced applications to modify the motor flux reference.

Function inputs

The following table specifies the input parameters of the *Motor Control Interface* function.

Parameter	Description
Torque lim 2 sel	Selects the Boolean signal that switches between the two alternate sets of torque and current limit parameters.
Adj mtr trq lim sel	Selects a variable motoring torque limit signal, used in place of (but limited by) the active constant limit parameter.
Adj gen trq lim sel	Selects a variable generating torque limit signal, used in place of (but limited by) the active constant limit parameter.
Adj cur lim ref sel	Selects a variable current limit adjust signal, used in place of (but limited by) the active constant limit adjust parameter.
Flux ref ratio sel	Selects a variable flux reference adjust signal, used in place of the constant adjust parameter *Flux ref ratio setpt*.

The following table specifies the input variables of the *Motor Control Interface* function.

Variable	Description
Torque ref pre limit	Primary torque reference signal from the application layer of drive functionality prior to motor control interface torque limits. Newton-meters or Pound-feet
Torque enable req	Torque reference enable Boolean command from the core drive sequencer necessary for the propagation of non-zero torque-producing current references to the motor control algorithm.
Flux current, avg	Flux producing component of current feedback utilized as a quadrature component in the transformation of the magnitude current limit to the torque-producing current limit. RMS amps

Function outputs

The following table specifies the output variables of the *Motor Control Interface* function.

Variable	Description
Torque ref post lim	Torque reference after application of positive & negatvie torque limits. Newton-meters or Pound-feet
Trq cur ref pre lim	Torque-producing current reference, transformed from *Torque ref post lim* by torque compensations, and enabled by *Torque enable req*. RMS amps
Torque current ref	Torque-producing current reference after application of positive & negative current limits. RMS amps
Motoring torque lim	Net motoring torque limit, scaled according to *100% Motor torque*. Newton-meters or Pound-feet
Regen torque limit	Net generating torque limit, scaled according to *100% Motor torque*, and reduced as necessary by DC Bus Regeneration Control. Newton-meters or Pound-feet
Torque cmd pos limit	Positive torque limit, derived from motoring & generating torque limits according to direction-sensitive steering control. Newton-meters or Pound-feet
Torque cmd neg limit	Negative torque limit, derived from motoring & generating torque limits according to direction-sensitive steering control. Newton-meters or Pound-feet
Current limit	Net current limit adjust. Per unit
Torque current limit	Torque-producing current limit adjust, scaled according to *Motor rated current*, and derived from the magnitude current limit according to *Flux current, avg*. RMS amps
Ix command pos limit	Positive current limit, derived from the torque-producing current limit, and reduced as necessary by Pullout Limit & Power-Dip Clamp Control. RMS amps
Ix command neg limit	Negative current limit, derived from the torque-producing current limit, and reduced as necessary by Pullout Limit & Power-Dip Clamp Control. RMS amps
Flux ref ratio	Net flux reference adjust signal.

Function configuration

The following table specifies the configuration parameters of the *Motor Control Interface* function.

Parameter	Description
Motoring torque lim1	Defines the motoring torque limit (or maximum value of the variable limit specified by *Adj mtr trq lim sel*) when the value of the Boolean signal selected by *Torque lim 2 sel* is False. Per unit
Motoring torque lim2	Defines the motoring torque limit (or maximum value of the variable limit specified by *Adj mtr trq lim sel*) when the value of the Boolean signal selected by *Torque lim 2 sel* is True. Per unit
Regen torque lim 1	Defines the generating torque limit (or maximum value of the variable limit specified by *Adj gen trq lim sel*) when the value of the Boolean signal selected by *Torque lim 2 sel* is False. Per unit
Regen torque lim 2	Defines the generating torque limit (or maximum value of the variable limit specified by *Adj gen trq lim sel*) when the value of the Boolean signal selected by *Torque lim 2 sel* is True. Per unit
Current limit 1	Defines the current limit adjust (or maximum value of the variable adjust specified by *Adj cur lim ref sel*) when the value of the Boolean signal selected by *Torque lim 2 sel* is False. Per unit
Current limit 2	Defines the current limit adjust (or maximum value of the variable adjust specified by *Adj cur lim ref sel*) when the value of the Boolean signal selected by *Torque lim 2 sel* is True. Per unit
Flux ref ratio setpt	Defines the flux reference adjust value when the variable adjust selector *Flux ref ratio sel* is Unused.

Function description

The variable *Torque ref pre limit* represents the primary torque reference signal from the application layer of drive functionality, and is provided by the *Speed/Torque Regulator*. The *Speed/Torque Regulator* serves as an important focal point for speed and torque regulation systems. This signal is limited according to application torque limits. Next it is converted to a torque-producing current command by a torque compensation function, and then it is further limited according to a combination of application and motor control current limiting functions.

Application limits are defined for motoring torque, generating torque, and current magnitude. For each type of limit a pair of fixed limit values can be configured, the dynamic selection of which is driven by a common user-specified Boolean signal. Each type of limit alternatively can be driven as a variable limit by a user-specified signal; this variable limit value is bounded between zero and the active fixed limit value. Application limits are defined as per-unit values. One per-unit torque is defined as *Motor rated power* at *Motor rated rpm*; one per-unit current is defined as *Motor rated current*

The active generating torque limit is subject to further limiting by the DC Bus Regeneration Control. The Regeneration Control can be configured to limit regenerative capability in response to DC Bus Voltage exceeding programmed limits. Both motoring & generating torque limits are dynamically applied as positive & negative torque limits according to the detected quadrant of operation.

The magnitude current limit is affected as a limit to the torque-producing current component based upon a dynamic calculation that considers the active value of the flux-producing current component. Pullout protection limits and power-dip clamp controls may dynamically further decrease the current limit prior to application to the torque-producing current command.

Appropriate excitation of the induction motor is provided by the motor control algorithm according to configured motor nameplate data and prevailing power supply conditions. However, in some advanced applications it may be appropriate for the application control layer to define further modification to the flux reference. This is accomplished using the *Flux ref ratio* signal, which may be adjusted statically by the fixed parameter *Flux ref ratio setpt* or a dynamic signal selected by the parameter *Flux ref ratio sel*. In either case the signal is defined as a per-unit offset to the nominal flux reference defined by the motor control; one per-unit flux is defined as *Motor rated voltage* at *Motor rated freq*.

Related diagrams

- Motor Control Interface (Core)

Speed Control Fault Check

The *Speed Control Fault Check* checks for the following fault and alarm conditions:

- Over speed
- Failure to rotate
- Loss of spd control
- Reverse rotation

Over speed configuration and operation

The following parameter configures the *Over speed* fault.

Parameter	Description
Over speed flt level	Overspeed fault level. RPM

The *Over speed* fault is declared when the following condition is met.

ABS(Speed reg fbk) > Over speed flt level

Failure to rotate configuration and operation

The following parameters configure the *Failure to rotate* fault.

Parameter	Description
Rotate fail flt lvl	The level which the speed regulator error must exceed for the fault condition to exist. RPM
Rotate fail spd lim	The level which the speed regulator feedback must remain below for the fault condition to exist. RPM
Rotate fail delay	The time for which the fault condition must persist before the fault is declared. Seconds

The *Failure to rotate* fault is declared when the following conditions persist for *Rotate fail delay*.

ABS(Speed reg error) >= Rotate fail flt lvl

ABS(Speed reg fbk) <= Rotate fail spd lim

Loss of spd control configuration and operation

The following parameters configure the *Loss of spd control* alarm.

Parameter	Description
Spd ctl loss flt lvl	The level which the speed regulator error must exceed for the alarm condition to exist. RPM
Spd ctl loss delay	The time for which the alarm condition must persist before the alarm is declared. Seconds

The *Loss of spd control* alarm is declared when the following condition persists for *Spd ctl loss delay*.

ABS(Speed reg error) >= Spd ctl loss flt lvl

In a standard drive configuration the *Loss of spd control* alarm is cleared when the following condition is met.

ABS(Speed reg error) < 90% x Spd ctl loss flt lvl

Reverse rotation configuration and operation

The following parameter configures the *Reverse rotation* fault.

Parameter	Description
Rev rotation fault	Enables the *Reverse rotation* fault.

The *Reverse rotation* fault is declared when the detected direction of *Speed reg fbk* is opposite to the commanded direction of rotation. The magnitude of *Speed reg fbk* must be greater than *Zero speed level* for the fault to occur.

Speed Feedback Calculation

The *Speed Feedback Calculation* function provides a set of speed feedback signals for control and display purposes.

Function inputs

There are three main sources of speed feedback information: tachometer feedback, estimated speed, and simulated speed. The following table specifies the input variables of the *Speed Feedback Calculation* function.

Variable	Description
Tach speed, instr.	Measured tachometer speed. Radians/second
Simulated speed	Simulated speed from motor simulation or from external source. Radians/second
Output freq, unfil	Estimated electrical frequency. Hertz

Function control outputs

The following table specifies the control output variables of the *Speed Feedback Calculation* function.

Variable	Description
Speed reg fbk	Speed feedback for the speed regulator. Appropriate selection of input speed signal filtered for control purposes. RPM

Function display outputs

The following table specifies the display output variables of the *Speed Feedback Calculation* function.

Variable	Description
Motor speed	Display version of either tachometer speed or simulated speed. RPM
Speed feedback	Display version of speed regulator feedback. RPM
Calculated speed	Display version of estimated speed feedback. RPM
Output frequency	Display version of the estimated electrical frequency. Hertz

Function configuration

The following table specifies the configuration parameters of the *Speed Feedback Calculation* function.

Parameter	Description
Motor tach PPR	Tachometer pulses per revolution.
Quantize Sim Spd	Enables tachometer quantization in the simulated speed feedback.
Speed feedback fil	Control filter frequency for *Speed reg fbk*. Radians/second
Tach speed filter	Display filter frequency for *Motor speed*. Radians/second
Spd fbk display fil	Display filter frequency for *Speed feedback*. Radians/second
Calculated spd fil	Display filter frequency for *Calculated speed*. Radians/second
Output freq fil	Display filter frequency for *Output frequency*. Radians/second

Related diagrams

- Speed Feedback (Spd_Fbk)

Speed/Torque Overview

The *Speed/Torque Overview* function coordinates the speed and torque control functions. See the **Related functions** section below for information on the different functions included in the *Speed/Torque Overview* function.

Function inputs

The following table specifies the input parameters that do not appear within any of the component functions of the *Speed/Torque Overview* function.

Parameter	Description
Speed loop sum sel	Selects speed reference signal to add to output of the *Speed Reference Generation* function. RPM

The following table specifies the input variables that do not appear within any of the component functions of the *Speed/Torque Overview* function.

Parameter	Description
Speed ref, ramped	Output of the *Speed Reference Generation* function. RPM

Function configuration

The following table specifies the configuration parameters that do not appear within any of the component functions of the *Speed/Torque Overview* function.

Parameter	Description
Max forward speed	Maximum forward reference to the speed regulator. RPM
Max forward speed	Maximum reverse reference to the speed regulator. RPM

Related functions

The speed and torque control functions included in the *Speed/Torque Overview* function are listed below.

- Speed Feedback Calculation
- Droop
- Speed/Torque Regulator
- Motor Control Interface

Related diagrams

- Speed / Torque Overview (Ovr_SpTq)

Speed/Torque Regulator

The *Speed/Torque Regulator* function.

Function inputs

The following table specifies fixed input variables of the *Speed/Torque Regulator* function (input variables selected by parameters are specified in Function configuration).

Variable	Description
Speed reg reference	Speed regulator reference, the net result of all reference selections and conditioning. RPM
Speed reg fbk	Speed regulator feedback, filtered and selected between motor tachometer speed feedback and estimated speed feedback. RPM
Sreg enable request	Boolean signal from the core drive sequencer which requests enabling of the *Speed/Torque Regulator* function.
Torque ctl pos frz	Boolean signal from the motor control interface indicating that a postive inner limit is encountered; used for speed regulator anti-windup control.
Torque ctl neg frz	Boolean signal from the motor control interface indicating that a negative inner limit is encountered; used for speed regulator anti-windup control.

Function outputs

The following table specifies the continuous signal variables of the *Speed/Torque Regulator* function.

Variable	Description
Speed reg output	Core regulator output of the *Speed/Torque Regulator* function, the scaled and gated sum of proportional (variable *Speed reg prop term*) and integral (variable *Speed reg int term*) regulator components. Newton-meters or Pound-feet
Torque ref pre limit	Final output of the *Speed/Torque Regulator* function provided to the motor control interface, the sum of the primary output of the speed regulator (variable *Speed reg output*), torque refererence (gated signal selected by parameter *Torque ref select*) and torque feedforward (non-gated signal selected by parameter *Torque feed fwd sel*). Newton-meters or Pound-feet
Speed reg error	Primary regulator error signal equal to the difference between *Speed reg reference* and *Speed reg fbk*. RPM
Spd reg integral ref	Conditioned error signal which defines the reference to the regulator integrator structure; differs from *Speed reg error* only in *Torque, spd override* mode (see below). RPM
Speed reg int term	Regulator integral component.
Speed reg prop term	Regulator proportional component.
Inertia	Active inertia compensation signal in use by the regulator, derived from either the *Fixed inertia* parameter or from the variable specified by parameter *Variable inertia sel*. Kilogram-meters^2 or Pound-feet^2
Speed reg net gain	Active net gain compensation in use by the regulator, the scaled product of *Inertia* and the parameter *Spd reg net gain*.

The following table specifies the logical signal variables of the *Speed/Torque Regulator* function.

Variable	Description
Speed reg mode	Primary state variable which reflects the active regulation state of the drive.
Enable spd reg out	Boolean signal from the primary regulator control logic which enables active signals to the variable *Speed reg output*.
Torque mode sel	Boolean signal from the primary regulator control logic which gates the variable *Torque ref input*.
Speed reg antiwindup	Boolean signal indicating that the speed regulator integrator value is frozen as an anti-windup response.

Function configuration

The following table specifies parameters that select input variables of the *Speed/Torque Regulator* function.

Parameter	Description
Torque mode sel	Selects the Boolean variable used to enable *Torque ref input* in *Speed* and *Torque* modes, and to control entry & exit of *Ovrd/Spd forced* mode within *Torque, spd override* modes.
Torque ref select	Selects the signal used as the *Torque ref input* signal. Note that this parameter may specify normal signal sources (acquired at the application loop rate) or one analog high-bandwidth signal source (acquired at the motor control loop rate).
Torque feed fwd sel	Selects the signal used as a torque feedforward signal, summed to the *Torque ref pre limit* in all states.
Spd reg init val sel	Selects the signal used to define preconditioning of internal state variables while in the *Off/Precond* state. The value of the signal determines the target value of *Speed reg output* to appear when the *Speed/Torque Regulator* function is enabled.
Variable inertia sel	Selects the signal used to dynamically define the *Inertia* compensation variable instead of being defined by the constant *Fixed inertia* parameter.

The following table specifies the configuration parameters of the *Speed/Torque Regulator* function.

Parameter	Description
Regulator type	Primary selector which configures the basic regulation mode of the drive (see below).
Torque reg stop mode	Boolean which enables the option to the *Torque with Spillover Speed* mode in which speed regulation mode is dynamically forced (*Ovrd/Spd forced*) during a stop sequence.
Spd reg prop cmd gn	Proportional gain affecting only the command path of the speed regulator compensation network.
Spd reg prop fbk gn	Proportional gain affecting only the feedback path of the speed regulator compensation network.
Spd reg prop filter	Bandwidth of the first-order lowpass filter applied to the net proportional path of the Speed regulator.
Spd reg integral gn	Integral gain of the speed regulator compensation network.
Spd reg net gain	Common gain (inner loop gain) of the speed regulator compensation network.
Fixed inertia	Fixed inertia compensation term of the speed regulator compensation network. Kilogram-meters^2 or Pound-feet^2
Spd reg pos err lim	Limit which defines the positive speed error tolerance for activation of spillover speed mode (transition from *Ovrd/Trq act* to *Ovrd/Spd Low*).
Spd reg neg err lim	Limit which defines the negative speed error tolerance for activation of spillover speed mode (transition from *Ovrd/Trq act* to *Ovrd/Spd High*).

Function description

The *Speed/Torque Regulator* function is an important focal point for both Speed and Torque regulation systems within the drive. The parameter *Regulator type* configures the basic regulation mode of the drive, and the variable *Speed reg mode* reflects the active regulation state of the drive. Speed reference and feedback signals converge at the Speed Regulator along with Torque reference and feedforward signals. The output of the *Speed/Torque Regulator* function is the primary torque reference presented to the motor control interface.

The primary modes of operation that may be selected are:

Speed regulator	The variable *Speed reg fbk* is regulated to follow the variable *Speed reg reference* according to the characteristics specified by configuration parameters.
Torque regulator	The variable specified by the parameter *Torque ref select* is gated to the output of the *Speed/Torque Regulator* function.
Torque, spd override	Similar to Torque mode except that speed regulation will override the torque reference in the event that the *Speed reg error* signal exceeds the limits specified by *Spd reg pos err lim* & *Spd reg neg err lim*.

In general the active state is a function of configuration parameters, commands from the drive sequencer and the application, and key signals within the regulator.

The torque feedforward signal specified by the parameter *Torque feed fwd sel* is always added to *Speed reg output* to form *Torque ref pre limit*. The *Torque ref input* signal specified by the parameter *Torque ref select* is added conditionally, based upon the active *Speed reg mode* and the value of the Boolean signal specified by the parameter *Torque mode sel*.

The active states of the *Speed/Torque Regulator* function are:

Off/Precond	Regulator is disabled by the sequencer: *Speed reg output* is zeroed, and *Torque ref input* is disabled. Internal states are continuously preconditioned based upon the signal specified by parameter *Spd reg init val sel*.
Torque regulator	Active *Torque* mode: *Torque ref input* is conditionally enabled to the output *Torque ref pre limit*, based upon the value of the Boolean signal specified by the parameter *Torque mode sel*. The speed regulator core is disabled, therefore *Speed reg output* is zero.
Speed regulator	Active *Speed* mode: *Speed reg output* responds "normally" to the core speed regulator. Based upon the value of the Boolean signal specified by the parameter *Torque mode sel*, the *Torque ref input* signal is conditionally added into the output *Torque ref pre limit*.
Ovrd/Trq act	Active *Torque, spd override* mode: Torque mode allowed since *Speed reg error* is within limits and the value of the signal specified by the parameter *Torque mode sel* is True; spillover speed action is "armed".

Ovrd/Spd forced	Forced *Torque, spd override* mode: Speed regulation mode dynamically forced because either the value of the signal specified by *Torque mode sel* is False, or the *Torque reg stop mode* is commanded by the sequencer.
Ovrd/Spd Low	Active *Torque, spd override* mode: Speed regulation mode dynamically overrides torque mode due to *Speed reg error* having exceeded limit specified by *Spd reg pos err lim*.
Ovrd/Spd High	Active *Torque, spd override* mode: Speed regulation mode dynamically overrides torque mode due to *Speed reg error* having exceeded limit specified by *Spd reg neg err lim*.
Lcl mode/Spd reg	Active *Local speed* mode: Drive is operating in Speed regulation mode in response to DDI commands. This mode is forced by local operation regardless of the configuration specified by the parameter *Regulator type*. The *Torque ref input* signal is disabled.

The speed regulator compensation network is fairly classical. It has parameters to adjust the proportional gain of command, proportional gain of feedback, and integral gain of speed error. Proportional and integral contributions are summed, and a final gain stage applies inertia compensation cascaded with a net gain term. A unity-gain lowpass filter is provided to allow softening of the proportional paths.

Anti-windup is provided to the integrator in the form of a pair of Booleans, *Torque ctl pos frz* and *Torque ctl neg frz*, provided from the motor control interface. Assertion of an anti-windup Boolean inhibits integrator changes in the associated positive or negative direction; the Boolean *Speed reg antiwindup* provides indication of the active status of this dynamic integrator limit.

Inertia compensation is defined by the parameter *Fixed inertia* unless the parameter *Variable inertia sel* is used. Actual platform signal units for specified Inertia are (kg-m^2), although the product human interfaces (Tool & DDI) allow treatment in (lb-ft^2) if preferred. Units represent the transformation between torque and acceleration expressed in terms of a mass and a radius of gyration. Data expressed as Wk^2 can be entered directly; data expressed in GD^2 should be divided by four prior to entry (to reflect the ratio between radius-squared and diameter-squared).

Related diagrams

- Speed Regulator (SReg)

System Data Parameters

Exec time/Chop freq

The parameter *Exec time/Chop freq* defines the Task 1 execution period and the chopping frequency for the Innovation Series drive product.

Task 1 is the fastest scheduled software process executed within the control. Primary bridge interface and high-bandwidth aspects of the motor control algorithm operate in Task 1. Slower tasks execute at integer multiples of the Task 1 interval. The Task 1 execution period determines the maximum inner regulator bandwidth and maximum fundamental operating frequency.

The chopping frequency defines the rate at which the power devices may switched through a full modulation cycle (for example, from the on state, to the off state, and back to the on state again). The chopping frequency affects the spectral content of the output waveform, and defines a bridge power de-rating factor which must be considered in the application of the product.

Chopping frequencies are synchronized to the Task 1 interval such that exactly one transition or two transitions can be configured to occur per Task 1 period.

Values

The following table describes the available selections for *Exec time/Chop freq*:

Parameter Selection	Exec Time (usec)	Chop Freq (KHz)	Fund Freq (Hz)	Power Derate (%)	Comments
333 usec, 1.5 KHz	333.3	1.5	200	100	Default
500 usec, 1.0 KHz	500.0	1.0	133	100	Evaluation only

Motor ctrl alg sel

Parameter *Motor ctrl alg sel* specifies the presence or absence of a tachometer in the system and the use of the tachometer in the motor control.

The drive can run the motor using a tachometer-based control scheme, a tachless control scheme, or a mixture of the two. Tachometer-based control uses speed feedback from the tachometer to regulate the speed and torque of the motor. Tachless control provides motor speed and torque regulation without a tachometer. The hybrid control scheme uses tachometer feedback for speed regulation but not for motor torque regulation. Greater speed and torque accuracy can be attained when a pulse tachometer is used with the tachometer-based control.

The following values are available for *Motor ctrl alg sel*:

- *Tachless control*: Tachless control of motor speed and torque.
- *Tach control and sfb*: Tachometer-based control of motor speed and torque.
- *Tachles ctl/Tach sfb*: Tachometer-based control of motor speed, tachless control of motor torque.

Caution

***Flux decay waiting*: When a V/Hz or Torque regulated Tachless drive is stopped and the motor is de-energized there is a requirement to wait for the motor flux to decay before restarting (1 to 20 seconds, depending on motor rotor circuit time constant). If a restart is attempted before the flux decays to a low enough level (2% of rated), the drive will be blocked from a restart and a *Run cmd w high flux* alarm will occur.**

Caution

***Restarting drive at zero speed*: When a V/Hz or Torque regulated Tachless drive is restarted at zero speed any motion produced externally during its pre-flux sequence (motor electrical time constant dependent, typical 0.5 to 2 sec.) will lead to malfunction. If the motor was stationary when restarted a sufficient delay coordinating other drives or machinery that prevents start of any motion must be guaranteed until after the pre-flux sequence is complete and the drive is ready to produce torque.**

***Operation at zero speed*: If there is a need for the Tachless drive (Torque regulated or V/Hz with Auto-boost) to sit at zero speed either the *Enb adaptv full flx* (see *Sequencer Commands*)must be used or the drive must be stopped and turned off then restarted when it is desired to move. Prolonged zero speed operation without the aforementioned precaution will cause drive malfunction.**

Caution

***Operation with Regenerative load*: If there is a need for regenerative load operation (Torque regulated or V/Hz with Auto-Boost) near zero speed, the minimum operating speed must be higher than the maximum anticipated slip rpm of the motor. This is required to avoid zero frequency operation (failure mode for Vector Tachless drive).**

Functional use

- Speed Feedback Calculation
- Tach Loss Detection

Motor efficiency

Parameter *Motor efficiency* specifies the motor efficiency, the mechanical output power that can be obtained at nameplate conditions, expressed as a percentage of the electrical power input. The efficiency is normally specified on the motor nameplate.

Typical motor efficiencies are near 93%. High-efficiency motors may have efficiencies in excess of 95%.

Units

- Presentation units: Percent
- Internal control units: Per unit

Motor service factor

Parameter *Motor service factor* specifies the ratio of the actual maximum power of the motor to its nameplate rated power.

Units

Motor service factor is a unitless number.

Motor winding cfg

Parameter *Motor winding cfg* specifies the winding configuration of the motor.

The following values are available for *Motor winding cfg*:

- *Wye E-LN=Sqrt3*E-PH*: Wye configuration.
- *Delta E-LN = E-PH*: Delta configuration.

The motor data sheet often lists the motor line voltage and phase voltage in place of the winding configuration. If the motor data sheet specifies E-LN for the line voltage and E-PH for the phase voltage, then the winding configuration can be determined using the following relationships:

Wye configuration: $\text{E-LN} = \sqrt{3} \times \text{E-PH}$

Delta configuration: $\text{E-LN} = \text{E-PH}$

Preflux Forcing

Parameter *Preflux Forcing* specifies the amount of peak current use to pre-flux the motor. The dimension is in per unit of motor nameplate amps. It is recommended to use 1.0 per unit field-forcing; however, in cases where motor rating is higher than inverter rating, the field-forcing Amps may have to be reduced to avoid inverter thermal overload during pre-fluxing. In general, using higher field-forcing Amps can reduce pre-flux duration.

Chapter 4 Wizards

Introduction

The drive's operator interface software includes wizards, which are automated Windows-based "forms" for drive configuration and tuneup. The wizards lead the user through critical setup parameters and calculate internal settings.

The drive Commissioning wizard must be run on every new configuration. After the initial configuration, use of the drive Commissioning wizard is optional, but still recommended. Other wizards are available to automatically tune drive regulators and to speed up specific startup tasks.

This chapter contains descriptions of the wizards, organized as follows:

Cell Test Wizard

Cell Test Options

The Cell Test wizard executes either the Fiber-Optic Test or the Bridge Cell Test depending on the value of the *Type of Cell Test* parameter. Selecting one of the Cell Tests and proceeding to the next Wizard page sets the *Type of Cell Test* parameter to the appropriate value.

Fiber-Optic Test

The Fiber-Optic Test verifies that the gate drive fiber-optics between the fiber-optic interface board (IS200FOSA) and the IGBT gate driver boards (IS200IGDM) are properly connected. *The test does not provide any automated diagnostic information.* Verification of the fiber-optic connections is done by visual inspection of the LED lighting sequence on the IGDM gate driver boards and is the *responsibility of the user*. The correct lighting sequence is described in the Fiber-Optic Test help section.

Caution

Read all of the Fiber-Optic Test instructions in the Fiber-Optic Test help section before running the test. The user must be familiar with the correct LED lighting sequence in order to determine if the fiber-optics are connected properly.

Bridge Cell Test

The **Bridge Cell Test** performs the following tests:

- *Short Circuit Detection Test* verifies that there are no undesired conductive paths within the inverter power bridge and the load connected to it.
- *Open Circuit Detection Test* verifies that all of the expected conductive paths in the inverter bridge are available and that the shunt feedbacks are valid.
- *Voltage Feedback Evaluation* verifies that all the voltage feedbacks are being measured correctly.
- *Dynamic Brake Cell Test* performs a short circuit detection test, open circuit detection test, and voltage feedback evaluation for the dynamic brake assembly.

Note The Dynamic Brake Cell Test is only performed if the drive includes the dynamic brake option.

Running the Fiber-Optic Test

Running the Test

Caution

Read all of the Fiber-Optic Test instructions in this section before running the test. The user must be familiar with the correct LED lighting sequence in order to determine if the fiber-optics are connected properly.

Once you are familiar with the test instructions, run the test as follows.

1. De-energize the drive following the procedures outlined in the installation and startup manual GEH-6381.

   (Confirm that the switchgear, control breaker CB1 and charger switch LSW1 are open and locked out, tagged out and checked for zero voltage. That the DC bus is fully discharged and checked for zero voltage. That safety grounds have been applied using proper grounding procedures.)

2. With safety grounds applied and the converter cabinet doors open, close control breaker CB1 and run the Cell Test Wizard from the toolbox. Choose the Fiber-Optic Test.

3. From the Fiber-Optic Test dialog box press Execute.

4. From the drive cabinet, observe the LED lighting sequence. The LEDs are located on the IGBT gate driver boards (IGDM). If the observed LED lighting sequence matches the correct LED lighting sequence (See Figure 1), then the test passed.

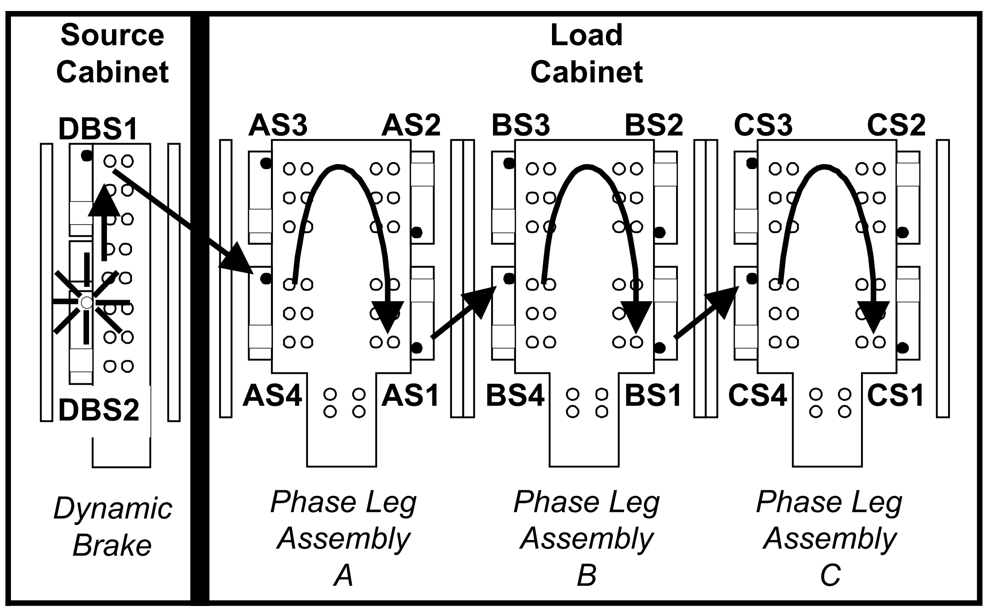


Figure 1. Physical Diagram of Correct LED Lighting Sequence

Figure 1 shows the dynamic brake and phase assemblies inside the drive cabinets. The dynamic brake assembly on the left is located in the source cabinet. The phase leg assemblies are located in the load cabinet.

Following is the correct LED lighting sequence for a drive with the dynamic brake option.

1. DBS1
2. DBS2
3. AS4
4. AS3
5. AS2
6. AS1
7. BS4
8. BS3
9. BS2
10. BS1
11. CS4
12. CS3
13. CS2
14. CS1

If the drive you are testing does not have the dynamic brake option, then the LED sequence will begin with device AS4 instead of DBS2. The sequence from AS4 to CS1 will remain the same.

Once the Fiber-Optic Test wizard has been executed, the drive waits five seconds before beginning the LED sequence. The sequence will be repeated three times, unless the user or a fault aborts it.

Troubleshooting

The test does not provide any automated diagnostic information. Verification of the fiber-optic connections is done by visual inspection of the LED lighting sequence on the IGDM gate driver boards and is the responsibility of the user.

The following messages display if the Fiber-Optic Test runs to completion, but do not necessarily indicate correct fiber-optic connections:

```
Fiber-Optic Test was invoked
```

```
Open drive door and observe LED lighting sequence.
```

```
Fiber-Optic Test completed.
```

```
If correct LED lighting sequence was not observed, fix
fiber-optic connections and run Fiber-Optic Test again.
```

The following table describes possible incorrect LED lighting sequences.

Problem	Description
LEDs light in wrong order	There are two or more incorrect fiber-optic connections on the FOSA board or on the IGDM boards.
LEDs are not lighting	There may be a bad fiber-optic connection on either the FOSA or IGDM boards, or a defective FOSA or IGDM board. Check the fiber-optic connections first.

The following are descriptions of error messages.

Error Message	Description/Procedure
Cell Test invoked in simulator mode.	The simulator mode variable *Simulate mode act* is TRUE. The Fiber-Optic Test cannot be run in simulator mode. Change the simulator mode by setting request parameter *Simulate mode* to FALSE and run the Fiber-Optic Test again.
Cell Test did not run to completion. Cell Test request was removed.	The Cell Test command was removed during Cell Test. The user may have aborted the test.
Cell Test did not run to completion. Internal Cell Test fault detected.	A drive trip fault occurred during the Fiber-Optic Test. Correct and clear any existing trip faults and run the Fiber-Optic Test again.
Fiber-Optic Test interrupted.	The Fiber-Optic Test could not be run due to one of the following reasons: Voltage was detected on the DC bus. The static charger was not in an idle state. A drive trip fault was detected. Correct and clear any existing drive trip faults. Press the "SWITCHGEAR OPEN" button on the drive cabinet door. Wait for the dc bus voltage to completely discharge. Run the Fiber-Optic Test again.
Fiber-Optic Test did not run. Fiber-Optic Test cannot be run with switchgear closed.	Press the "SWITCHGEAR OPEN" button on the drive. Wait for the DC bus voltage to completely discharge. Run the Fiber-Optic Test again.

Running the Bridge Cell Test

Running the Test

Run the test as follows:

1. Confirm that the drive switchgear is open and the drive is ready to be charged. To prepare the drive for charging, follow the re-energizing procedures outlined in the installation and startup manual GEH-6381. (Safety grounds removed, converter doors closed, locks and tags cleared, charger switch LSW1 and control breaker CB1 closed and control cabinet door closed).
2. From the toolbox, run the Cell Test wizard and choose the Bridge Cell Test.
3. From the Bridge Cell Test dialog box press Execute. Follow the instructions in the wizard dialog boxes.

Troubleshooting

The following messages display if the Bridge Cell Test runs to completion and passes:

```
Cell Test was invoked

Press 'INITIATE CHARGE & CLOSE' button on drive.  Drive
will be charged, but switchgear will not be closed.

Short circuit detection test passed.

Open circuit detection test passed.

Voltage feedback evaluations passed.

<<< Completed Successfully >>>
```

The following are descriptions of bridge test failure messages.

Error Message	Description/Procedure
Short circuit detection test failed. Check for one or more of the following.	An undesirable conductive path was detected in the drive. This message will be followed by messages describing the nature of the test failure.
POSSIBLE SHORTED DEVICES:	All IGBTs and diodes that may be shorted will be listed. However, the short circuit detection may have been caused by a bad gate connection or IGBTs not switching on. This will also be listed in the following message. Check for shorted IGBTs and clamp diodes first.
POSSIBLE DEVICES WITH BAD GATE CONNECTIONS OR ARE NOT SWITCHING ON:	All IGBTs which returned a gate drive fault during the test will be listed. The fault could have been caused by a shorted device as listed in the previous message, or one of the following problems:
	Bad connection between the IGDM gate drive board and the IGBT listed
	Defective IGDM board on the IGBT listed
	Defective IGBT listed
Open circuit detection test did not run.	The open circuit detection test does not run if the short circuit detection test fails.
Open circuit detection test failed. Check for one or more of the following.	An expected conductive path was not detected or a current feedback was incorrect or missing. This message will be followed by messages describing the nature of the test failure.
POSSIBLE OPEN DEVICES:	All IGBTs, diodes, and load connections that may be opened will be listed. However, the open circuit detection may have been caused by a current feedback (shunt) error.
POSSIBLE SHUNT ERRORS:	All possible shunt errors will be listed. If shunt connections appear to be correct, check for correct current scale and offset variables in the drive.
Voltage feedback evaluation was not performed.	The voltage feedback evaluation is not performed if the short circuit detection test or the open circuit detection test fails.
Voltage feedback evaluation failed. Check for one or more of the following.	Correct voltage feedbacks were not measured. This message will be followed by messages describing the nature of the test failure.
POSSIBLE VOLTAGE FEEDBACK ERRORS:	All voltage feedbacks that did not match expected values will be listed.
Dynamic Brake Cell Test did not run.	The Dynamic Brake Cell Test is not performed if the short circuit detection test, open circuit detection test, or the voltage feedback evaluation fails.
Dynamic Brake Cell Test failed. Check for one or more of the following.	One of the following dynamic brake tests failed:
	Dynamic brake short circuit detection test
	Dynamic brake open circuit detection test
	Dynamic brake voltage feedback evaluation
	This message will be followed by messages describing the nature of the test failure.

Dynamic brake open circuit detection test did not run.	The dynamic brake open circuit detection test is not performed if the short circuit detection test fails.
Dynamic brake voltage feedback evaluation was not performed.	The dynamic brake voltage feedback evaluation is not performed if the short circuit detection test or the open circuit detection test fails.

The following are descriptions of error messages:

Error Message	Description/Procedure
Cell Test invoked in simulator mode.	The simulator mode variable *Simulate mode act* is TRUE. The Bridge Cell Test cannot be run in simulator mode. Change the simulator mode by setting request parameter *Simulate mode* to FALSE and run the Bridge Cell Test again.
Cell Test did not run to completion. Cell Test request was removed.	The Cell Test command was removed during Cell Test. The user may have aborted the test.
Cell Test did not run to completion. Internal Cell Test fault detected.	A drive trip fault occurred during the Bridge Cell Test. Correct and clear any existing trip faults and run the Bridge Cell Test again.
Cell Test did not run. Cell Test cannot be run with switchgear closed.	Press the "SWITCHGEAR OPEN" button on the drive. Wait for the DC bus voltage to completely discharge. Run the Bridge Cell Test again.
Cell Test did not run to completion. Motor was not at zero speed.	The Bridge Cell Test cannot be run if the motor is not at zero speed. Wait for the motor to stop and run the Bridge Cell Test again.
Cell Test did not run to completion. DC bus could not be charged.	The Bridge Cell Test was unable to charge the DC bus. Following are some of the possible problems which may exist in the drive:
	Defective static charger
	Shorted DC bus (POS to NEG)
	Incorrect DC voltage feedbacks
Cell Test did not run to completion. DC bus could not be balanced.	The Bridge Cell Test was unable to balance the DC bus. Following are some of the possible problems which may exist in the drive:
	Shorted DC bus (POS to NEU or NEG to NEU)
	Incorrect DC voltage feedbacks
	Shorted DBS1 or DBS2 IGBTs (if the drive includes the dynamic brake option).
Cell Test did not run to completion. Motor current did not decay.	The Bridge Cell Test detected motor current 1 second after the last pulse was completed.

DAC Setup

The *DAC Setup* wizard directs configuration of the analog outputs (DACs). For more information on the DACs, see the *Analog Inputs/Outputs and Mapping* function help.

Drive Commissioning

Drive Commissioning: Overview

The *Drive Commissioning* wizard guides the user through the process of configuring the drive for a particular application. It asks a series of questions that allow the user to specify important control parameters. It also directs the drive to perform calculations that determine the values of other parameters. At the conclusion of the wizard, the drive has most of the information that it needs to run successfully.

The *Drive Commissioning* wizard may be run more than once, with the following note of caution. Some of the parameters that are changed by the rule calculations may be modified by the user after the wizard has finished. If any parameter modifications have been made, they may be lost when the *Drive Commissioning* wizard runs. Parameter changes should be reviewed each time the wizard runs. In addition, a parameter backup prior to running the wizard is recommended.

Drive Commissioning: Intelligent Part Number

The Intelligent Part Number (IPN) specifies the Innovation Series product and the basic configuration of the product. The IPN is the catalog number for the Innovation Series product. It can be found on the inside of the cabinet door.

Verify that the following parameters correctly match the drive's IPN information:

- *IPN frame size*
- *IPN shunt size*
- *IPN volt rating*

Related functions

- *Intelligent Part Number (IPN)*

Drive Commissioning: Drive Units

Three different unit systems are available for displaying parameters and variables:

- *Imperial (English)*
- *Metric (SI)*
- *Native (Platform)*

The *Native (Platform)* unit system displays parameters and variables in the same units that the internal control uses.

Select one of the three unit systems.

Related functions

- *Language and Units Presentation*

Drive Commissioning: AC Source Selection

The frequency selection is used to calibrate the input line monitor. Use the frequency of the AC line input to this Innovation Series Drive. The choices are usually either 50 or 60 Hertz.

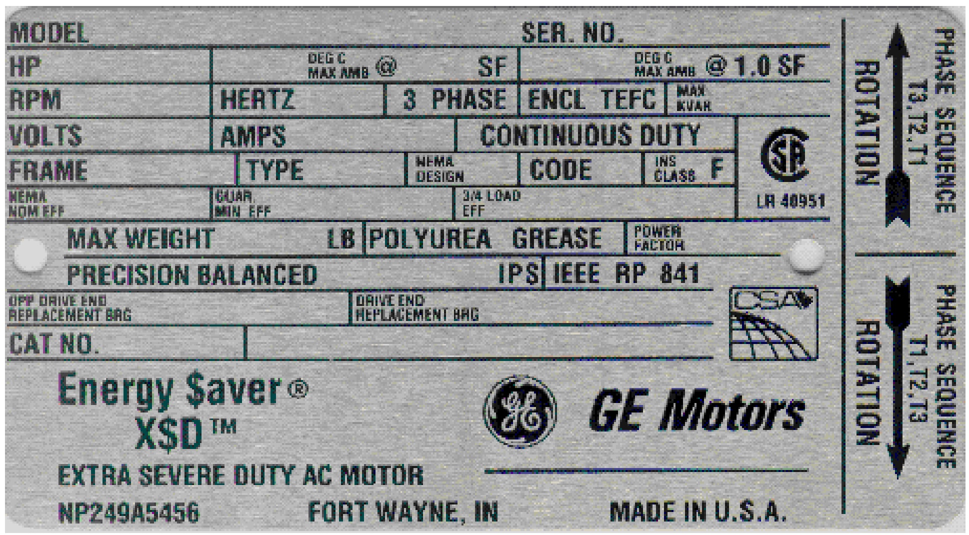
Dynamic braking (DB) is an option in some drives. If your drive has been provided with this equipment configure it for operation. DB absorbs energy from the load in applications where fast deceleration is required.

Related elementaries

- Innovation Series MV Type G drive data sheet (1AC)

Drive Commissioning: Motor Nameplate Data

The motor nameplate contains the basic information for the motor. The drive is capable of operating the motor efficiently based on the nameplate data.



Two consecutive *Drive Commissioning* wizard pages ask for motor nameplate data. Enter values for the following parameters based on the nameplate information:

- *Motor rated voltage*
- *Motor rated freq*
- *Motor rated current*
- *Motor rated rpm*
- *Motor rated power*
- *Motor efficiency*
- *Motor service factor*

Related functions

- *Primary Motor & Application Data*
- *Motor efficiency*
- *Motor service factor*

Drive Commissioning: Motor Crossover Voltage

Crossover Voltage specifies the voltage above which field weakening occurs. Field weakening allows the drive to achieve greater motor speeds without increasing voltage by decreasing the volts per hertz ratio.

Set *Crossover Voltage* to the appropriate voltage level. If *Crossover Voltage* is set to **<No Value>**, the drive begins field weakening at the voltage specified by *Motor rated voltage*, which was defined previously.

Related functions

- *Primary Motor & Application Data*

Drive Commissioning: Motor Protection Class

The motor protection class indicates the motor's capacity to run under overload conditions. The following values are available for the motor protection class:

- *Class10:150%for30sec*: IEC motors. Motor can withstand 150% overload for 30 seconds.
- *Class20:150%for60sec*: US standard motors. Motor can withstand 150% overload for 60 seconds.
- *Class30:150%for90sec*: Specially designed motors. Motor can withstand 150% overload for 90 seconds.

The drive uses the protection class information to determine motor thermal characteristics which are used in protective functions.

Select the motor protection class that corresponds to the motor connected to the drive.

Related functions

- *Timed Overcurrent Detection*

Drive Commissioning: Motor Poles

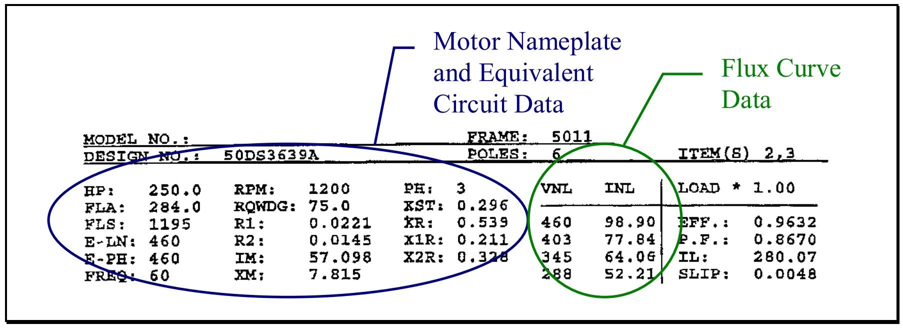
Parameter *Motor poles* specifies the number of magnetic poles in the motor. If the correct value is known, enter it. Otherwise leave blank or set to **<No Value>**, in which case the drive will calculate the number from motor nameplate data. It is recommended that the correct value be obtained and entered if parameter *Motor rated rpm* is less than 900.

Related functions

- *Primary Motor & Application Data*

Drive Commissioning: Motor Data Sheet

The motor data sheet provides additional motor parameters beyond what is available on the motor nameplate. This includes equivalent circuit data, winding resistances and winding inductances. Flux curve data is also often included. If the motor data sheet is not available for the applied motor, the control will determine the motor parameters during the tune-up phase.



Drive Commissioning: Motor Data Sheet - Equivalent Circuit Data

The motor data sheet is available from the motor supplier. It is a useful source of motor operating parameters that may not be listed on the motor nameplate. The motor data sheet is also a good way to verify motor nameplate data.

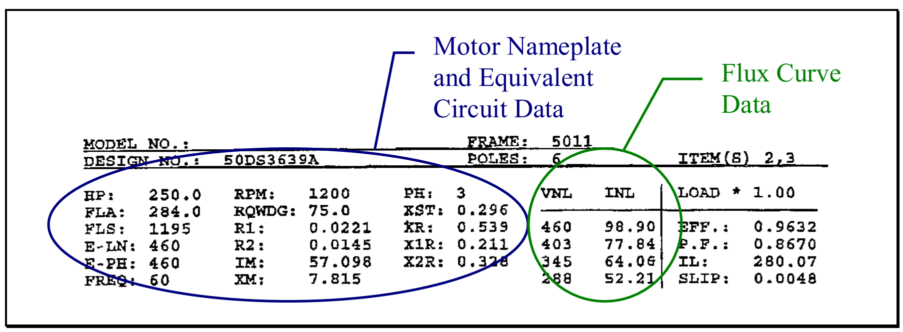
The Motor Data Sheet should contain hot resistance values for Stator(R1), Rotor (R2), and the 'Hot' temperature at which they were measured.

The Motor Data Sheet may contain cold resistance values for Stator (R1) and Rotor (R2).

The Motor Data Sheet should contain values for Stator(X1) and Rotor(X2) Leakage Reactance and Magnetizing (Xm) and Starting Reactance (Xst).

Leave unknown entries blank (not zero). Entries can be returned to blank (**<No Value>**) by highlighting the entered value and pressing delete.

Below is an example of a motor data sheet:



On this motor data sheet, the *synchronous* speed of the motor is listed as RPM. The rated full load speed of the motor is listed as FLS and is the speed that should be entered for *Motor rated rpm.*

Motor winding cfg: On some motor data sheets, the winding will simply be listed as wye or delta. In the example above, the line-neutral voltage (E-LN) is the same as the line-line voltage (E-PH). Hence the motor has a delta winding configuration. For a wye winding configuration the line-line voltage will be less than the line-neutral voltage by E-PH = E-LN ÷ √3.

Motor winding resistances: *Stator hot res R1*and *Rotor hot res R2* values are listed above as **R1** and **R2**. The "hot" temperature is listed here as **RQWDG,** is in units of degrees Celsius. It is the temperature at which the hot resistances were calculated. It should be entered in *Rated rotor temp*. *Stator cold res R1* and *Rotor cold res R2* are not listed in the sample motor data sheet. As such, their entries should be left blank. When *Stator cold res R1* and *Rotor cold res R2* are listed, they should have values less than their hot counterparts.

Motor winding reactance: *Stator lkg react X1*and *Rotor lkg react X2* values are listed above as **X1R** and **X2R** respectively. *Magnetizing react Xm* is listed as XM. *Starting react Xst*is listed as XST.

Drive Commissioning: Motor Data Sheet - Flux Curve

Often the Motor Data Sheet will contain four or five pairs of coordinates (volts, amps) that describe the motor flux curve. The example below includes four points or pairs of flux curve coordinates.

VNL	INL	LOAD * 1.00	
460	98.90	Eff.:	0.9632
403	77.84	P.F.:	0.8670
345	64.06	IL:	280.07
288	52.21	SLIP:	0.0048

Flux Curve Data from Motor Data Sheet

Point 5 is the highest voltage point; Point 1 is the lowest voltage point. For curves that list fewer than five flux curve points, start with Point 5 and work down (voltage values should be monotonically decreasing). This example would leave data point one blank.

If the flux curve is not known, flux curve information will be determined during the motor control tune-up. Leave unused points blank, not zero. Entries can be returned to blank (**<No Value>**) by highlighting the entered value and pressing delete.

Drive Commissioning: Motor and Process Speed Referencing

Applied top RPM specifies the maximum speed the motor is expected to run in the application. It is used to calculate the overspeed fault level and other motor control settings.

Set *Applied top RPM* to the maximum motor speed for the application.

Related functions

- *Primary Motor & Application Data*
- *Local Speed Reference*

Drive Commissioning: Tachometer Support

The Innovation Series drive can operate with or without a tachometer. Three different tachometer modes are available in the drive:

- *Tachless control*: The tachless motor control algorithm provides motor speed and torque control without tachometer feedback.
- *Tach control and sfb*: The tachometer-based motor control algorithm uses tachometer feedback to provide motor speed and torque control.
- *Tachles ctl/Tach sfb*: The motor control uses tachometer feedback to provide motor speed control, but does not use tachometer feedback to provide torque control.

Select one of the three tachometer modes.

Related functions

- Motor ctrl alg sel

Drive Commissioning: Tachometer Pulses Per Revolution

Motor tach PPR specifies the number of pulses per one revolution of the digital A-Quad-B tachometer. The drive performs an internal conversion between basic counts and quadrature counts, so the quadrature nature of the tachometer does not need to be considered when setting *Motor tach PPR*.

Set *Motor tach PPR* to the number of tachometer pulses per revolution.

Related functions

- Speed Feedback Calculation

Drive Commissioning: Tachometer Loss Protection

If the drive detects the loss of tachometer feedback, it can take one of two actions:

- *Trip*: The *Tach loss trip* fault is reported and the drive stops running.
- *Alarm*: The *Tach loss alarm* is reported and the drive continues to run using the tachless motor control algorithm..

Select the action the drive should take in response to the loss of tachometer feedback.

Related functions

- Tach Loss Detection

Drive Commissioning: Stopping Configuration

When the drive is running normally and the run request becomes false, the drive will be brought to a stop. A normal stop can be generated from one of several different inputs, but has 1 of 3 stopping behaviors as configured by the parameter *Normal stop mode*.

Value of Normal stop mode	Behavior
Ramp stop	The drive follows a linear speed deceleration ramp down to zero speed as configured by the Speed Reference Ramp function. Once the drive detects that Speed reg fbk has reached the Zero speed level, the sequencer disables the regulators and stops the drive.
Quick stop	The speed reference is stepped to zero so that the speed is brought is brought to zero as quickly as possible (the drive is in current limit). Once the drive detects that Speed reg fbk has reached the Zero speed level, the sequencer disables the regulators and stops the drive.
Coast stop	The regulators are immediately disabled and power is removed from the motor so that it will coast to a stop. The sequencer will prevent the drive from being re-started until Speed reg fbk has reached the Zero speed level, unless Flying restart is enabled. **Note** It is possible for the motor to continue to be turned by other members of the process.

Note If *Normal stop mode* is set to *Quick stop* or *Coast stop*, it is recommended that the parameter *Bypass Q/C stop* be set to ***Yes***. Otherwise, if the application uses *Full flux request* or has a post flux delay set in the parameter, *Flux off delay time*, the sequencer will not properly maintain flux on the drive.

Drive Commissioning: Flying Restart

Flying Restart is a feature that allows the drive to acquire control of a motor that is already turning. Possible selections are as follows:

- *Enable fly restart*: Allows the drive to restart while the motor speed is above the *Zero speed level*.
- *Disable fly restart*: The motor speed must be below the *Zero speed level* before the drive can be restarted, otherwise a trip fault, *Flying restrt disabl*, will be generated.

Locked shaft restart: The application must assure that the shaft is locked (by a brake or other means) when the drive is started. This mode may decrease the time that it takes to pre-flux the drive.

Note In this mode, failure to insure that the shaft is locked may cause the drive to misoperate.

Drive Commissioning: X-Stop Configuration

The *Run req & xstop open* trip fault occurs when the X stop circuit is open, the drive is stopped, and one of the following requests is issued: *Run request*, *Jog request*, or *Full flux request*.

The state of the X stop circuit is determined by the value of the variable to which parameter *X stop request sel* points. The trip fault can be disabled, along with all other X stop behavior, by setting parameter *X stop request sel* equal to *Unused*.

An X-stop can have 1 of 5 stopping behaviors as configured by the parameter *X stop mode*.

Value of X stop mode	Behavior
Nrml (ramp) stop	The drive follows a linear speed deceleration ramp down to zero speed as configured by the *Speed Reference Ramp* function. Once the drive detects that *Speed reg fbk* has reached the *Zero speed level*, the sequencer disables the regulators and stops the drive.
Quick stop	The speed reference is stepped to zero so that the speed is brought is brought to zero as quickly as possible (the drive is in current limit). Once the drive detects that *Speed reg fbk* has reached the *Zero speed level*, the sequencer disables the regulators and stops the drive.
Coast stop	The regulators are immediately disabled and power is removed from the motor so that it will coast to a stop. The sequencer will prevent the drive from being re-started until *Speed reg fbk* has reached the *Zero speed level*, unless *Flying restart* is enabled.
Trip flt stop	Behavior is similar to that of a Coast stop, except that a Trip fault, *X stop*, is also generated.
Emerg ramp stop	The drive follows a linear speed deceleration ramp down to zero as configured by the parameter *Emerg ramp rate*. (See also the *Speed Reference Ramp*.) Once the drive detects that *Speed reg fbk* has reached the *Zero speed level*, the sequencer disables the regulators and stops the drive.

Once the drive is stopped, *X stop active* must be set **False** before the drive is re-started. Otherwise, if any type of run is requested, the sequencer will generate an *Run req & xstop open* Trip fault.

Drive Commissioning: X-Stop Ramp Time

X stop request sel points to the variable whose transition to **False** causes the drive to stop in X-stop mode. *Emerg ramp rate* is used as the Ramp deceleration rate when X-stop is active.

Drive Commissioning: Run Ready Permissive String

Bypass Q/C stop

This parameter removes *Coast stop active* and *Quick stop active* from the *Ready to run* permissive, when they are normally included. *Bypass Q/C stop* should be set to *Yes* if *Normal stop mode* is set to *Quick stop* or *Coast stop*.

(Also see *Stopping Commands and Modes*.)

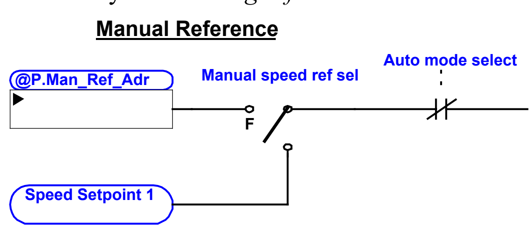
Drive Commissioning: Starting and Stopping the Drive

Select the signals used to drive the following functions:

Parameter	Description
Run permissive sel	When used, this parameter selects a variable that populates *Run permissive*. When unused, *Run permissive* is always set to **True**.
Run request select	Selects the variable that drives *Run request*. This input is only active in “Remote mode” (*Local mode active* is **False**). The sequencer normally treats the signal as a +/- edge-triggered input to set *Run request*. However, if *Stop PB select* is used, the sequencer looks only at the + edge of the signal to set *Run request*.
Jog request select	Selects the variable that drives *Jog request*. This input is only active in “Remote mode.” It is treated as a +/- edge-triggered input.
Reverse select	Selects the source of the boolean which can be used to reverse the remote speed reference.

Drive Commissioning: Manual Reference

When Manual Reference is selected, the running speed reference is determined by the setting of *Manual speed ref sel*. A fixed manual reference, *Speed setpoint 0*, is used when *Manual speed ref sel* is set to **Spd_Setpt**. When *Manual speed ref sel* is set to **Man_Ref_Adr**, the running speed reference is supplied by the variable selected by *Man analog ref sel*.



Drive Commissioning: Maximum Speed References

Parameter	Description
Max forward speed	Maximum forward reference to the speed regulator. This maximum is enforced immediately prior to the speed regulator and after all other speed offsets have been summed into the reference path.
Max reverse speed	Maximum reverse reference to the speed regulator. This minimum is enforced immediately prior to the speed regulator and after all other speed offsets have been summed into the reference path.

Drive Commissioning: Jog Speed Setpoints

Enter the Jog speed setpoints:

When the drive is being jogged in remote mode, *Remote jog speed* supplants the running reference during the time that the jog is commanded.

When the drive is being jogged in local mode, *Local jog speed* supplants the running reference during the time that the jog button is held.

Drive Commissioning: Reference Ramp Bypass

The speed reference ramp function, which limits the rate of change of the speed reference, may be disabled.

Select **Yes** to bypass the speed reference ramp. Select **No** to enable the ramp.

Related functions

- *Speed Reference Ramp*

Drive Commissioning: Reference Ramp Mode

Two ramp modes are available for the speed reference ramp function, which differ in the way the ramp rates are implemented:

- *Indep accel/decel*: Speed independent ramp rate mode.
- *Prog accel/decel*: Programmed ramp rate mode.

When the speed independent ramp rate mode is active, one acceleration rate and one deceleration rate are implemented for all speeds. The rate of change of the speed reference is limited to the acceleration rate when the magnitude of the speed reference is increasing. The rate of change of the speed reference is limited to the deceleration rate when the magnitude of the speed reference is decreasing.

When the programmed ramp rate mode is active, the acceleration and deceleration rates depend on the magnitude of the speed reference. Three separate acceleration rates and three separate deceleration rates may be defined for the ramp. The rate of change of the speed reference is limited to the active acceleration rate when the magnitude of the speed reference is increasing. The rate of change of the speed reference is limited to the active deceleration rate when the magnitude of the speed reference is decreasing.

Select *Indep accel/decel* to activate the speed independent ramp rate mode. Select *Prog accel/decel* to select the programmed ramp rate mode.

Related functions

- *Speed Reference Ramp*

Drive Commissioning: Reference Ramp Speed Independent Rates

The speed independent ramp rate mode implements one acceleration rate and one deceleration rate for all speeds. The rate of change of the speed reference is limited to the acceleration rate when the magnitude of the speed reference is increasing. The rate of change of the speed reference is limited to the deceleration rate when the magnitude of the speed reference is decreasing.

The acceleration and deceleration ramp rates belong to one of two ramp rate sets. Ramp rate set 1 is defined by *Acceleration rate 1* and *Deceleration rate 1*. Ramp rate set 2 is defined by *Acceleration rate 2* and *Deceleration rate 2*.

Enter values for the four parameters to define the ramp rates.

Related functions

- *Speed Reference Ramp*

Drive Commissioning: Reference Ramp Speed Independent Rate Set Selection

The speed independent ramp rate mode implements one acceleration rate and one deceleration rate for all speeds. The rate of change of the speed reference is limited to the acceleration rate when the magnitude of the speed reference is increasing. The rate of change of the speed reference is limited to the deceleration rate when the magnitude of the speed reference is decreasing.

The acceleration and deceleration ramp rates belong to one of two ramp rate sets. *Ramp rate 2 select* specifies which set is active. When *Ramp rate 2 select* is **False**, ramp rate set 1 is active. When it is **True**, ramp rate set 2 is active.

Specify the signal which *Ramp rate 2 select* selects.

Related functions

- *Speed Reference Ramp*

Drive Commissioning: Reference Ramp Programmed Acceleration Rates

The programmed ramp rate implements a speed dependent ramp rate profile. The acceleration rate depends on the magnitude of the speed reference. The rate of change of the speed reference is limited to the acceleration rate when the magnitude of the speed reference is increasing.

Each of the three acceleration ramp rates is active in a particular speed region. *Acceleration rate 1* is active in region 1, *Acceleration rate 2* is active in region 2, and *Acceleration rate 3* is active in region 3. The speed magnitude increases as the reference progresses from region 1 to region 2 to region 3.

Enter values for the three parameters to define the acceleration ramp rates.

Related functions

- *Speed Reference Ramp*

Drive Commissioning: Reference Ramp Programmed Acceleration Speeds

The programmed ramp rate implements a speed dependent ramp rate profile. The acceleration rate depends on the magnitude of the speed reference. The rate of change of the speed reference is limited to the acceleration rate when the magnitude of the speed reference is increasing.

There are three speed regions which are characterized by unique acceleration ramp rates. Region 1 is defined for speed magnitudes less than *Accel break point 1*. Region 2 is defined for speed magnitudes between *Accel break point 1* and *Accel break point 2*. Region 3 is defined for speed magnitudes greater than *Accel break point 2*.

Enter values for the two parameters which set the boundaries of the speed regions.

Related functions

- *Speed Reference Ramp*

Drive Commissioning: Reference Ramp Programmed Deceleration Rates

The programmed ramp rate implements a speed dependent ramp rate profile. The deceleration rate depends on the magnitude of the speed reference. The rate of change of the speed reference is limited to the deceleration rate when the magnitude of the speed reference is decreasing.

Each of the three deceleration ramp rates is active in a particular speed region. *Deceleration rate 1* is active in region 1, *Deceleration rate 2* is active in region 2, and *Deceleration rate 3* is active in region 3. The speed magnitude increases as the reference progresses from region 1 to region 2 to region 3.

Enter values for the three parameters to define the deceleration ramp rates.

Related functions

- *Speed Reference Ramp*

Drive Commissioning: Reference Ramp Programmed Deceleration Speeds

The programmed ramp rate implements a speed dependent ramp rate profile. The deceleration rate depends on the magnitude of the speed reference. The rate of change of the speed reference is limited to the deceleration rate when the magnitude of the speed reference is decreasing.

There are three speed regions which are characterized by unique acceleration ramp rates. Region 1 is defined for speed magnitudes less than *Accel break point 1*. Region 2 is defined for speed magnitudes between *Accel break point 1* and *Accel break point 2*. Region 3 is defined for speed magnitudes greater than *Accel break point 2*.

Enter values for the two parameters which set the boundaries of the speed regions.

Related functions

- *Speed Reference Ramp*

Drive Commissioning: DDI Increment and Decrement Rates (Local Mode)

Local Inc/Dec rate is the rate of change in the local speed reference offset (in local mode) when the increment (+) and decrement (-) buttons on the DDI are pressed.

Drive Commissioning: Speed/Torque Regulator Configuration

The questions that follow select and configure the desired regulator mode. Note that the regulator is not fully configured until the *Speed Regulator Tuneup* has run.

Related functions

- *Speed/Torque Regulator*

Drive Commissioning: Speed/Torque Regulator Modes

Three regulator modes are available:

- *Speed regulator*: Speed regulator.
- *Torque regulator*: Torque regulator.
- *Torque, spd override*: Torque regulator with speed override.

When the speed regulator mode is active, the drive controls the motor speed so that it follows the speed command. When the torque regulator mode is active, the drive sets the output of the regulator to a selected torque reference signal. The torque with speed override mode is similar to the torque regulator mode, except that the drive begins to control the speed when the difference between the speed command and the speed feedback is too large.

Select *Speed regulator* to activate the speed regulator mode. Select *Torque regulator* to activate the torque regulator mode. Select *Torque, spd override* to activate the torque regulator with speed override mode.

Related functions

- *Speed/Torque Regulator*

Drive Commissioning: Torque Regulator Reference and Output

When the torque regulator mode is selected, the drive sets the output of the regulator to a selected torque reference signal.

The torque reference signal is selected by *Torque ref select*. *Torque ref select* may specify normal signal sources acquired at the application loop rate or one analog high bandwidth signal source acquired at the motor control loop rate.

The drive sets the regulator output to the torque reference when the torque regulator output is enabled. *Torque mode sel* selects the signal that enables the regulator output.

Enter values for the two parameters that configure the torque regulator mode.

Related functions

- *Speed/Torque Regulator*

Drive Commissioning: Torque with Speed Override Reference and Output

When the torque regulator with speed override mode is selected, the drive sets the output of the regulator to a selected torque reference signal, except when the difference between the speed command and the speed feedback is too large. When the error between those two speed signals is too large, the drive begins to control the motor speed so that it follows the speed command.

The torque reference signal is selected by *Torque ref select*. *Torque ref select* may specify normal signal sources acquired at the application loop rate or one analog high bandwidth signal source acquired at the motor control loop rate.

When speed override is not active, the drive sets the regulator output to the torque reference when the torque regulator output is enabled. *Torque mode sel* selects the signal that enables the regulator output.

Enter values for the two parameters that specify the torque reference and regulator output enable for the torque regulator with speed override mode.

Related functions

- *Speed/Torque Regulator*

Drive Commissioning: Torque with Speed Override Speed Error

When the torque regulator with speed override mode is selected, the drive sets the output of the regulator to a selected torque reference signal, except when the difference between the speed command and the speed feedback is too large. When the error between those two speed signals is too large, the drive begins to control the motor speed so that it follows the speed command.

Spd reg pos err lim specifies the allowable difference between the speed command and the speed feedback when the motor is running too slow. If the feedback is less than the command and the difference between the two is greater than *Spd reg pos err lim*, then the drive switches from torque regulation to speed regulation.

Spd reg neg err lim specifies the allowable difference between the speed command and the speed feedback when the motor is running too slow. If the feedback is greater than the command and the difference between the two is greater than *Spd reg neg err lim*, then the drive switches from torque regulation to speed regulation.

Enter values for the two parameters that specify the maximum allowable speed error.

Related functions

- *Speed/Torque Regulator*

Drive Commissioning: Torque with Speed Override Stopping Behavior

When the torque regulator with speed override mode is selected, the drive sets the output of the regulator to a selected torque reference signal, except when the difference between the speed command and the speed feedback is too large. When the error between those two speed signals is too large, the drive begins to control the motor speed so that it follows the speed command.

When the drive stops, it can stop either as a speed regulator or as a torque regulator.

Select *Torque W/Spd Overide* to stop the drive in torque regulator mode. Select *Speed Regulator* to stop the drive in speed regulator mode.

Related functions

- *Speed/Torque Regulator*

Drive Commissioning: Torque and Current Limits

Selecting *Torque limit res* to use **Identical Limits** will use a single per-unit value to set the motoring and generating torque limits based on *100% Motor torque* and the current limit based on *100% Motor current*.

Selecting *Torque limit res* for **Separate Limits** allows the process owner to selectively limit the drive statically or dynamically.

Drive Commissioning: Torque and Current Limits Uniform

Torque overload is the overload limit value that will be used for all torque and current limits based on motor per-unit. A rule populates all torque and current limits based upon this entry and motor nameplate date.

Drive Commissioning: Failed Calculation

The calculation FAILED because of improperly entered motor data.

Check:

- Motor nameplate data
- Motor data sheet data
- Flux curve points are monotonic

Check the FAULTS that were generated to help determine the source of this error.

Drive Commissioning: Torque and Current Limit Selection

Normal and alternate torque and current limits are available. They can be dynamically selected by the state of the boolean variable at *Torque lim 2 sel*.

Torque lim 2 sel contains the address of a boolean which may dynamically switched between the normal and alternate torque limits and current limits. When *Torque lim 2 sel* is false the normal limits are used, when *Torque lim 2 sel* is true the alternate limits are used. A selection of **True** or **False** forces the limits to remain at the selected setting.

Drive Commissioning: Normal Torque and Current Limits

Enter *Motoring torque lim1*, *Regen torque lim 1* and *Current limit 1*. These values will be used when *Torque lim 2 sel* is false.

Drive Commissioning: Alternate Torque and Current Limits

Enter *Motoring torque lim2*, *Regen torque lim 2* and *Current limit 2*. These values will be used when *Torque lim 2 sel* is true.

Drive Commissioning: Motoring Torque Limits

Enter the normal(1) and alternate (2) motoring torque limits:

*Motoring torque lim1*will be used when *Torque lim 2 sel* is false.

*Motoring torque lim2*will be used when *Torque lim 2 sel* is true.

Drive Commissioning: Generating Torque Limits

Enter the normal(1) and alternate (2) generating torque limits:

Regen torque lim 1 will be used when *Torque lim 2 sel* is false.

Regen torque lim 2 will be used when *Torque lim 2 sel* is true.

Drive Commissioning: Current Limits

Enter the normal (1) and alternate (2) per-unit current limits:

Current limit 1 will be used when *Torque lim 2 sel* is false.

Current limit 2 will be used when *Torque lim 2 sel* is true.

Drive Commissioning: Power Dip Ride-Through

Power dip ride-through can allow the drive to recover from a momentary loss of line. The *Power Dip Protection* attempts to sustain DC link voltage for a selectable time interval when a low voltage condition is detected. If the line does not recover before the time expires, the *Power dip* trip fault will occur.

Related functions

- *Power Dip Protection*

Drive Commissioning: Parameter Calculation

A calculation is performed in the drive that sets many additional operating parameters based on the parameters just entered. At the end of the wizard the parameters will be uploaded to the tool with the opportunity for review.

Drive Commissioning: Simulator Mode

A Simulator mode is available in the drive. The simulator mode allows the drive to be “run” while not necessarily attached to a motor or to a process. This can be useful for system evaluation, troubleshooting, or training. In simulator mode the drive will behave as if it was turning a motor providing speed, current and voltage feedbacks.

Simulated loads and inertias may be set in the menu under drive simulation parameters.

Drive Commissioning: Hardware Fault Strings in Simulator Mode

Two protective hardware circuits must be satisfied to allow cell firing and therefore allow the drive to run. They are *Local fault string* and *System fault string*. These protective strings can be ignored for the purpose of running the drive in simulator mode. If they are not ignored, they must be satisfied to make the drive run as a simulator.

Drive Commissioning: Simulator Mechanical Configuration

Enter the desired values for the parameters, *Simulated inertia* and *Sim const friction*. These parameters are the minimum required to configure the drive's mechanical simulator. Other simulator configuration parameters are described in the *Simulator* function.

Related functions

- *Simulator*.

Drive Commissioning: Exit Reminder

After the *Drive Commissioning* wizard completes, the drive should have a **hard reset** performed. This should clear any faults that have occurred because of intermediate parameter values during the setup process.

The following wizards should be run to complete the start-up process:

- Cell Test
- Motor Control Tuneup
- Speed Regulator Tuneup

Drive Commissioning: Conclusion

The *Drive Commissioning* Wizard has concluded.

Once this wizard is exited, the drive should have a **hard reset** performed. This should clear any faults that have occurred because of intermediate parameter values during the setup process.

The following wizards should be run to complete the start-up process:

- Cell Test
- Motor Control Tuneup
- Speed Regulator Tuneup

Line Transfer Tuneup

Line Transfer Tuneup: Overview

The *Line Transfer Tuneup* wizard is provided to facilitate quick and reliable setup of line transfer functions. This wizard allows the user to enable transfer functions and direct I/O. If you are using the XferMtr command it will check phase rotation, and measure the phase angle and voltage magnitude relationships needed to correctly carryout the command. Because the wizard uses drive output instrumentation to do these measurements it will generally be necessary for the user to manually close the utility contactor to connect the drive output to the line. Depending on the application it may be necessary to disconnect the motor in order to complete the wizard. Until this wizard has be successfully completed the drive will not accept line transfer commands.

There are many issues beyond drive software that must be considered before attempting transfers and captures. For detailed information all applications issues see the "Innovation Series Line Transfer Application Guide".

Line Transfer Tuneup: Motor Transfer Data

This wizard can configure the drive to perform motor transfer and capture operations. The motor transfer data parameters configure the drive to transfer a motor to the utility line. Enter the motor transfer data parameters.

Transfer mtr req sel selects the signal that initiates the motor transfer. Set as required by your application.

Line reference specifies the source of the utility line reference. Set to *Internal* to use the internally generated line reference signal. If required by your application an external line reference may be needed in which case set *Line reference* to match the type of external line reference signal you have.

Utility swgr close specifies the I/O point that drives the utility switchgear close command during the motor transfer sequence. Set *Utility swgr close* to the desired I/O point.

MA pickup time specifies the time allowed for the MA contactor to close once it has been commanded to close during the motor transfer sequence. Set *MA pickup time* to the desired MA contactor close delay time.

For more information on the *Line Transfer Tuneup* wizard and issues related to the setting of these parameters see the "Innovation Series Line Transfer Application Guide".

Line Transfer Tuneup: Motor Capture Data

This wizard can configure the drive to perform motor transfer and capture operations. The motor capture data parameters configure the drive to transfer a motor to the utility line. Enter the motor capture data parameters.

Capture mtr req sel selects the signal that initiates the motor capture. Set *Capture mtr req sel* to the desired signal.

Anticipated torque specifies the expected motor torque at the time of motor capture. This parameter has an effect on the smoothness of the capture. By correctly anticipating the amount of torque the control can more smoothly capture the motor. This value is in PU of motor rated torque and should be determined by observing the load torque on the motor when running at synchronous speed. If you are unsure of the value to use then use the default value.

Utility swgr open specifies the I/O point that drives the utility switchgear open command during the motor capture sequence. Set *Utility swgr open* to the desired I/O point.

For more information on the *Line Transfer Tuneup* wizard see the "Innovation Series Line Transfer Application Guide".

Line Transfer Tuneup: Operation

This wizard configures the drive to perform motor transfer and capture operations.

This is the section of the wizard that will verify operation of the MA contactor, check for correct phase rotation at the drive output and measure the phase angle and voltage magnitude relationships needed to carryout transfer commands in the future.

Utility characteristics can be measured while the motor is running off the utility. If the motor is not running off the utility and cannot be started across the line, disconnect the motor leads **BEFORE** running this command.

Verify that the utility switchgear permissives are correct before executing this command so that you will be able to manually close the switchgear when asked. This wizard will not send commands to the utility switchgear.

To proceed, click the Execute button.

Drive response window for internal line reference

Display	Description
Phase angle no load	The phase angle difference measured between the drive source voltage and the utility voltage. The utility voltage was measured at the drive output. A positive phase angle indicates the utility lags the drive source. For a negative phase angle, the utility leads the drive source.
Utility phase offset	Offsets consisting of the phase angle no load plus phase compensation due to transformer loading.
Utility AC line	The utility line voltage measured at the drive output.
Drive AC source	The drive source voltage.
Utility volt scale	Volt scale = Utility AC line voltage / Drive AC source voltage

Drive response window for external line reference

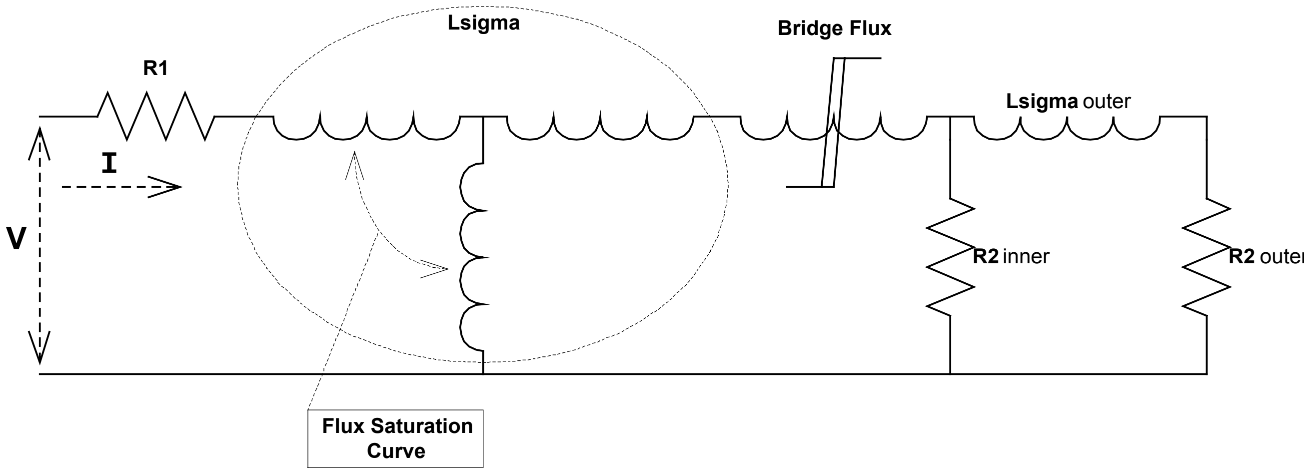
Display	Description
Phase angle no load	The phase angle difference measured between the external reference and the utility voltage. The utility voltage was measured at the drive output. A positive phase angle indicates that the utility lags the external reference. For a negative phase angle, the utility leads the external reference.
Utility phase offset	Offset consisting of the phase angle no load plus phase compensation due to transformer loading.
Utility AC line	The utility line voltage measured at the drive output.
External reference	The external voltage measured at the analog input.
Utility volt scale	Set equal to 1.0 when using an external reference.
Ext ref Vpt scale	Volt scale = Utility AC line voltage / External line reference voltage

For more information on the *Line Transfer Tuneup* wizard see the "Innovation Series Line Transfer Application Guide".

Motor Control Tuneup

Motor Control Tuneup: Equivalent Circuit

The equivalent circuit for the induction motor used in the motor control tune-up is:



The motor elementals and flux saturation curve will be measured for the phase combinations of *AB* and *BC*. After both sets of measurements are completed the balance of each phase pair will be compared for each motor elemental and saturation curve data point. The deviation of *R1, R2*, saturation curve should be less than 10% and for *Lsigma* less than 25%. The averages of the motor elementals and saturation curve are saved in the engineering parameters (At_xxx) and used in the recalculation of the motor control tune-up values.

Motor Control Tuneup: Measurements

When selecting all the measurements the VCO's will be calibrated and for both phase combinations, *AB* and *BC*, the measurements of Tau, R1, R2 inner, R2 outer, Lsigma starting, Lsigma outer, Lsigma curve, Bridge flux and the Flux saturation curve will be performed. These measurements will be checked for balance between phase combinations and monotonically increasing curves. If these checks are passed the results will be averaged and the motor control rules will calculate new tune-up values.

Each measurement can be selected separately along with which phase combinations to use and whether new tune-up values are calculated.

- Use phase A-B in measurements
- Use phase B-C in measurements
- Calibrate VCO offsets before making measurements
- Measure R1, stator resistance
- Measure R2, outer rotor resistance
- Measure Lsigma, leakage inductance (starting, outer & curve) along with inner rotor resistance and bridge flux
- Measure flux saturation curve
- Calculate new motor control tune-up values
- Skip phase balance check

Clearing measured elementals will calculate new tune-up values based on the original motor data.

Motor Control Tuneup: Operation

This will perform the requested measurements of the previous screen and a dialog box will appear to show the progress.

Use of the *Abort* function will cancel the measurements and throw present results away.

Panel Meter Setup

The *Panel Meter Setup* wizard directs configuration of the panel meters. For more information on the panel meters, see the *Analog Inputs/Outputs and Mapping* function help.

Per Unit Setup

The *Per Unit Setup* wizard directs configuration of the per unit parameters that determine scaling for the DDI. It is recommended that the control be allowed to calculate the default per unit settings.

Line Protection Setup

Line Protection: Introduction

The *Line Protection Setup* wizard sets parameters which affect line protection functions concerning overfrequency, underfrequency, overvoltage, and undervoltage. If the *Drive Commissioning* wizard has been performed, these parameters were setup automatically. Perform the *Line Protection Setup* wizard only if you need to restore these parameters to their original settings or if you need to override the default parameter settings.

Line Protection: Default Settings

The *Line Protection Setup* wizard defaults are highly recommended. Making the default selection will result in voltage and frequency protection settings that are in line with the specifications of the drive and that are proven settings.

Line Protection: Overvoltage

These parameters set the level of protection of the ac line overvoltage protection. It is highly recommended to use the control default values as calculated in the previous steps (you can go backward).

- *Line OV fault level* is the ac line voltage above which the *AC line over voltage* trip fault occurs.
- *Line OV alarm level* is the ac line voltage above which the *AC line voltage high* alarm occurs.
- *Line OV alarm clear* is the ac line voltage below which the *AC line voltage high* alarm goes away.

Related functions

- *Line Monitor*

Line Protection: Undervoltage

These parameters set the level of protection of the ac line undervoltage protection. It is highly recommended to use the control default values as calculated in the previous steps (you can go backward).

- *Line UV fault level* is the ac line voltage below which the *AC line under volt* trip fault occurs.
- *Line UV alarm level* is the ac line voltage below which the *AC line volts low* alarm occurs.
- *Line UV alarm clear* is the ac line voltage above which the *AC line volts low* alarm goes away.

Related functions

- *Line Monitor*

Line Protection: Overfrequency

These parameters set the level of protection of the ac line overfrequency protection. It is highly recommended to use the control default values as calculated in the previous steps (you can go backward).

- *Over freq flt level* is the ac line frequency above which the *AC line over freq* trip fault occurs.
- *Over freq alm level* is the ac line frequency above which the *AC line freq high* alarm occurs.
- *Over freq alm clear* is the ac line frequency below which the *AC line freq high* alarm goes away.

Related functions

- *Line Monitor*

Line Protection: Underfrequency

These parameters set the level of protection of the ac line underfrequency protection. It is highly recommended to use the control default values as calculated in the previous steps (you can go backward).

- *Under freq flt level* is the ac line frequency below which the *AC line under freq* trip fault occurs.
- *Under freq alm level* is the ac line frequency below which the *AC line freq low* alarm occurs.
- *Under freq alarm clr* is the ac line frequency above which the *AC line freq low* alarm goes away.

Related functions

- *Line Monitor*

Line Protection: Conclusion

You have completed the *Line Protection Setup* wizard. The control is now ready to run with the new values after the parameter upload.

Pulse Test

Pulse Test: Introduction

The Pulse Test wizard is a diagnostic tool which allows the user to produce voltage pulses using the power bridge. Such pulses and the resulting currents which are induced are useful in performing detailed analysis of the load or power bridge. The bridge is capable of performing a number of different types of voltage pulses and so the wizard is more complicated than might be expected.

In general the Pulse Test user specifies the power bridge devices used to make the voltage pulses and the duration of the pulses.

Pulse Test: Analog Output Configuration

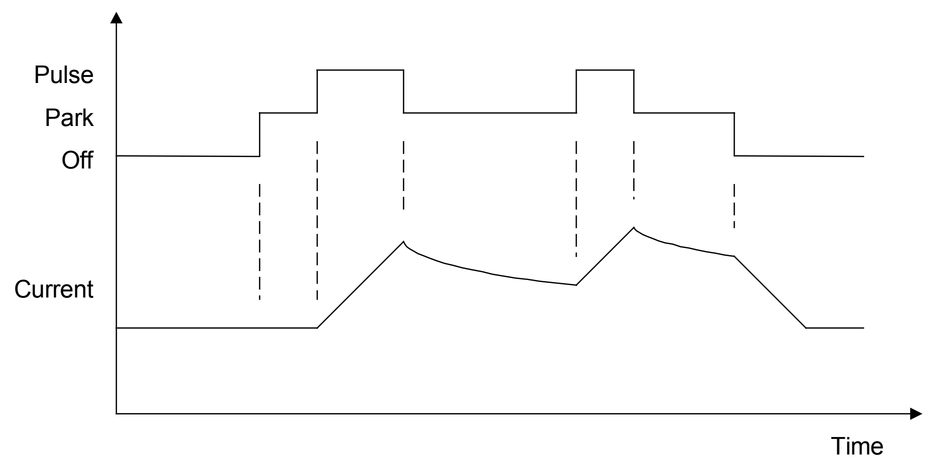
The Pulse Test user may configure two analog output channels from within the Pulse Test Wizard.

During the course of the Pulse Test it is often useful to observe certain drive variables, such as phase currents (variables *Phase A current*, *Phase B current*, and *Phase C current*) and line-line voltages (variables *Output volts, A-B* and *Output volts, B-C*).

Pulse Test: Bridge State Configuration

During the course of the Pulse Test the power bridge is sequenced between different states. The sequence is OFF, PARK, PULSE, PARK, PULSE, PARK, OFF. The user specifies the meaning of the PARK and PULSE states and the duration the sequencer remains in each of these states.

The diagram below shows in a general manner how the Pulse Test switches the power bridge between the different states. It also shows how current in the bridge might appear, without indicating a specific bridge phase, current direction, or current magnitude.



Detailed descriptions of the Park and Pulse states are as follows:

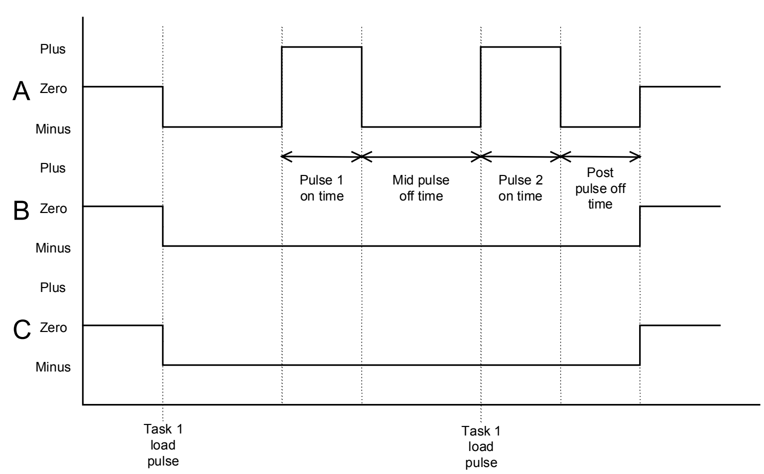
Bridge State	Description
Off state	All the power devices in the bridge are turned off. Due to the nature of the power devices and the topology of the power circuit any currents which exist in off phases are quickly driven to zero. Phases not included in the pulse or park state remain in the off state.
Park state	The devices in the bridge are turned on in such a way as to impress no voltage between the selected drive terminals. Devices are turned on such that the selected drive terminals are all connected to the same DC voltage potential within the bridge (MINUS, ZERO or PLUS). Phases not selected for the park state are left OFF for the duration of the park state. Phases listed in the park state and NOT listed in the pulse state will remain in the park state for the duration of the pulse state. Any current existing in the power bridge will circulate between the drive and the load and decay to zero at a rate that depends on the load electrical time constant.
Pulse state	The devices in the bridge are turned on in such a way as to impress a voltage between the selected drive terminals and the terminals left in the park state. Voltage is created using the devices to connect the pulsed terminals to another internal DC voltage potential. This condition can lead to rising currents if a load is connected to the bridge. The total phase-phase voltage developed is the difference between the internal DC bus voltages selected for the park and pulse states (MINUS, ZERO, PLUS).

The Pulse Test user specifies the phases to park and the park state potential by setting parameters *Park phase* and *Park level* to desired values.

The Pulse Test user specifies the phases to pulse and the pulse state potential by setting parameters *Pulse phase* and *Pulse level* to desired values.

Consider the following example response for parameters set as follows:

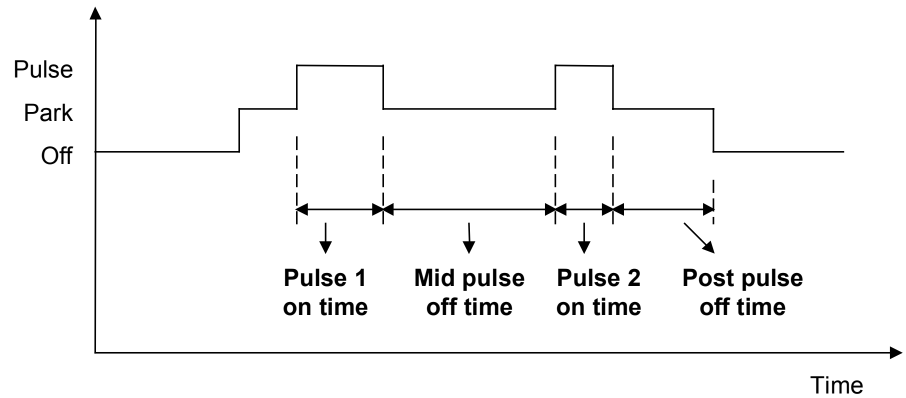
Park phase	=	A, B, C
Park level	=	MINUS
Pulse phase	=	A
Pulse level	=	PLUS



Pulse Test: Timer Configuration

The Pulse Test allows up to two voltage pulses to be commanded and produced by the power bridge. The duration of the voltage pulses, and the duration of the current decay time between the pulses and after the pulses, is specified by the pulse test timer parameters *Pulse 1 on time*, *Pulse 2 on time*, *Mid pulse off time*, and *Post pulse off time*.

The diagram below shows a Pulse Test profile and indicates how the timer parameters are defined.



All the timer parameters have units of seconds. If any of the parameters equals zero, the corresponding pulse on or off time is skipped during the Pulse Test.

The user should keep several issues in mind when specifying these times. First it is possible for large currents to develop in the bridge as result of these pulses. The power bridge will protect itself against excessively large currents by declaring an IOC fault. Any fault will abort the pulse test sequence and require you to perform a fault reset before another pulse can be commanded. The second issue is that there are several constraints which the pulse test wizard must deal with when issuing pulses. Among these are minimum pulse widths, lockout times and transition constraints. The wizard must always observe these constraints. As a result you may not get the exact pulse you command or in some cases you may get no pulse at all. For instance, if you declare a pulse that is smaller than the required minimum pulse then you will get no pulse. Finally you should be aware that the pulse test wizard always schedules the end of the mid pulse off time to occur on a task 1 boundary. This is the pivot point of the sequence and all other timings are computed from this point.

Pulse Test: Operation

The Pulse Test is a diagnostic test that produces a current pulse in the power bridge and load.

After specifying the Pulse Test configuration parameters, click on the Execute button to invoke the Pulse Test.

Remaining Parameter Setup

The *Remaining Parameter Setup* wizard directs configuration of parameters that cannot be assigned default values during the commissioning process. It is recommended that the control be allowed to calculate the default parameter settings.

Simulator Setup

Simulator Setup: Introduction

The *Simulator Setup* configures the drive to run in simulator mode.

Simulator Setup: Simulator Mode

If you would like to run the drive in simulator mode, select *Yes*.

If you do not want to run the drive in simulator mode, select *No*.

Related functions

- *Simulator*

Simulator Setup: Hardware Fault String Override

If you would like to disable the *Local flt* and *System flt* trip faults in simulator mode, select *Yes*.

If you would like to continue to check for the *Local flt* and *System flt* trip faults in simulator mode, select *No*.

Related functions

- Hardware Fault Strings

Simulator Setup: Simulator Mechanical Configuration

Enter the desired values for the parameters, *Simulated inertia* and *Sim const friction*. These parameters are the minimum required to configure the drive's mechanical simulator. Other simulator configuration parameters are described in the *Simulator* function.

Related functions

- *Simulator*

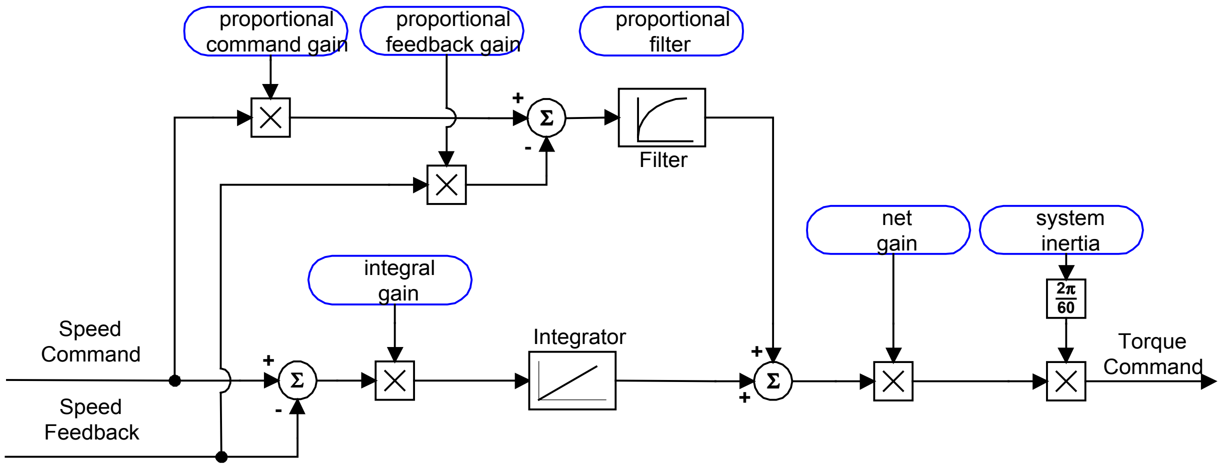
Simulator Setup: Conclusion

The *Simulator Setup* has reconfigured the drive with your selections.

Speed Regulator Tuneup

Speed Regulator Tuneup: Model

The simplified model of the speed regulator is:



The system inertia can be either measured or entered and the gains can be entered separately or calculated from bandwidth, damping and stiffness for a 1st and 2nd order closed loop response.

Speed Regulator Tuneup: System Inertia

System inertia can be either measured by rotating the motor and watching the acceleration produced by a constant torque or entered by the user.

Note The last measured/entered value is the default for entering a new value.

Speed Regulator Tuneup: Inertia Measurement Command

This will perform the system inertia measurement by rotating the motor and watching the acceleration produced by a constant torque. A dialog box will appear to show the progress of the measurements.

Use of the *Abort* function will cancel the measurements and throw present results away.

Advanced Help: (privilege level 4 required)

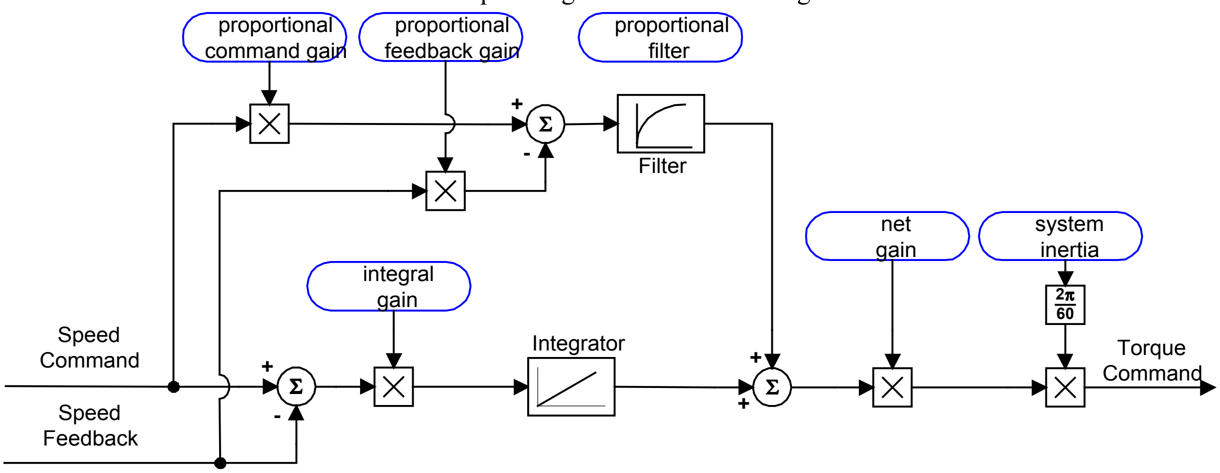
- If error “Problem With Torque for Rampup Test” occurs set At_MeasJ_Spd to 90% of the speed, in RPM, reached during test.
- If error “CoastDown Test Finished Prematurely” occurs set At_MeasJ_Spd to a value, in RPM, that would require the motor 1 sec to coast down.

Speed Regulator Tuneup: Speed Regulator Mode

- Manually tune-up individual gains
- 1st order closed loop response
- 2nd order closed loop response
- 2nd order closed loop response with stiffness filter for load disturbances

Speed Regulator Tuneup: Manual Regulator Tuneup

Enter the requested gains based on the diagram below:



System *Inertia* was previously measured or entered.

Speed Regulator Tuneup: 1st Order Response

Calculate speed regulator gains based on 1st order closed loop response and set the speed feedback filter to 10 times the bandwidth.

- Speed Regulator Bandwidth in radians/sec

Speed Regulator Tuneup: 2nd Order Response

Calculate speed regulator gains based on 2nd order closed loop response and set the speed feedback filter to 10 times the bandwidth.

- Speed Regulator Bandwidth in radians/sec
- Speed Regulator Damping Ratio
  (value of 1 is critically damped)
- Speed Regulator Tracking Bandwidth in radians/sec
  (bandwidth for coordinated section so reference errors are identical, practical limits are ω/2d to 2ω, where 0 is unused)

Note If Tracking Bandwidth is equal to Regulator Bandwidth the speed regulator will give a 1st order response to a step input and a 2nd order response is given for a Tracking Bandwidth of 0.

Speed Regulator Tuneup: 2nd Order Response with Stiffness Filter

Calculate speed regulator gains based on 2^{nd} order closed loop response and set the speed feedback filter to 10 times the bandwidth.

- Speed Regulator Bandwidth in radians/sec
- Speed Regulator Damping Ratio
  (value of 1 is critically damped)
- Speed Regulator Stiffness Filter
  (stiffer value is larger and 1 produces a 2^{nd} order response)
- Speed Regulator Tracking Bandwidth in radians/sec
  (bandwidth for coordinated section so reference errors are identical, practical limits are ω/2d to 2ω, where 0 is unused)

Note If Tracking Bandwidth is equal to Regulator Bandwidth the speed regulator will give a 1^{st} order response to a step input and a 2^{nd} order response is given for a Tracking Bandwidth of 0.

Speed Regulator Tuneup: Calculate Speed Regulator Gains Command

This will perform the speed regulator gain calculations based on the previous information of inertia, regulator mode, bandwidth, damping and stiffness.

Notes

Chapter 5 Signal Mapping

Introduction

The IS200DSPX Digital Signal Processor board (DSPX) contains and implements the drive's control software. The DSPX is located in the drive's control rack.

The drive software's Motor Control Layer (MCL) performs motor control functions, such as current regulation. MCL interfacing is through a signal map. An operator can configure the signal map using either the Drive Diagnostic Interface (keypad) or the GE Control System Toolbox (see Figure 5-1).

Signals are either LAN or I/O-based variables that control the drive and provide drive status feedback. For example, an analog input signal provides speed reference.

This chapter describes the signal mapping, as follows:

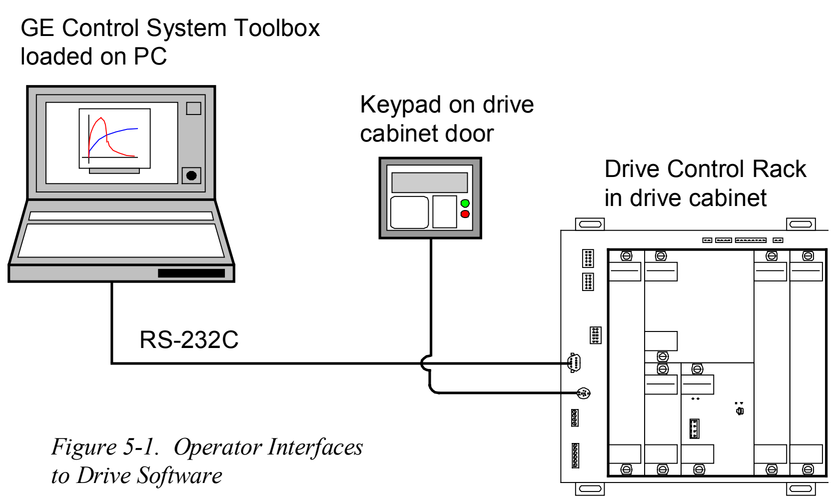


Figure 5-1. Operator Interfaces to Drive Software

LAN Interfaces

The LAN interfacing for the MCL requires the addition of a communications module to the control rack, as follows (refer to Figure 5-2):

Interface	Module	Communications Supported
Profibus™-DP Slave	IS215PBIA	Freeze and synchronous mode 9.6 kb to 12 Mb
Genius®	IS215GBIA	LAN heartbeat
ISBus Slave	IS215DSPX	From MCL, no additional modules required
Application Control Layer (ACL)	IS215ACLI	From the ACL, other LANs supported: Modbus™ RTU Allen Bradley DH+ Modbus Ethernet Ethernet SRTP Ethernet Global Data Requires configuration in the ACL

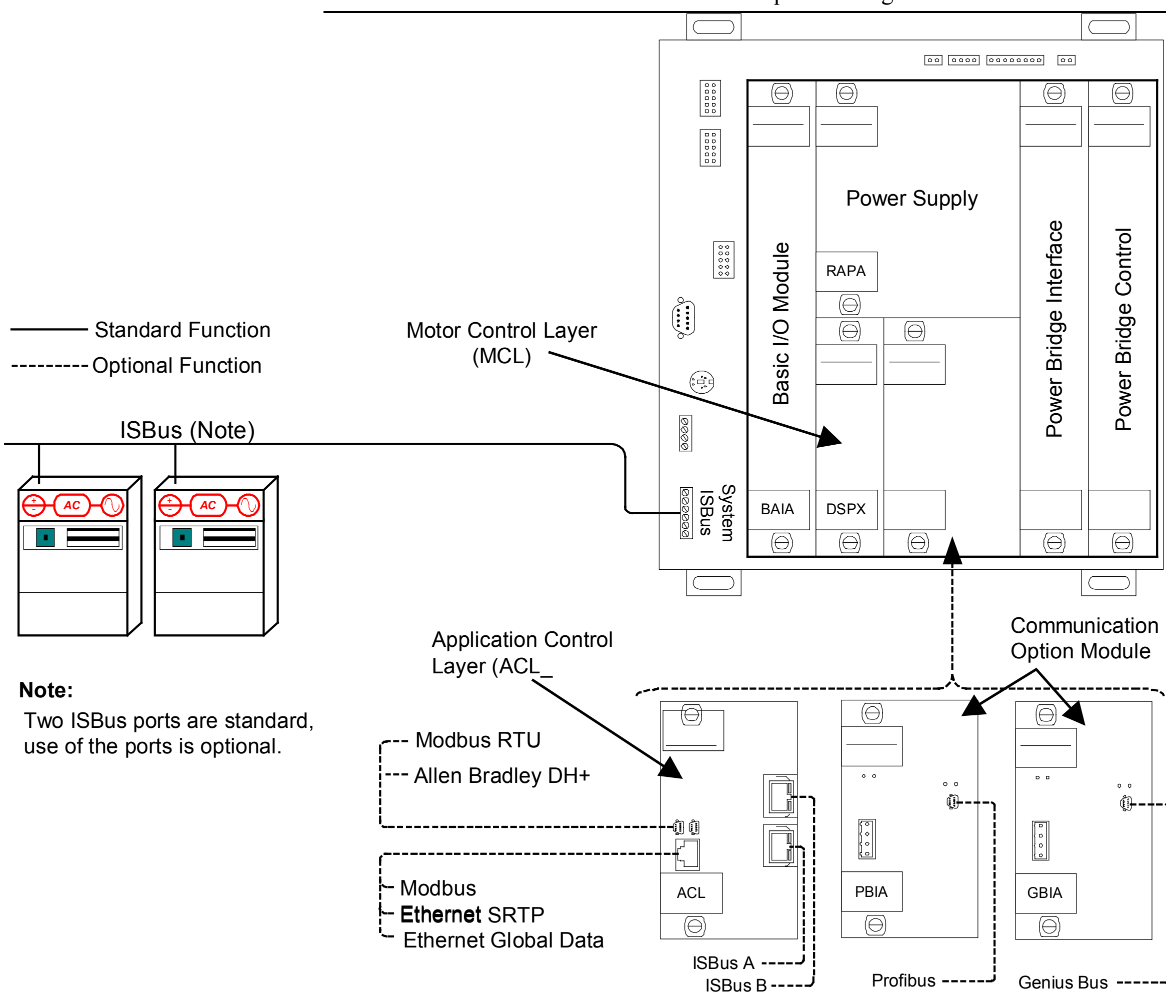


Figure 5-2. LAN Interface Options

Parameter Configuration for Signal Mapping

Parameters are used in the drive for configuration of functions. For example, six parameters are used to configure the ramp rate function generator in the general industries pattern.

The 64-byte, bi-directional signal map is configured with either the keypad or the toolbox. Refer to the data sheets associated with these interface modules for a detailed description of the configuration.

LAN Interface	Configuration Data Sheets (Documents)
Genius Bus	GEI-100269, Auxiliary Genius Bus Interface Module IS215GBIAH_A__
Profibus-DP	GEI-100419, Auxiliary Profibus-DP Interface Module IS215PBIAH_A__
ISBus	GEH-6417
ACL- based	GEI-100434

Variable Mapping

Also refer to "Variable Maps" in this chapter.

The drive software uses variables either of two ways:

As dynamic references for controlling the drive

- To contain feedback on the drive status

For example, the variables Speed Feedback and Speed Reference are associated with the speed regulator function.

The variable map is defined in terms of **paired pages**, as follows:

Page Type	Direction of Data
Reference	From the controller to the drive (for example, Speed Reference)
Feedback	From the drive to the controller (for example, Speed Feedback)

Each element in the map is assigned a data type, used by standard assignments as follows:

Data Type	Format
Real	32 bits per IEEE 754 (23-bit mantissa, 8-bit exponent, 1-bit sign)
Boolean	1 bit per signal

The following table specifies variables that indicate the LAN health and status for the LAN Configuration and Health function.

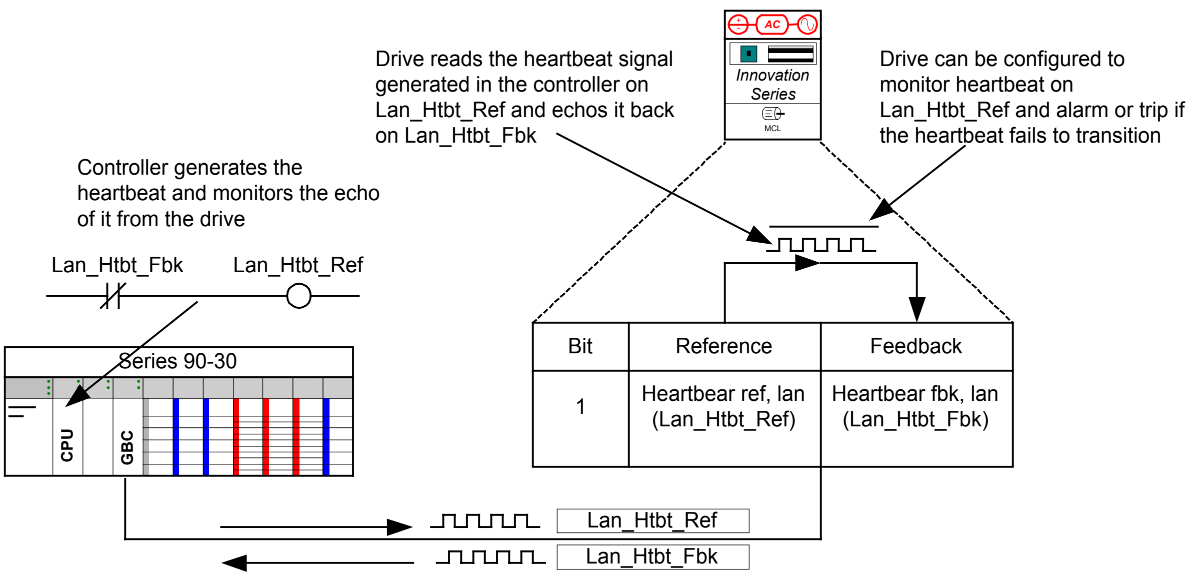
Variable	Description
LAN connection OK	Indicates that the health of the LAN connection is good, such that the LAN watchdog function is satisfied.
LAN commands OK	Indicates that the health of the LAN references are good, based upon the detection of two successive LAN connection OK indications.
Heartbeat ref, LAN	LAN heartbeat signal that is generated by the controller. The drive can be configured to alarm or trip upon the failure of this heartbeat. The drive also echoes this signal back out the Heartbeat Fbk LAN variable.
Heartbeat Fbk, LAN	Drive echoes the Heartbeat ref variable out on Heartbeat Fbk.
Sys ISBus error Cnt	Not applicable
Sys ISBus error Reg	Not applicable
Frame PLL OK status	Not applicable
FPLL Freq Output	Not applicable

Applying the LAN Heartbeat Echo Feature

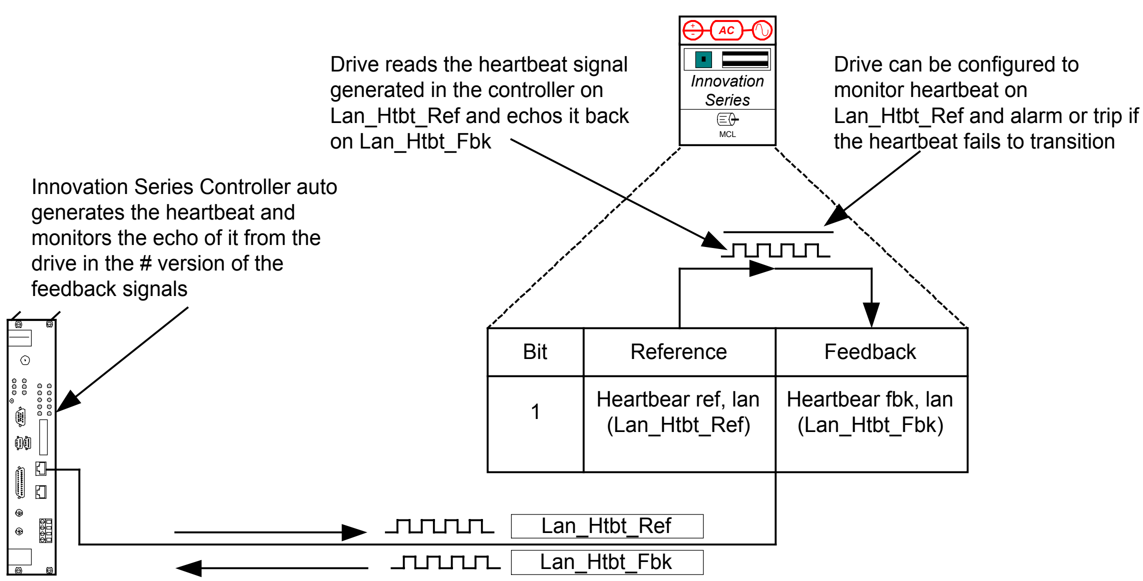
When controlling a drive over a LAN, both the controller and the drive need to monitor and react to changes in the status of LAN health. The heartbeat echo feature in the drive provides a mechanism for this function.

The following illustrations indicate how the drive and controller obtain status on the LAN integrity and possible configuration options.

Heartbeat Echo Function with a PLC



Heartbeat Echo Function with an Innovation Series Controller



Application of Feedback Signals

In most control systems the LAN (Genius, Profibus-DP, and such) operates asynchronous with the execution of control logic. Two situations can occur:

- **Under Sampling** - If the control logic sweep rate is slower than the LAN sweep rate, certain samples of feedback signals from the drive are not seen by the control logic.
- **Over Sampling** - If the control logic sweep rate is faster than the LAN sweep rate, certain feedback signal samples from the drive are seen multiple times by the control logic.

To address the under sampling problem, signal conditioning is provided for dedicated *analog* feedback channels in the form of sequential averaging. Feedback signals are comprised of a series of short-term averages of the source signal. The parameter *LAN fbk avg time* configures the averaging period; updates to the feedback signal map are performed coherently.

Note that when an integer relationship exists between *LAN frame time* and *LAN fbk avg time*, then the frame and feedback averaging periods are synchronized to the extent possible. This synchronization is optimal for synchronous LAN interfaces, such as those provided by the ISBus.

Variable Maps

This section defines the signal maps for the ACMVAC4-G (General Industries) pattern. The following tables provide:

- Standard 32-bit SPFP maps
- 20-character user names and 12-character symbolic names
- Units or scale groups (as appropriate)

Real Variable Map

	Reference		Feedback	
Byte	Variable	Functionality	Variable	Functionality
1-4	Request bits 1, lan (Lan_Req1_Wrd)	multiple bits, see table below	Feedback bits 1, lan (Lan_Fbk1_Wrd)	multiple bits, see table below
5-8	Auto speed ref, lan (Lan_Spd_Ref) SpeedRpm_Scl	Auto analog ref sel (Auto_Ref_Adr) Behavior 2	Fault number (Lan_Flt_Code) <integer>	number of the active fault with (1) highest severity (trip/alarm) (2) earliest time-stamp
9-12	Spd ref offset, lan (Lan_Spd_Offs) SpeedRpm_Scl	Speed loop sum sel (Spd_Outr_Adr) Behavior 2	Speed feedback, lan (Lan_Spd_Fbk) SpeedRpm_Scl	=Avg[Spd_Fbk] sequential averages
13-16	Torque ref, lan (Lan_Trq_Ref) Torque_Scl	Torque ref select (Trq_Ref_Adr) Behavior 2	Motor torque, lan (Lan_Trq_Fbk) Torque_Scl	=Avg[Trq_Cal_T2] sequential averages
17-20	Not Used		Motor current, lan (Lan_I_Mag) "A rms"	=Avg[I_Mag_T2 x Sqrt(1/2)] sequential averages
21-24	Not Used		Not Used	
25-28	GP lan ref 1 (Lan_R01_Ref)	general purpose real var	GP lan fbk reg 1 (Lan_R01_Fbk)	GP lan fb reg 1 sel (Lan_R01_Adr)
29-32	GP lan ref 2 (Lan_R02_Ref)	general purpose real var	GP lan fbk reg 2 (Lan_R02_Fbk)	GP lan fb reg 2 sel (Lan_R02_Adr)
33-36	Torque fdfwd, lan (Lan_Trq_Ffd) Torque_Scl	Torque feed fwd sel (Trq_Ffd_Adr) Behavior 2	Motor power, lan (Lan_Mtr_Pwr) Power_Scl	=Avg[Mtr_Pwr_T2] sequential averages
37-40	Flux reference, lan (Lan_Flx_Adj) <no units>	Flux adjust select (Flx_Adj_Adr) Behavior 2	Motor voltage, lan (Lan_V_Mag) "V rms"	=Avg[V_Mag_T2 x Sqrt(3/2)] sequential averages
41-44	Droop comp ref, lan (Lan_Drp_Comp) <no units>	Droop comp ref sel (Drp_Comp_Adr) Behavior 2	Not Used	
45-56	Not Used		Not Used	
57-60	GP lan ref 3 (Lan_R03_Ref)	general purpose real var	GP lan fbk reg 3 (Lan_R03_Fbk)	GP lan fb reg 3 sel (Lan_R03_Adr)
61-64	GP lan ref 4 (Lan_R04_Ref)	general purpose real var	GP lan fbk reg 4 (Lan_R04_Fbk)	GP lan fb reg 4 sel (Lan_R04_Adr)

Boolean Variable Map

	Reference		Feedback	
Byte	Variable	Functionality	Variable	Functionality
1	Heartbeat ref, lan (Lan_Htbt_Ref)	Heartbeat function: transitions expected	Heartbeat fbk, lan (Lan_Htbt_Fbk)	Heartbeat function: loopback Heartbeat ref, lan
2	Fault reset req, lan (Lan_Flt_Rst)	Fault reset select (Flt_Rst_Adr) Behavior 1, edge	No faults or alarms (No_Flt)	no active (uncleared) faults, "not (trip OR alarm)"
3	Trip request, lan (Lan_Trp_Req)	Fault.Lan trip request (Lan_Trp) Behavior 0	Trip fault active (Trip_Flt)	active trip fault, "trip"
4	Alarm request, lan (Lan_Alm_Req)	Fault.Lan alarmrequest (Lan_Alm) Behavior 0	Local fault string (Loc_Flt)	local hardware permissive; bridge inhibited
5	Not Used		System fault string (Sys_Flt)	system hardware permissive; bridge inhibited
6	Not Used		Ready to Run (Run_Rdy)	device is ready & will respond to run request
7	Not Used		Bridge is on (Brg_Pwr_Enb)	bridge power enabled; sequencer command
8	Not Used		Running (Running)	Set, Clear: Ref_Enb_Stat & Sreg_Stat , /Ref_Enb_Stat & /Sreg_Stat
9	Run request, lan (Lan_Run_Req)	Run request select (Run_Req_Adr) Behavior 1, edge	Run active (Run_Act)	Running & (Run_Req & /Jog_Req)
10	Jog request, lan (Lan_Jog_Req)	Jog request select (Jog_Req_Adr) Behavior 1, edge	Jog active (Jog_Act)	Running & (Jog_Req)
11	X stop request, lan (Lan_Xstp_Req)	X stop request sel (X_Stp_Adr) Behavior 1, level	X stop active (X_Stp_Cmd)	result of Xstop requests
12	Full flux req, lan (Lan_FFlx_Req)	Full flux req sel (Fflx_Req_Adr) Behavior 1, edge	Full flux active (Seq_Stat.Flx_Enb_Stat)	flux model indicates that net commanded flux is established
13	Rev mode req, lan (Lan_Rev_Req)	Reverse select (Rev_Req_Adr) Behavior 2	Reverse mode active (Reverse)	result of Rev mode requests
14	Torque mode req, lan (Lan_Tref_Enb)	Torque mode sel (Tref_Enb_Adr) Behavior 2	Torque mode active (Trq_Mode_Act)	speed regulator function is regulating torque

Byte	Reference		Feedback	
	Variable	Functionality	Variable	Functionality
15	Droop disab req, lan (Lan_Drp_Inh)	Droop disable select (Drp_Inh_Adr) Behavior 2	Speed mode active (Spd_Mode_Act)	speed regulator function is regulating speed
16	Trq lim 2 req, lan (Lan_Tlim_Sel)	Torque lim 2 sel (Tlim_Sel_Adr) Behavior 2	In cur or trq lim (Trq_Lim_Act)	Inner torque regulator in limit=(Sreg_Frz_Pos||_Neg)
17	Ramp rate 2 req, lan (Lan_Rmp_Sel)	Ramp rate 2 select (Rmp_Sel_Adr) Behavior 2	Not Used	
18	*Ramp bypass req, lan (Lan_Rmp_Byp)*	*Bypass ramp (Rmp_Bypass)*	MA contactor closed (Seq_Stat.MA_Enb_Stat)	sequencer task status; real or modeled contactor status
19	Auto mode req, lan (Lan_Auto_Req)	Auto mode select (Auto_Adr) Behavior 2	Auto mode active (Auto_Mode)	result of Auto mode requests
20	Not Used		Zero speed active (Zero_Spd)	speed feedback is below zero speed (after delay)
21-24	Not Used		Not Used	
25	GP lan req bit 01 (Lan_B01_Req)	general purpose bool var	GP lan fbk bit 01 (Lan_B01_Fbk)	GP lan fb bit 01 sel (Lan_B01_Adr)
. . .				
32	GP lan req bit 08 (Lan_B08_Req)	general purpose bool var	GP lan fbk bit 08 (Lan_B08_Fbk)	GP lan fb bit 08 sel (Lan_B08_Adr)

Notes

Appendix A Function Block Diagrams

Introduction

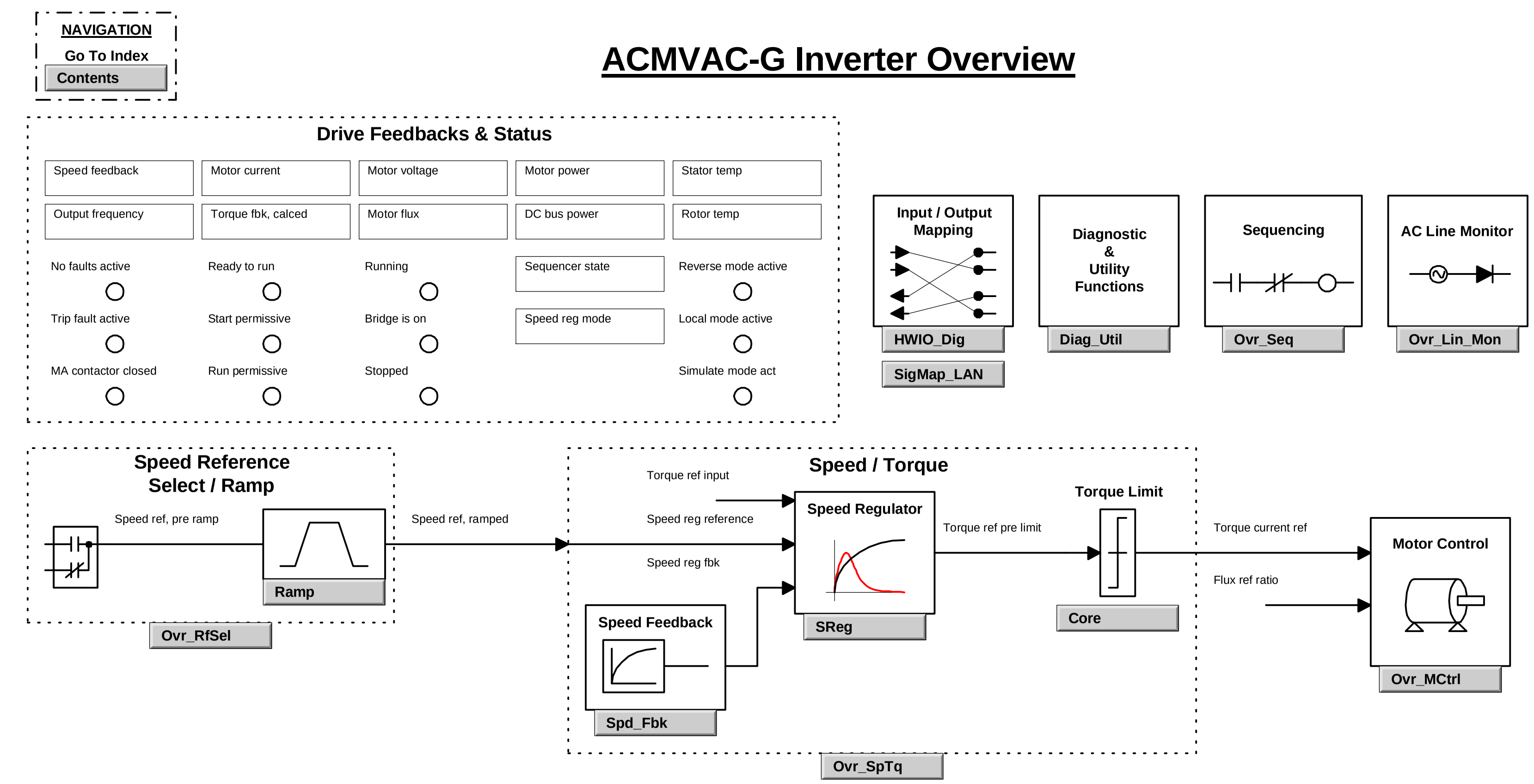
Application firmware consists of coordinated blocks of code called **functions** (refer to Chapter 3). The drawings in this section are **function block diagrams** for the Innovation Series Medium Voltage – GP Type G drive.

Caution

To prevent personal injury or equipment damage caused by equipment malfunction, only adequately trained personnel should modify any programmable machine.

Note These diagrams are available as navigable, online drawings in the optional Windows®-based drive configuration software, the GE Control System Toolbox.

ACMVAC-G Inverter Overview



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Factory Test Only

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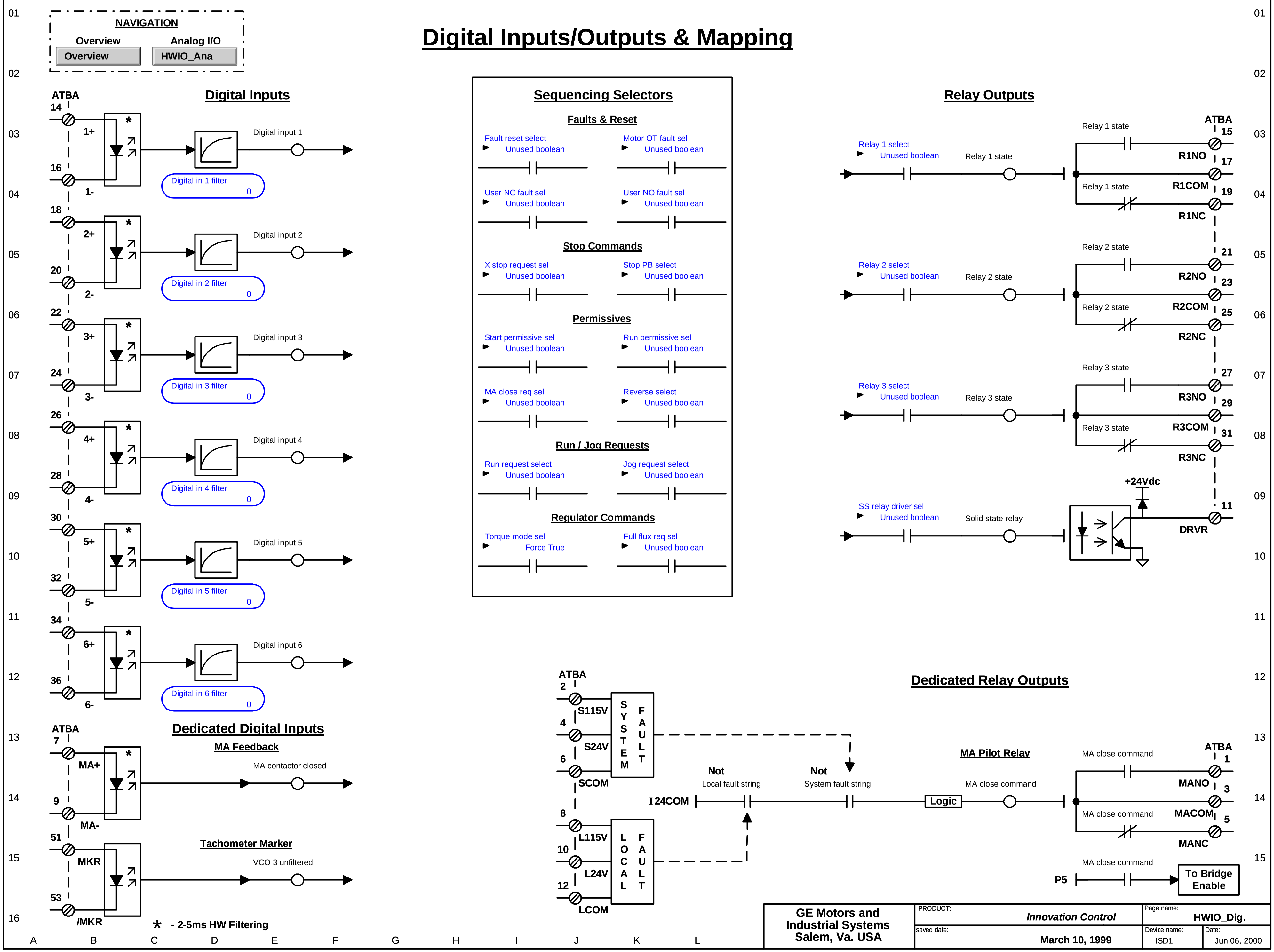
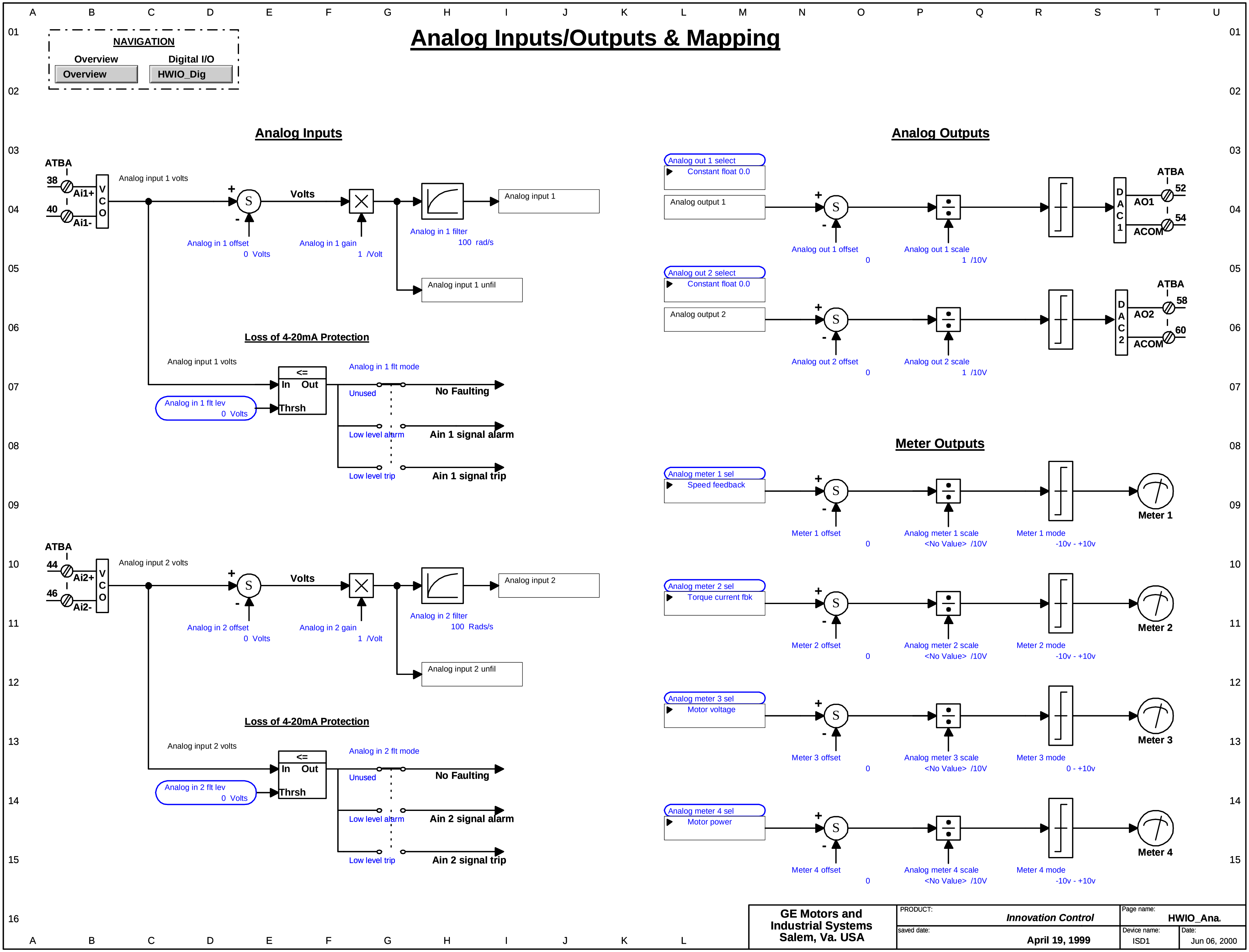
Digital Inputs/Outputs & Mapping





Analog Inputs/Outputs & Mapping
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Digital I/O
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Analog Inputs
ATBA
38
Ai1+
40
Ai1-
V
C
O
Analog input 1 volts
Volts
Analog in 1 offset
0 Volts
Analog in 1 gain
1 /Volt
Analog in 1 filter
100 rad/s
Analog input 1
Analog input 1 unfil
Loss of 4-20mA Protection
Analog input 1 volts
<=
In
Out
Thrsh
Analog in 1 flt lev
0 Volts
Analog in 1 flt mode
Unused
No Faulting
Low level alarm
Ain 1 signal alarm
Low level trip
Ain 1 signal trip
ATBA
44
Ai2+
46
Ai2-
Analog input 2 volts
Volts
Analog in 2 offset
0 Volts
Analog in 2 gain
1 /Volt
Analog in 2 filter
100 Rads/s
Analog input 2
Analog input 2 unfil
Loss of 4-20mA Protection
Analog input 2 volts
Analog in 2 flt lev
0 Volts
Analog in 2 flt mode
Unused
No Faulting
Low level alarm
Ain 2 signal alarm
Low level trip
Ain 2 signal trip
Analog Outputs
Analog out 1 select
Constant float 0.0
Analog output 1
Analog out 1 offset
0
Analog out 1 scale
1 /10V
D
A
C
1
AO1
ACOM
ATBA
52
54
Analog out 2 select
Constant float 0.0
Analog output 2
Analog out 2 offset
0
Analog out 2 scale
1 /10V
D
A
C
2
AO2
ACOM
ATBA
58
60
Meter Outputs
Analog meter 1 sel
Speed feedback
Meter 1 offset
0
Analog meter 1 scale
<No Value> /10V
Meter 1 mode
-10v - +10v
Meter 1
Analog meter 2 sel
Torque current fbk
Meter 2 offset
0
Analog meter 2 scale
<No Value> /10V
Meter 2 mode
-10v - +10v
Meter 2
Analog meter 3 sel
Motor voltage
Meter 3 offset
0
Analog meter 3 scale
<No Value> /10V
Meter 3 mode
0 - +10v
Meter 3
Analog meter 4 sel
Motor power
Meter 4 offset
0
Analog meter 4 scale
<No Value> /10V
Meter 4 mode
-10v - +10v
Meter 4
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ISD1
Date:
Jun 06, 2000

Drive Lan Signal Map

NAVIGATION

Back: Overview | Next: SigMap_Bit1

Configuration

- Network interface: None
- LAN fbk avg time: 0 Sec
- Sys ISBus node #: -1
- LAN frame time: 1 ms Sec

Status

- LAN connection ok
- LAN commands OK
- LAN trips inhibit: No
- LAN cmds inhibit: No

Page 1

#	Reference: Variable	Reference: Functionality	Feedback: Signal	Feedback: Functionality
1	**Request bits 1, lan**	*(see table)* SigMap_Bit1	**Feedbck bits 1, lan**	*(see table)* SigMap_Bit1
2	Auto speed ref, lan	Auto analog ref sel: Constant float 0.0	Fault number	**active fault number: 1) highest severity, 2) earliest time-stamp**
3	Spd ref offset, lan	Speed loop sum sel: Constant float 0.0	Speed feedback, lan	*averaged* Speed feedback
4	Torque ref, lan	Torque ref select: Constant float 0.0	Motor torque, lan	*averaged* Torque fbk, calced
5	<spare>		Motor current, lan	*averaged* Motor current
6	<spare>		<spare>	
7	GP lan ref 1	**general purpose real var**	GP lan fbk reg 1	GP lan fbk reg 1 sel: Unused float
8	GP lan ref 2	**general purpose real var**	GP lan fbk reg 2	GP lan fbk reg 2 sel: Unused float

Page 2

#	Reference: Variable	Reference: Functionality	Feedback: Signal	Feedback: Functionality
1	Torque fdfwd, lan	Torque feed fwd sel: Constant float 0.0	Motor power, lan	*averaged* Motor power
2	Flux reference, lan	Flux ref ratio sel: Unused float	Motor voltage, lan	*averaged* Motor voltage
3	Droop comp ref, lan	Droop comp ref sel: Constant float 0.0	<spare>	
4	<spare>		<spare>	
5	<spare>		<spare>	
6	<spare>		<spare>	
7	GP lan ref 3	**general purpose real var**	GP lan fbk reg 3	GP lan fbk reg 3 sel: Unused float
8	GP lan ref 4	**general purpose real var**	GP lan fbk reg 4	GP lan fbk reg 4 sel: Unused float

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NAVIGATION

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Drive Lan Boolean Signals (bits 0-15)

Status

LAN connection ok — LAN trips inhibit: No

LAN commands OK — LAN cmds inhibit: No

	0	1	2	3	4	5	6	7
Request Bits Variable	(Heartbeat)	Fault reset req, lan	Trip request, lan	Alarm request, lan				
Function	Heartbeat function: transitions expected	Fault reset select: Unused boolean	Fault. LAN trip request	Fault. LAN alarm request				
Feedback Bits Signal	(Heartbeat) LAN heartbeat time: 0 Sec	No faults active	Trip fault active	Local fault string	System fault string	Ready to run	Bridge is on	Running
Function	Heartbeat function: loopback Heartbeat Request	no active (uncleared) faults, "not (trip OR alarm)"	active trip fault, "trip"	local hardware permissive: bridge inhibited	system hardware permissive: bridge inhibited	device is ready & will respond to a run request	bridge power enabled; sequencer command	reference is enabled & speed regulator is active

	8	9	10	11	12	13	14	15
Request Bits Variable	Run request, lan	Jog request, lan	X stop request, lan	Full flux req, lan	Rev mode req, lan	Torque mode req, lan	Droop disab req, lan	Trq lim 2 sel, lan
Function	Run request select: Unused boolean	Jog request select: Unused boolean	X stop request sel: Unused boolean	Full flux req sel: Unused boolean	Reverse select: Unused boolean	Torque mode sel: Force True	Droop disable sel: Force False	Torque lim 2 sel: Force False
Feedback Bits Signal	Run active	Jog active	X stop active	Flux enable status	Reverse mode active	Torque mode active	Speed mode active	In cur or trq limit
Function	Running & Run Request & Not Jog Request	Running & Jog Request	result of Xstop requests	flux model indicates that net commanded flux is established	result of Reverse mode requests	speed regulator function is regulating torque	speed regulator function is regulating speed	Inner torque regulator in limit; freeze Sreg Integ

GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: *Innovation Control*	Page name: SigMap_Bit1.	
	saved date: June 4, 1998	Device name: ISD1	Date: Jun 06, 2000

Drive Lan Boolean Signals (bits 16-31)

NAVIGATION

Back: SigMap_Bit1

Back to: SigMap_LAN

Back to: Overview

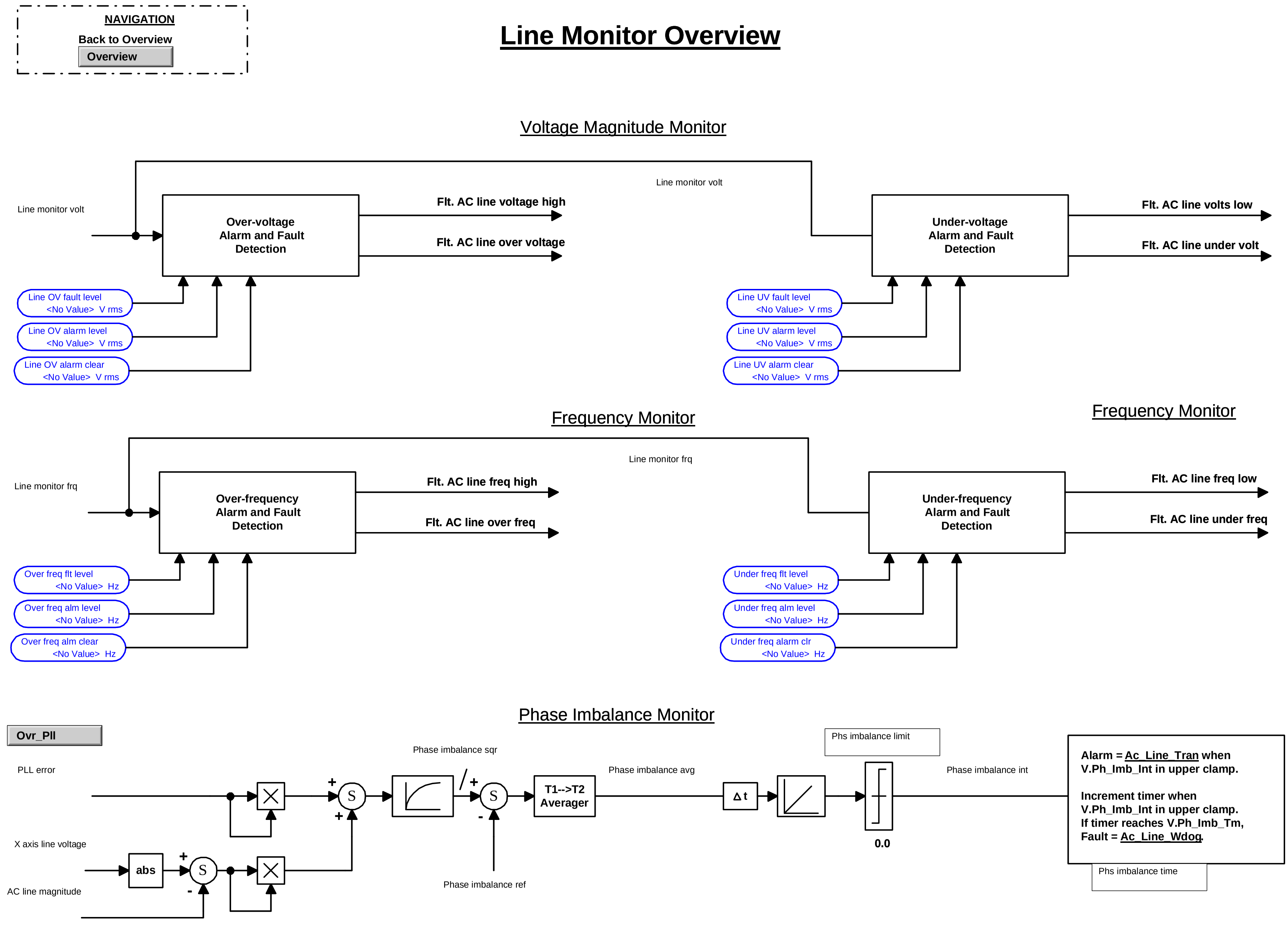
Status

LAN connection ok	LAN commands OK
LAN trips inhibit: No	LAN cmds inhibit: No

	16	17	18	19	20	21	22	23
Request Bits Variable	Ramp rate 2 sel, lan		Auto mode req, lan					
Function	Ramp rate 2 select: Force False		Auto mode select: Force False					
Feedback Bits Signal		MA cont enable stat	Auto mode active	Zero speed active				Lan diag fbk bit 1
Function		seq task status; real or modeled contactor status	result of Auto mode requests	speed feedback is below zero speed (after delay)				diagnostic boolean var

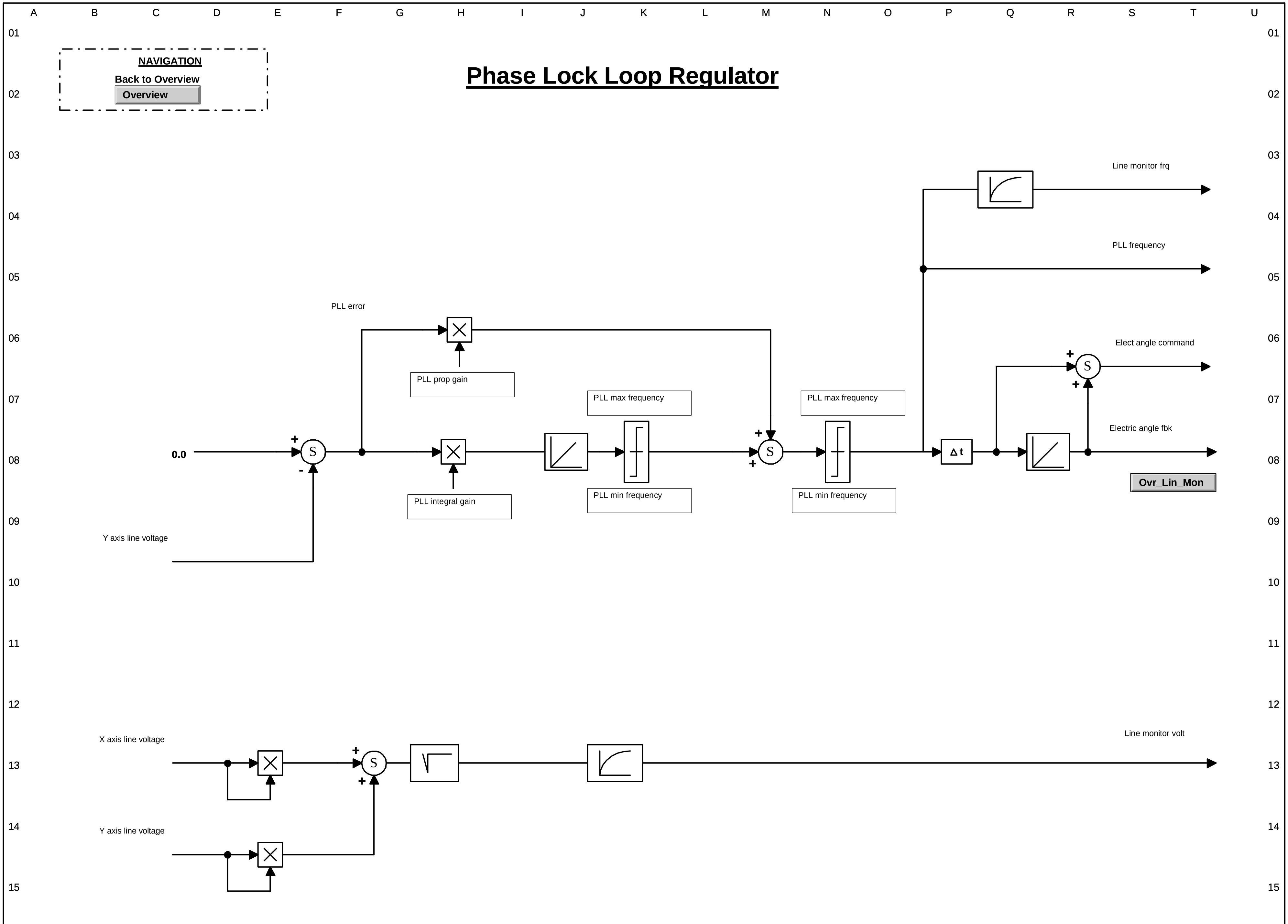
	24	25	26	27	28	29	30	31
Request Bits Variable	GP lan req bit 1	GP lan req bit 2	GP lan req bit 3	GP lan req bit 4	GP lan req bit 5	GP lan req bit 6	GP lan req bit 7	GP lan req bit 8
Function	general purpose boolean var	general purpose boolean var	general purpose boolean var	general purpose boolean var	general purpose boolean var	general purpose boolean var	general purpose boolean var	general purpose boolean var
Feedback Bits Signal	GP lan fbk bit 1	GP lan fbk bit 2	GP lan fbk bit 3	GP lan fbk bit 4	GP lan fbk bit 5	GP lan fbk bit 6	GP lan fbk bit 7	GP lan fbk bit 8
Function	GP lan fbk bit 1 sel: Unused boolean	GP lan fbk bit 2 sel: Unused boolean	GP lan fbk bit 3 sel: Unused boolean	GP lan fbk bit 4 sel: Unused boolean	GP lan fbk bit 5 sel: Unused boolean	GP lan fbk bit 6 sel: Unused boolean	GP lan fbk bit 7 sel: Unused boolean	GP lan fbk bit 8 sel: Unused boolean

Line Monitor Overview



GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: *Innovation Series*	Page name: Ovr_Lin_Mon.
	Version --- Issued Date: November 18, 1998	Device name: ISD1 / Date: Jun 06, 2000

Phase Lock Loop Regulator



GE Motors and Industrial Systems Salem, Va. USA

PRODUCT: *Innovation Series*

Version — Issued Date: **March 24, 1999**

Page name: **Ovr_Pll.**

Device name: ISD1

Date: Jun 06, 2000

Sequencing Overview

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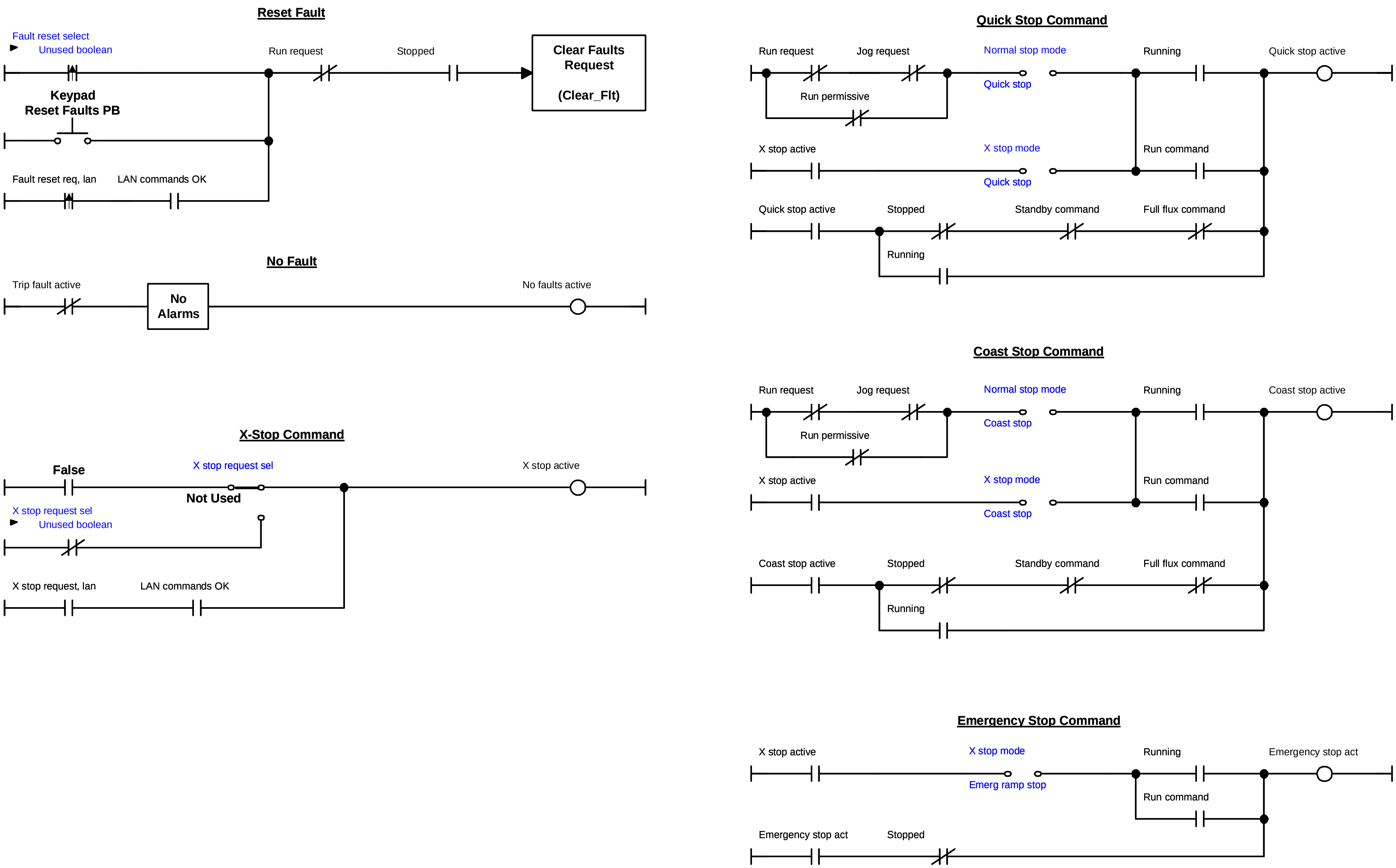
To Next Sheet: GenSeq_2

General Sequencing #1

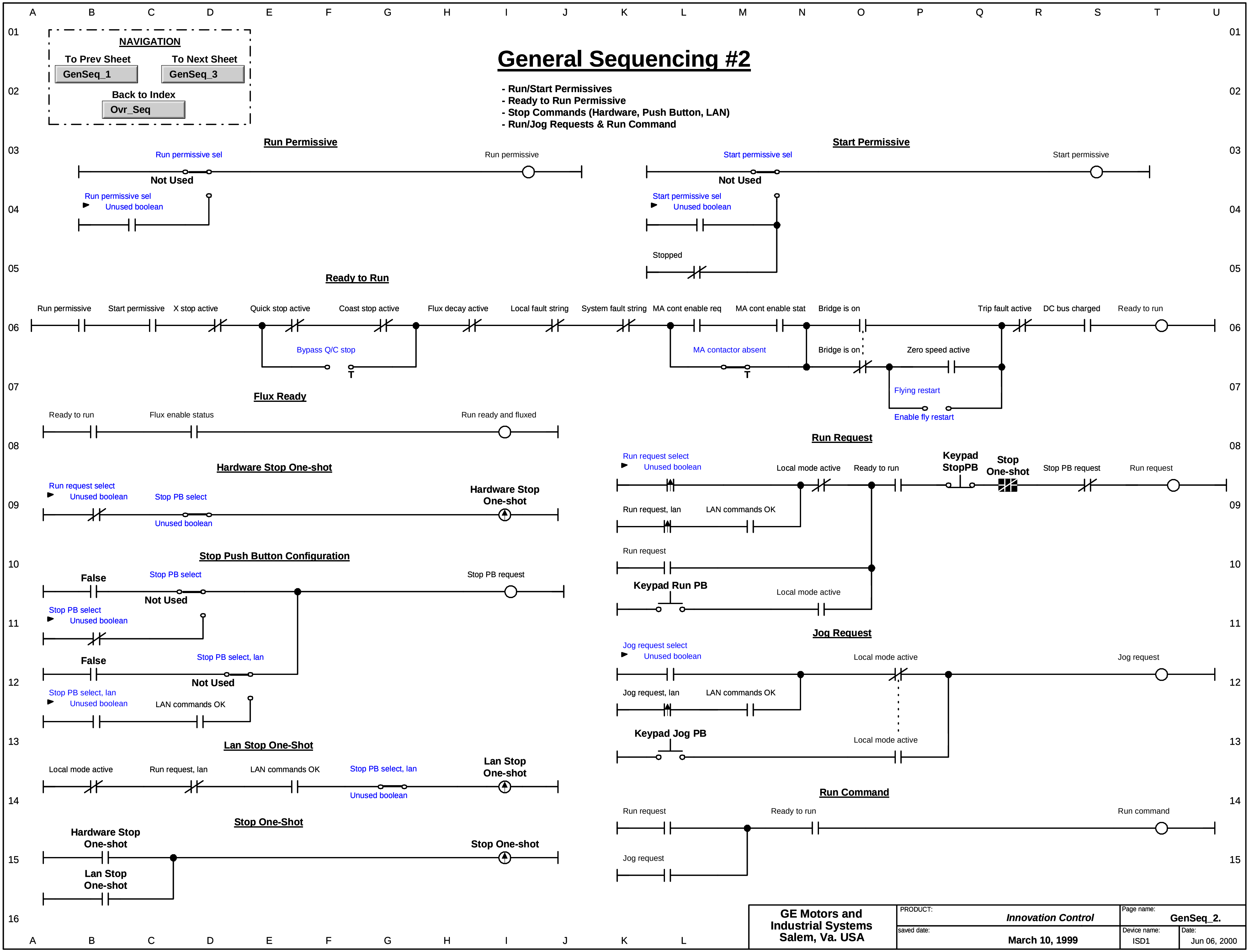
- Fault Reset Logic
- Stop Commands
(X-Stop, Quick Stop, Coast Stop, Emergency Stop)



GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: *Innovation Control*	Page name: GenSeq_1.	
	saved date: **May 1, 1998**	Device name: ISD1	Date: Jun 06, 2000

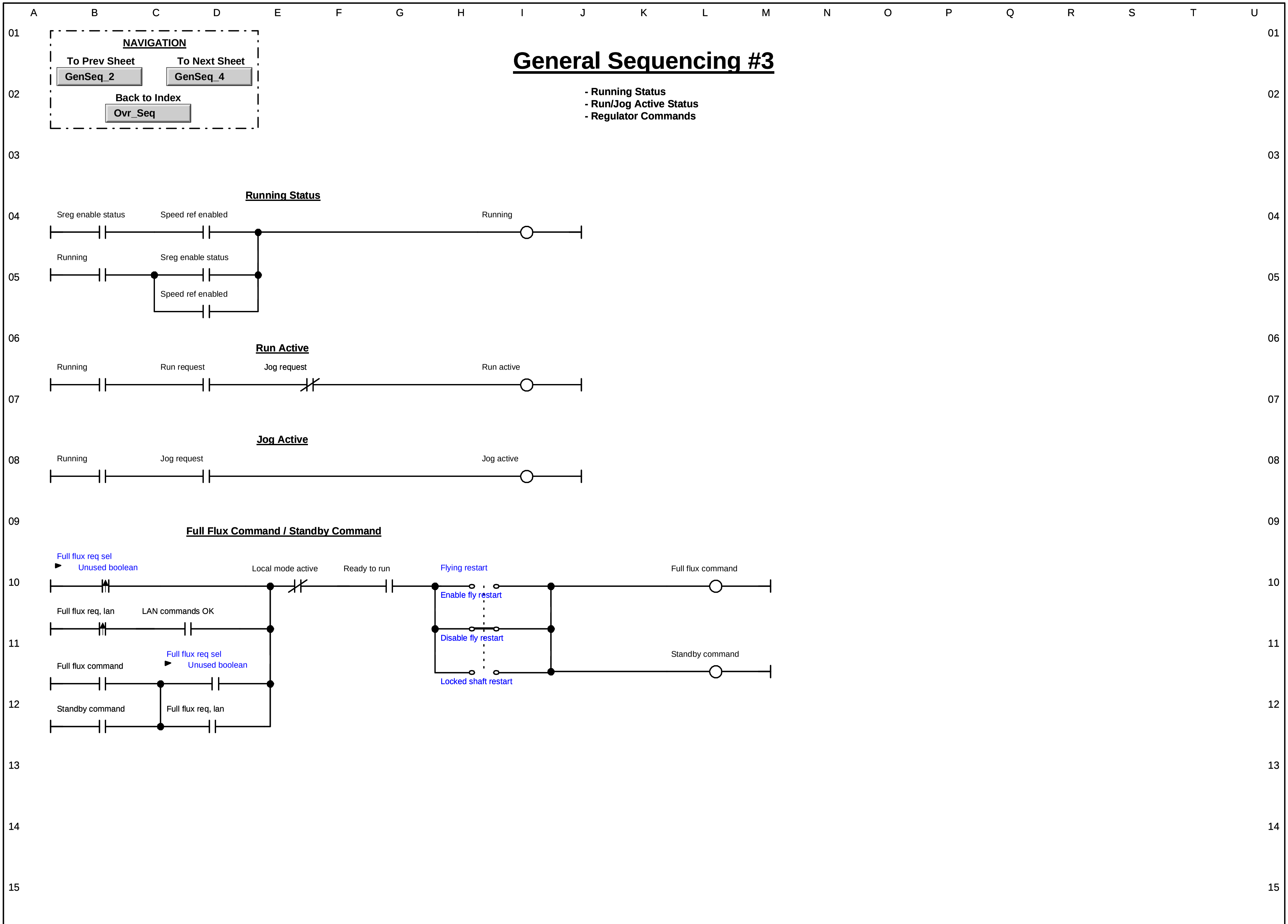
General Sequencing #2

- Run/Start Permissives
- Ready to Run Permissive
- Stop Commands (Hardware, Push Button, LAN)
- Run/Jog Requests & Run Command



General Sequencing #3

- Running Status
- Run/Jog Active Status
- Regulator Commands



GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: *Innovation Control*	Page name: GenSeq_3.	
	saved date: April 22, 1999	Device name: ISD1	Date: Jun 06, 2000

General Sequencing #4

- Contactor Control

NAVIGATION

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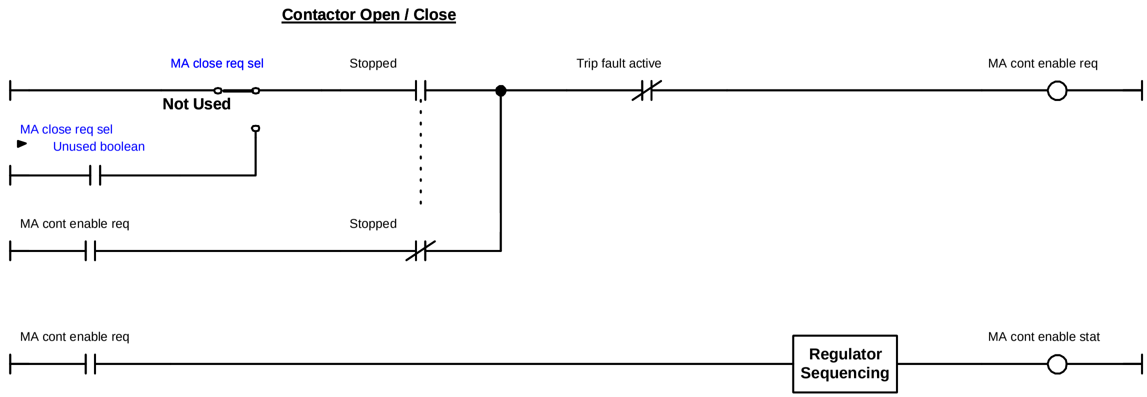
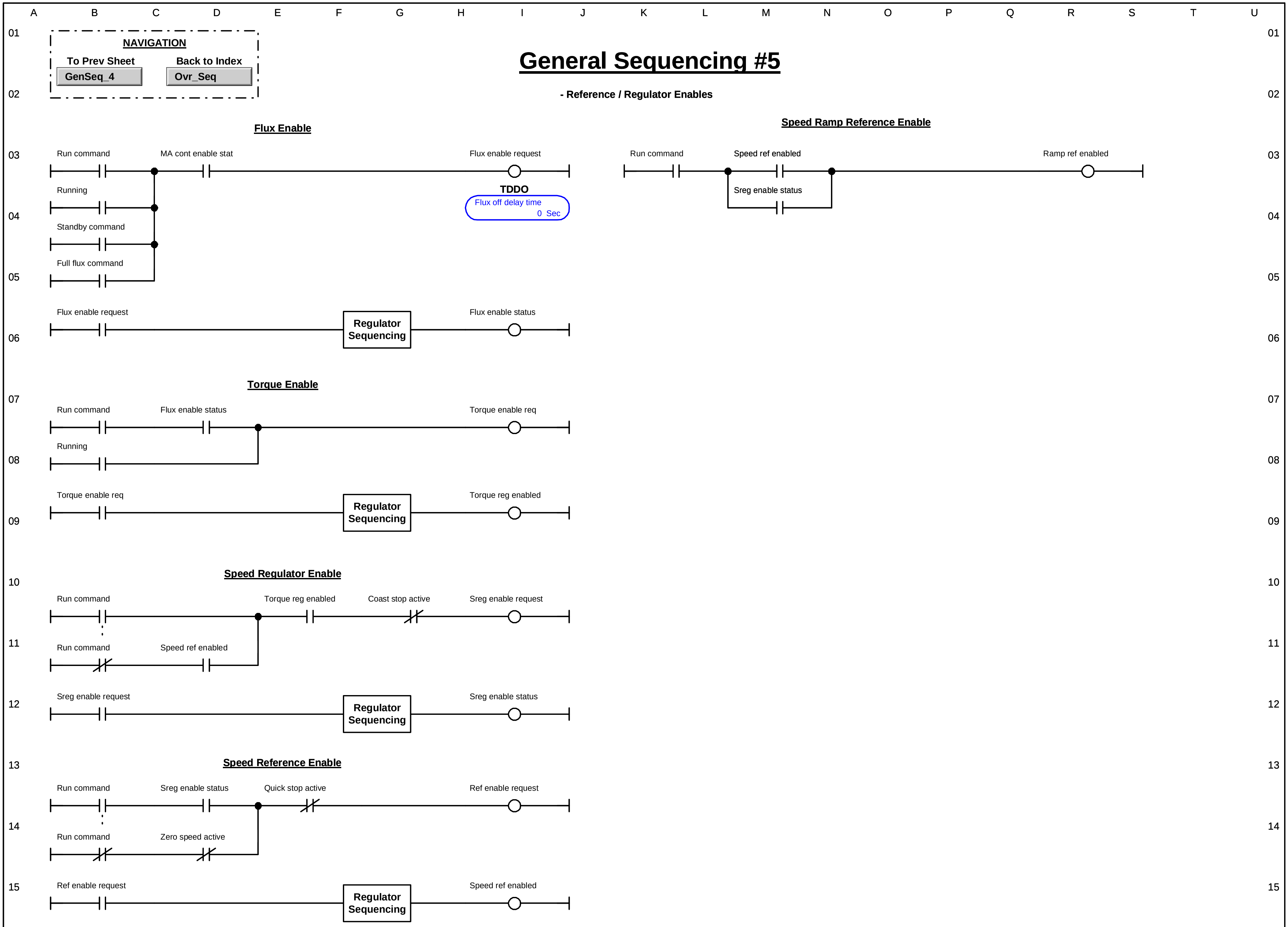


GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: *Innovation Control*	Page name: GenSeq_4.
	saved date: March 10, 1998	Device name: ISD1 / Date: Jun 06, 2000

General Sequencing #5

- Reference / Regulator Enables



GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: Innovation Control	Page name: GenSeq_5.	
	saved date: August 25, 1998	Device name: ISD1	Date: Jun 06, 2000

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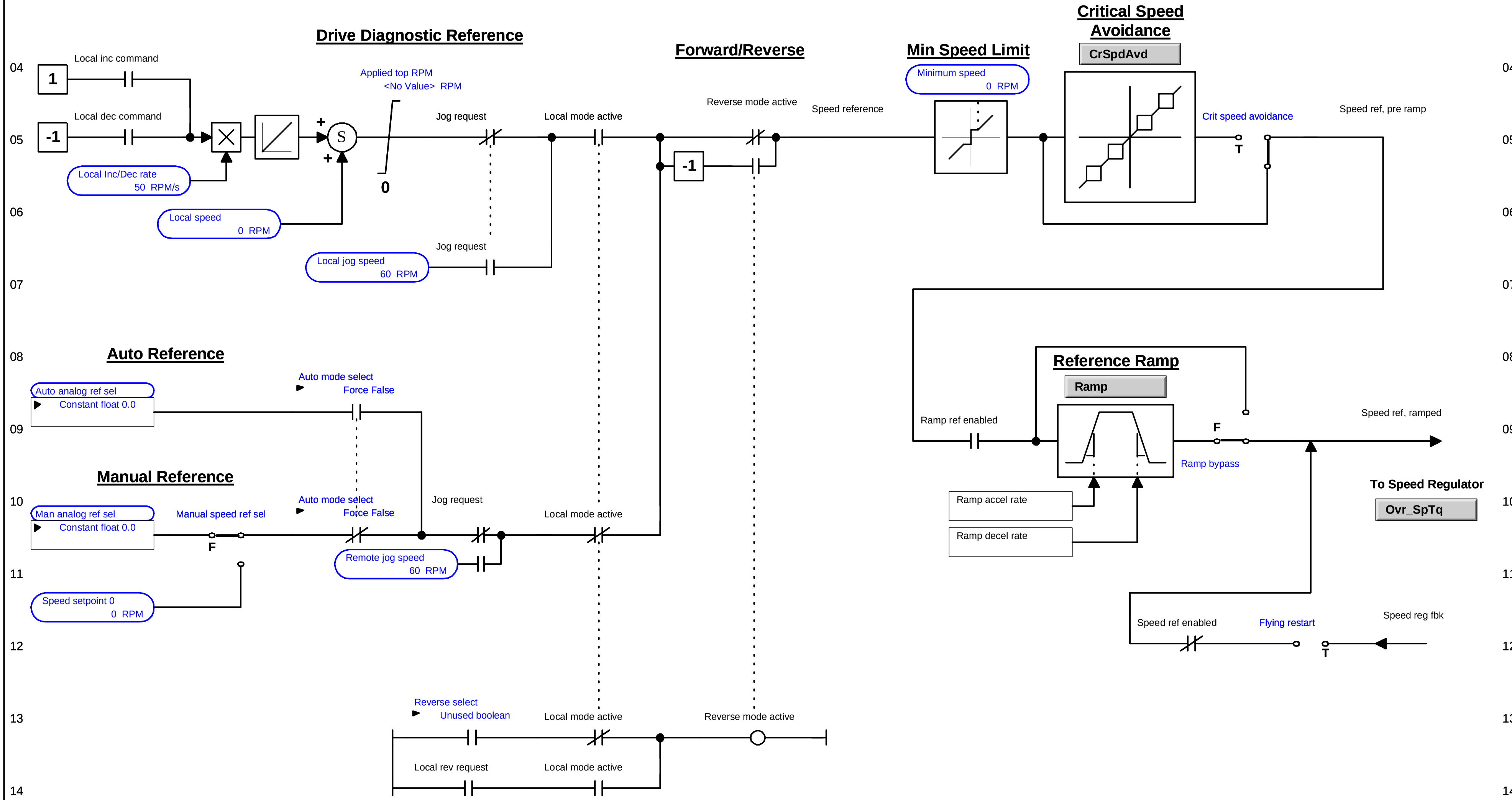
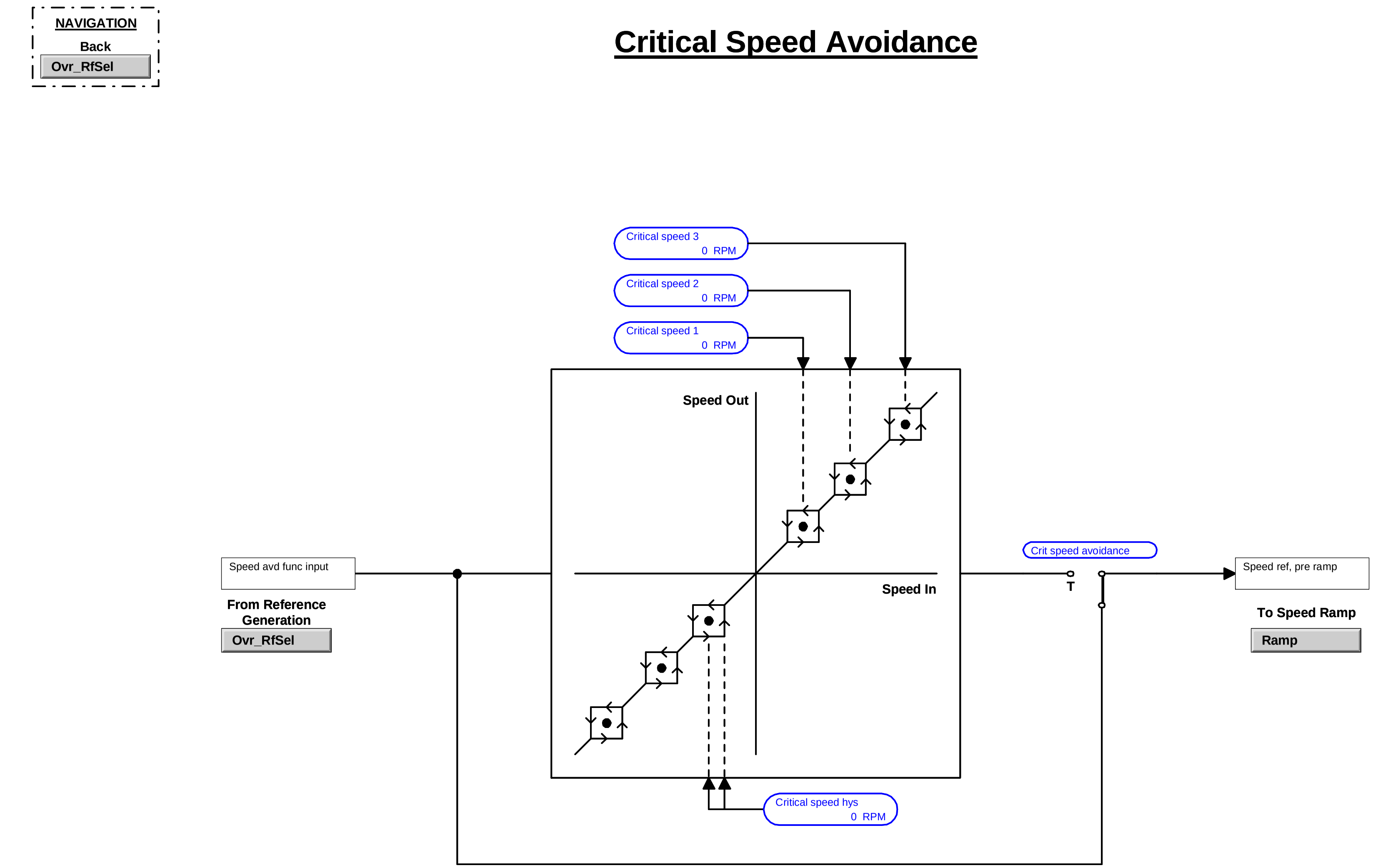
Speed Reference Generation



GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: *Innovation Control*	Page name: Ovr_RfSel.	
	saved date: March 10, 1998	Device name: ISD1	Date: Jun 06, 2000

Critical Speed Avoidance



GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: *Innovation Control*	Page name: CrSpdAvd.
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Speed Reference Ramp

NAVIGATION

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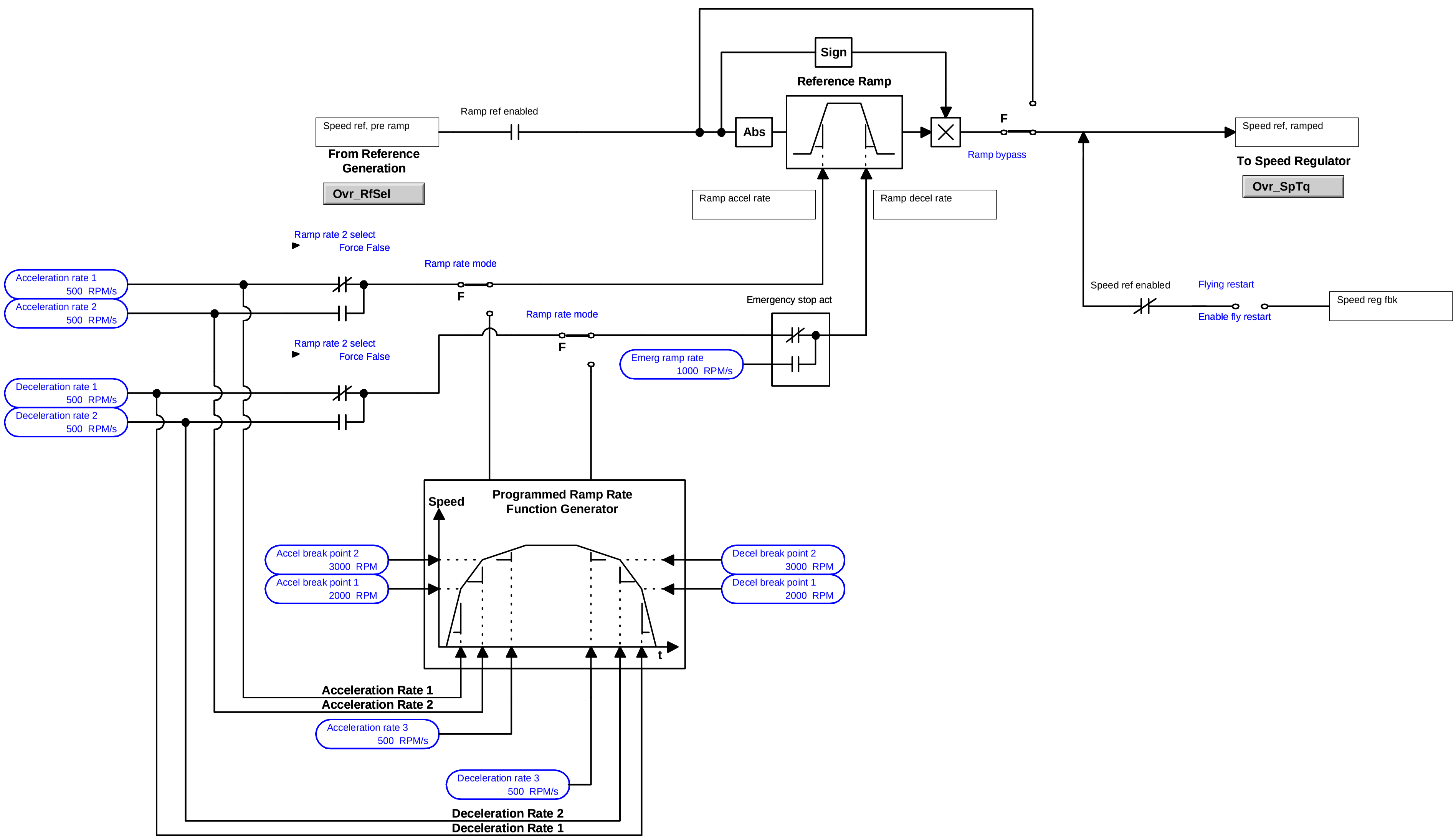
Ovr_RfSel



GE Motors and Industrial Systems Salem, Va. USA

PRODUCT:	Innovation Control	Page name:	Ramp.
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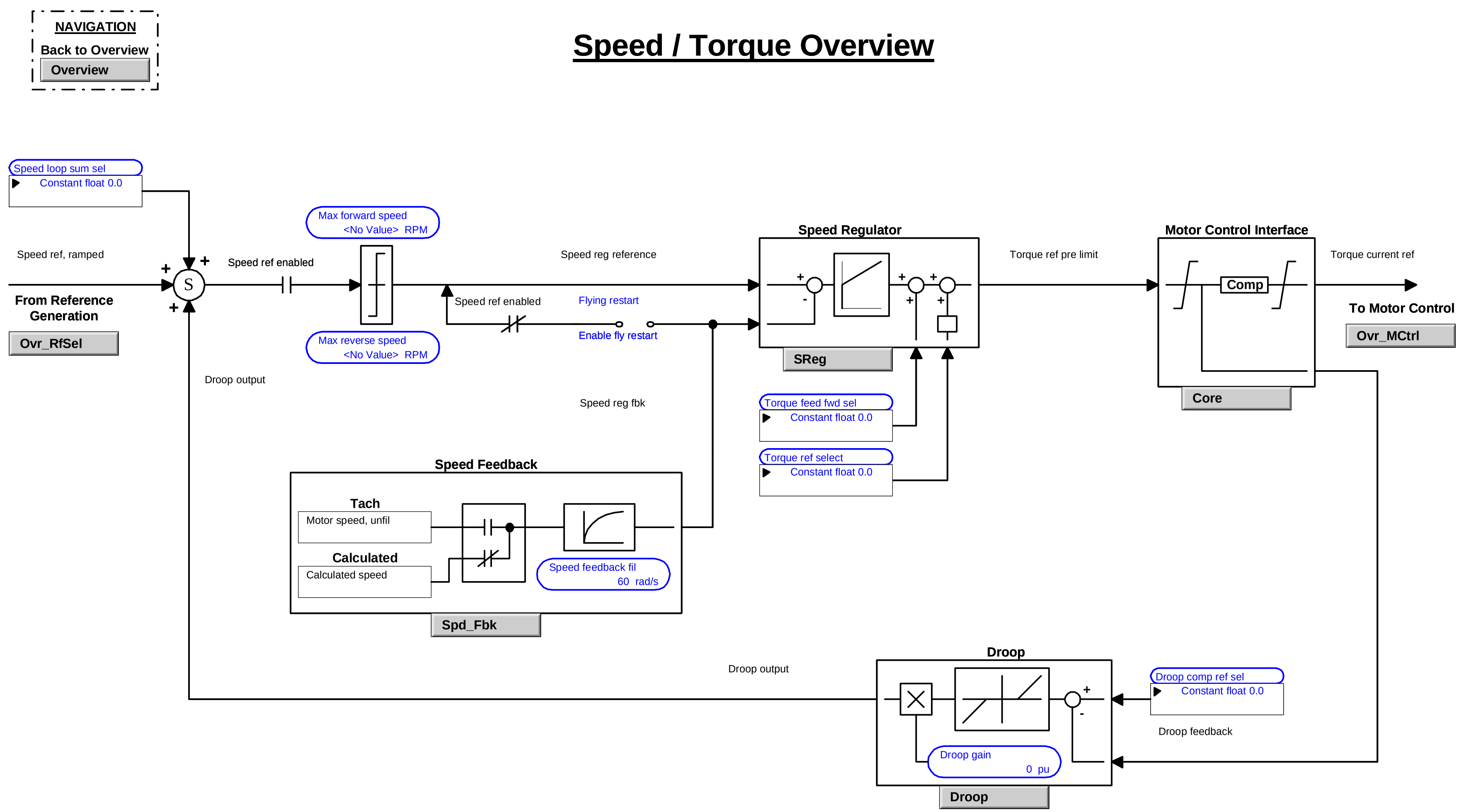
Speed / Torque Overview



GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: Innovation Control	Page name: Ovr_SpTq.
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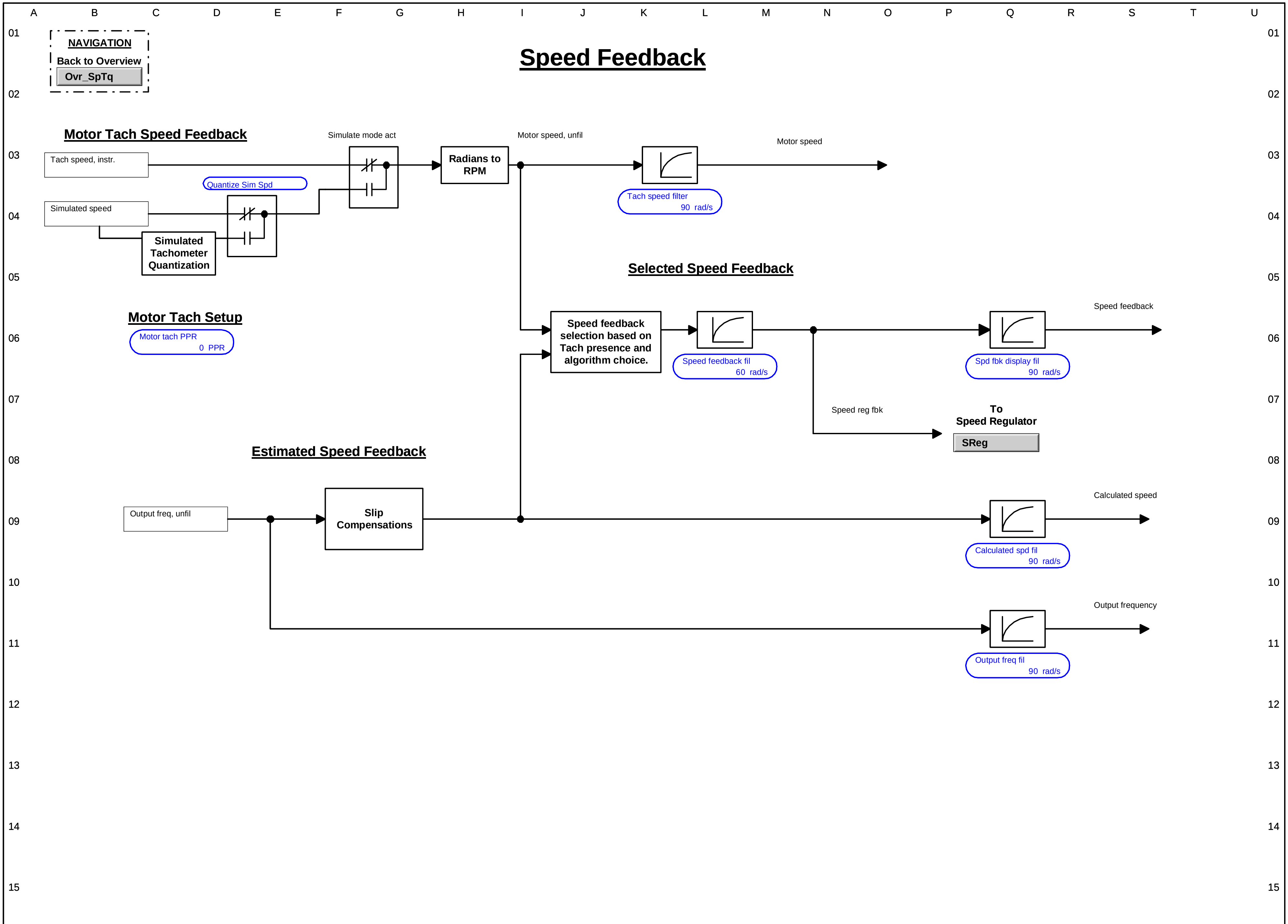
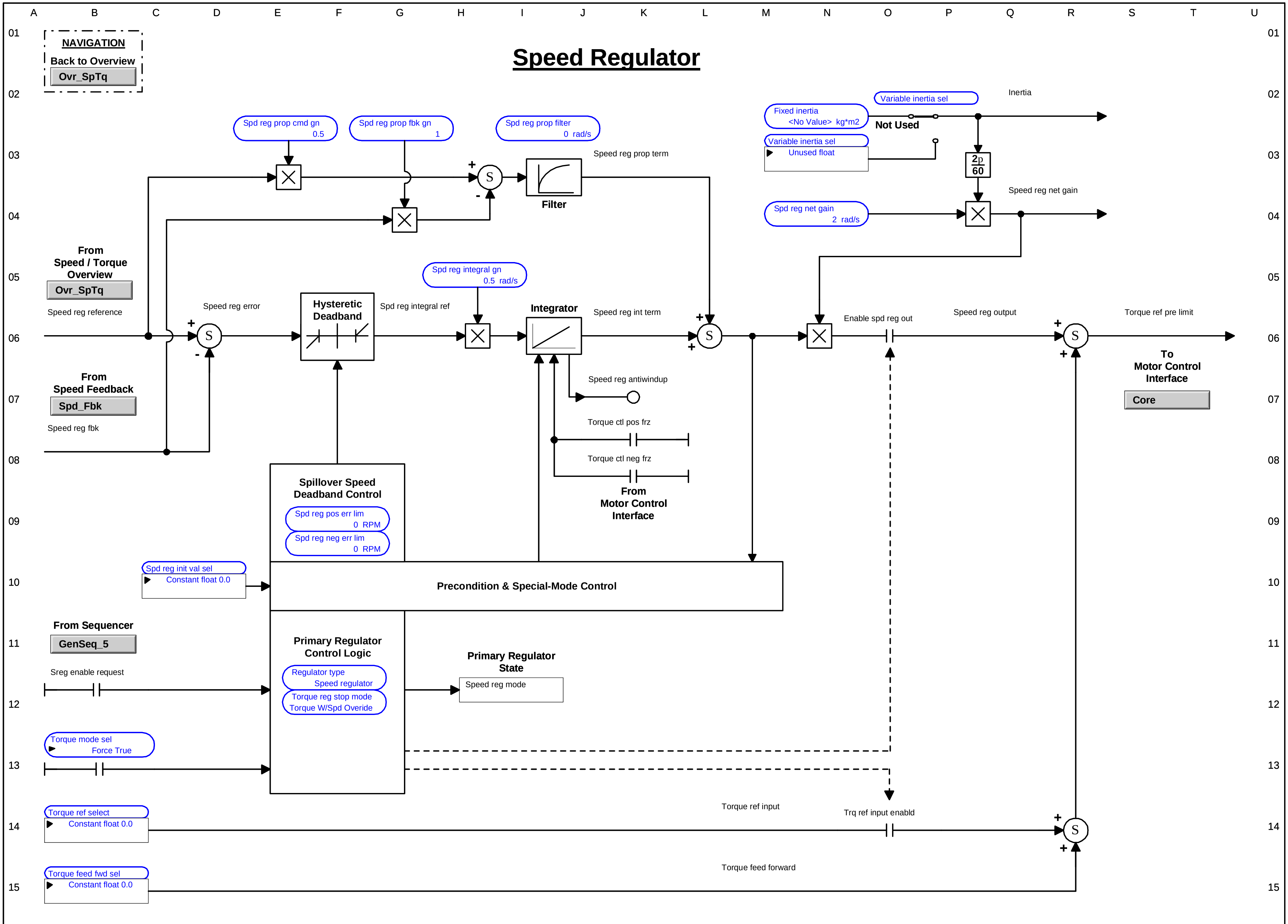
Speed Feedback



GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: Innovation Control	Page name: Spd_Fbk.	
	saved date: May 18, 1998	Device name: ISD1	Date: Jun 06, 2000

Speed Regulator



GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: *Innovation Control*	Page name: SReg.	
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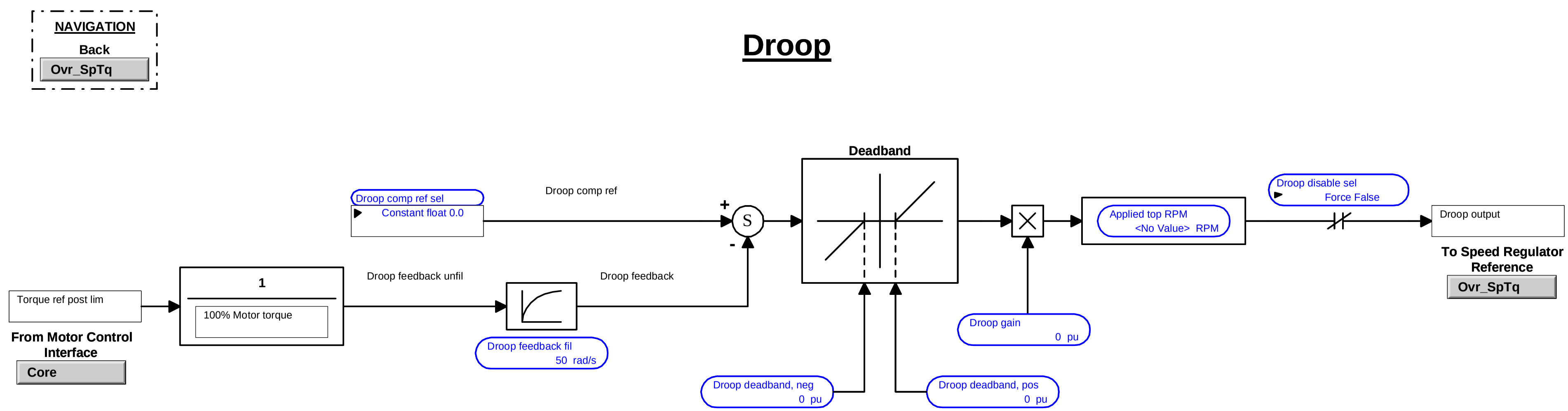
Droop



GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: *Innovation Control*	Page name: Droop.
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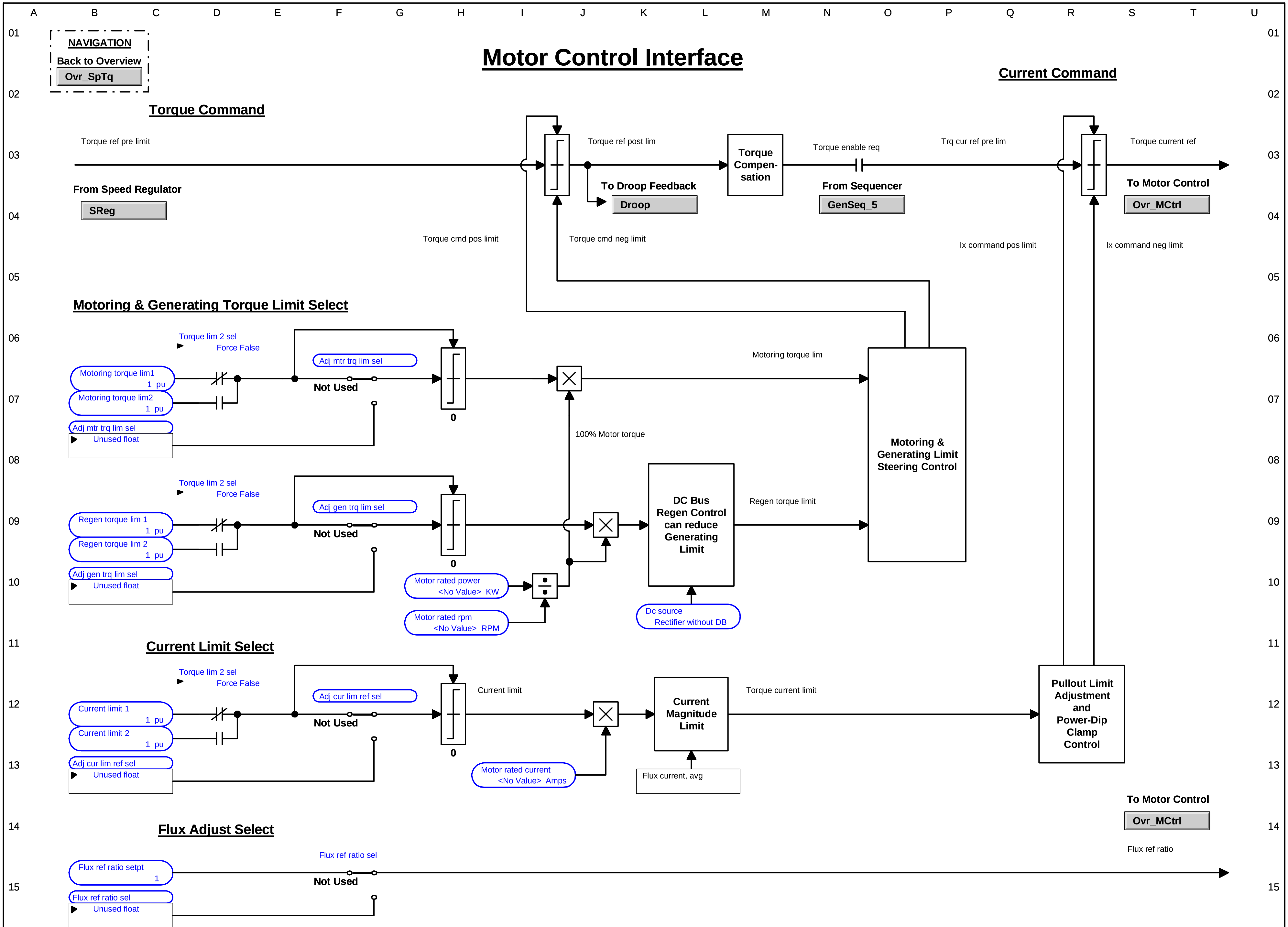
Motor Control Interface



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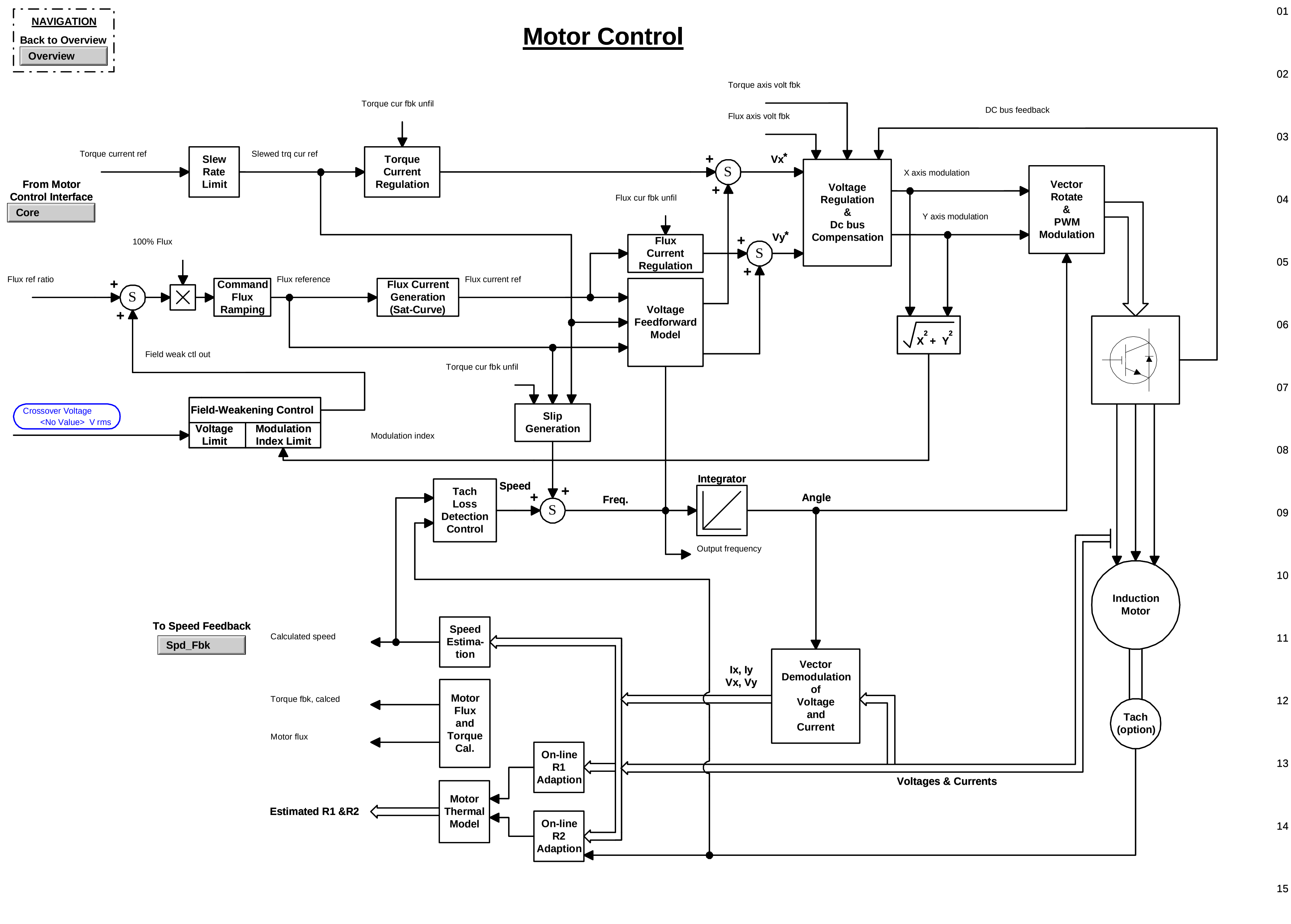
Motor Control



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PRODUCT: Innovation Control	Page name: Ovr_MCtrl.	
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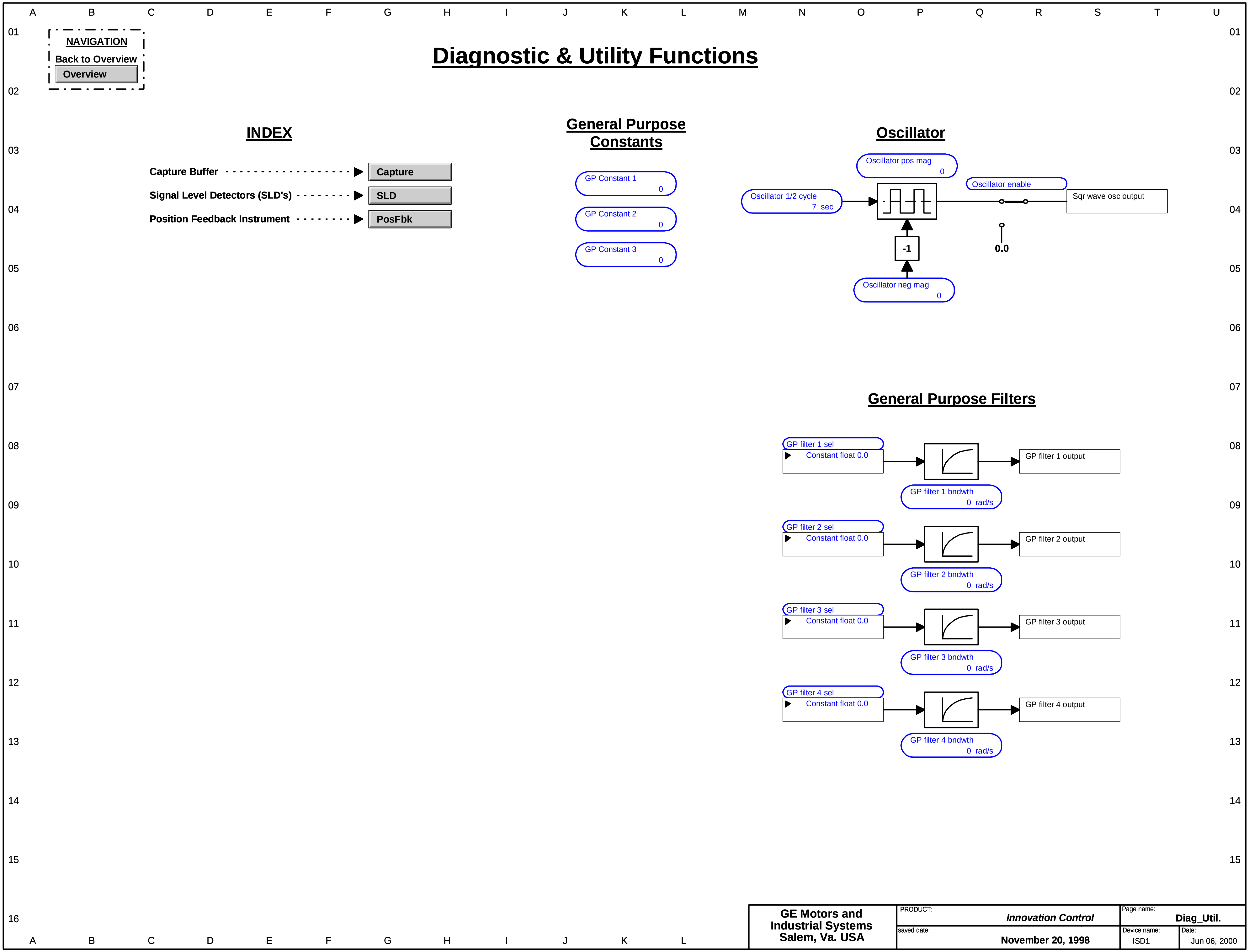
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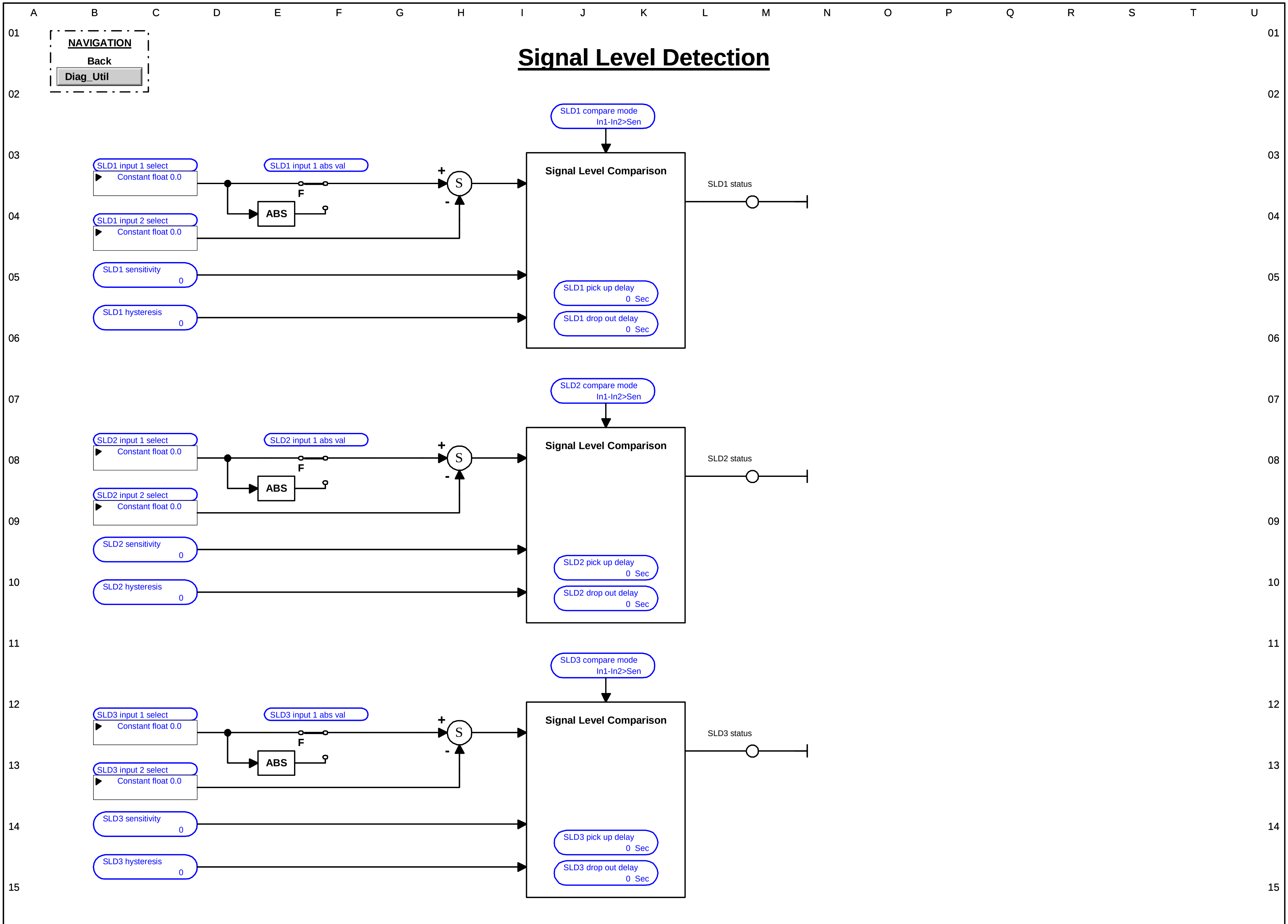
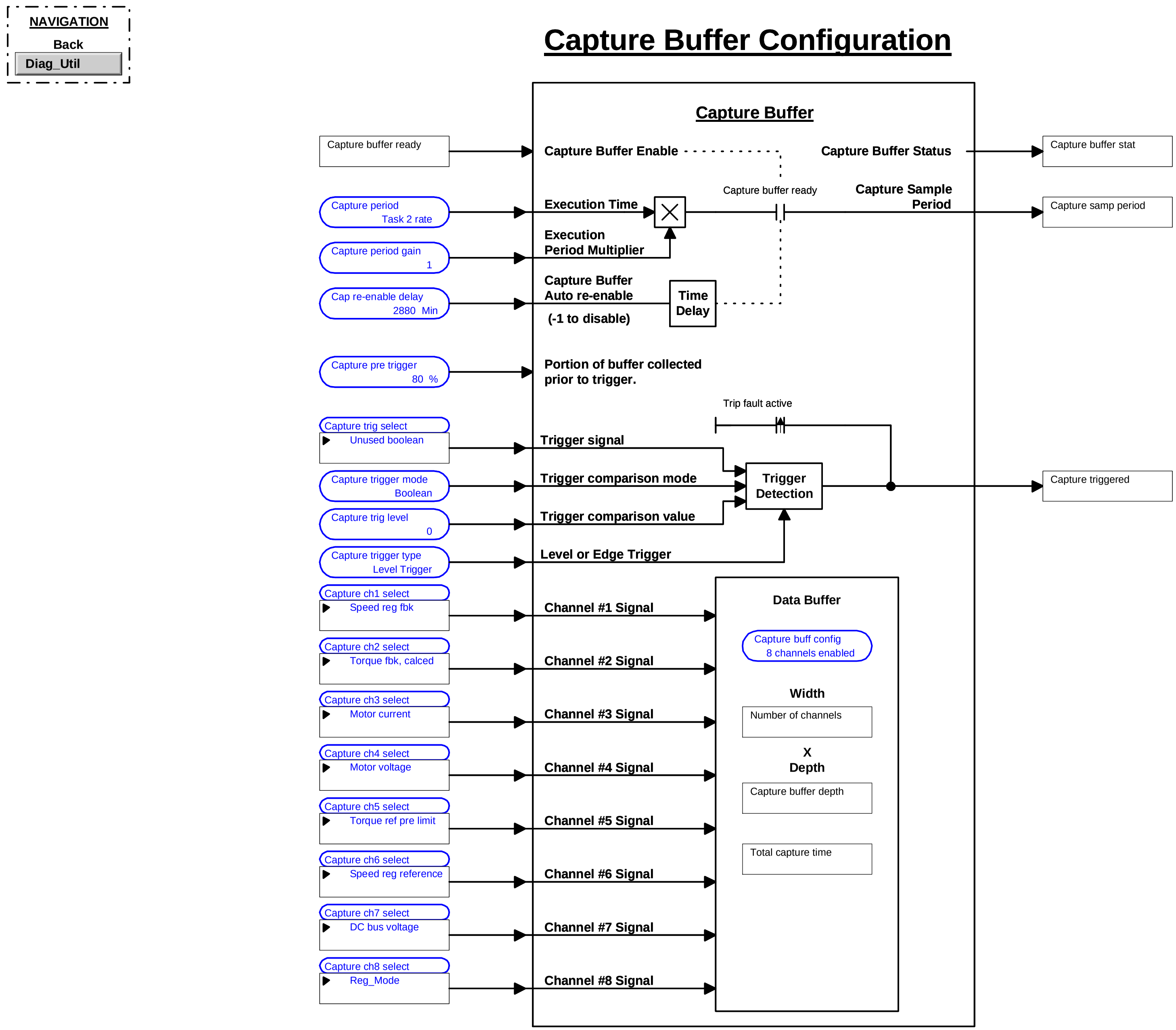
Signal Level Detection



GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: Innovation Control	Page name: SLD.
	saved date: February 23, 1998	Device name: ISD1 / Date: Jun 06, 2000

Capture Buffer Configuration



GE Motors and Industrial Systems Salem, Va. USA	PRODUCT: *Innovation Control*	Page name: Capture.
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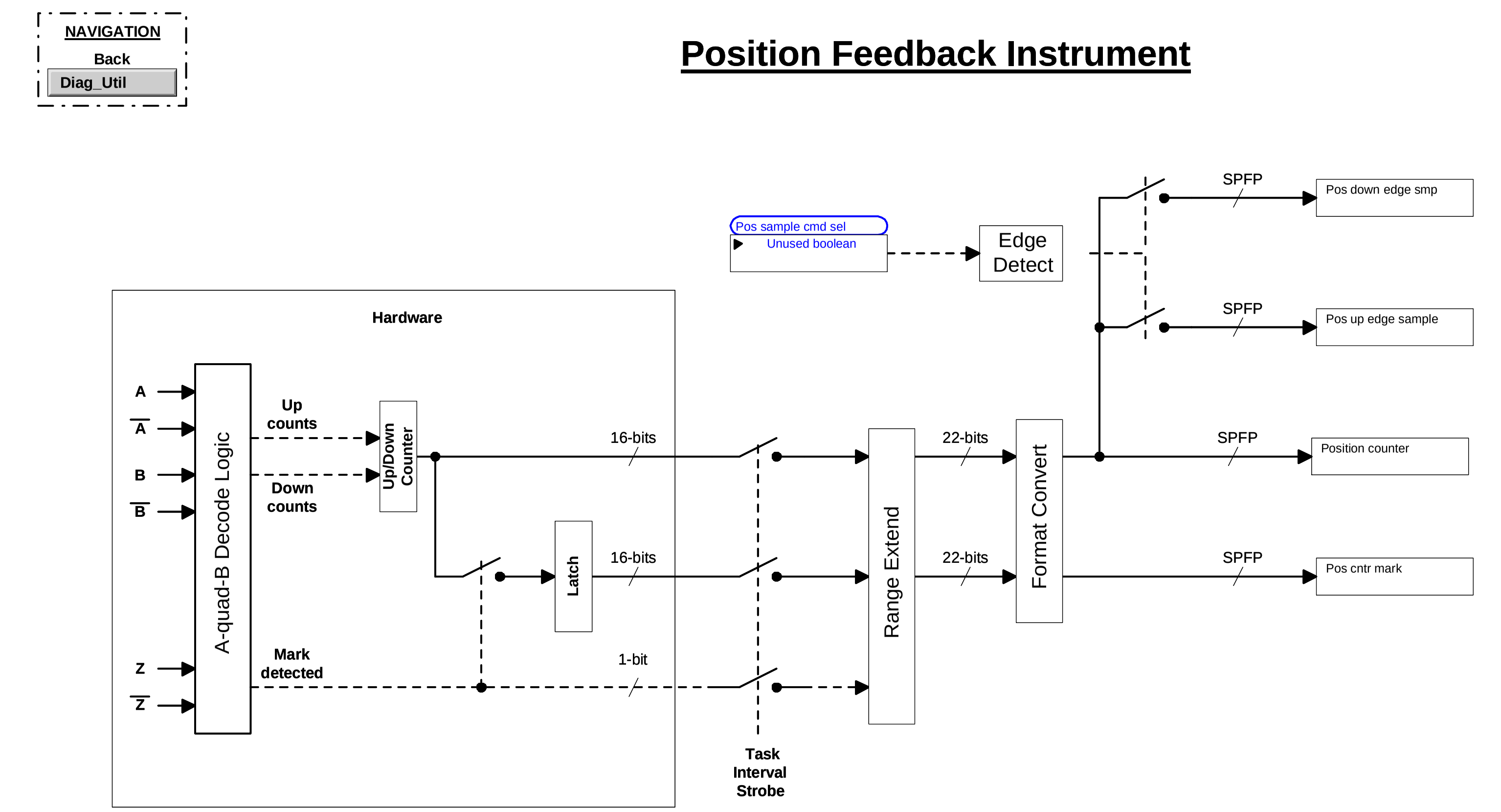
Position Feedback Instrument



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Reader Comments

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