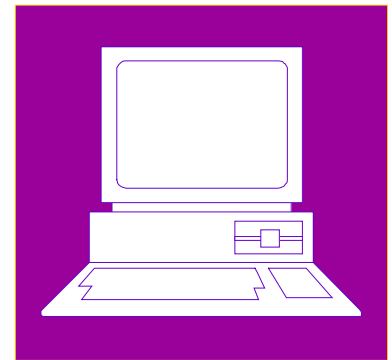
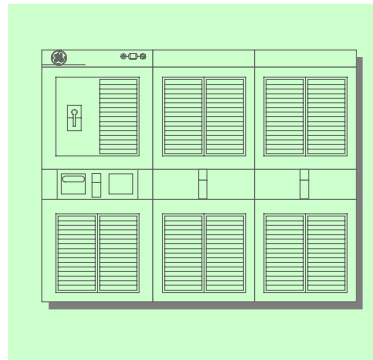
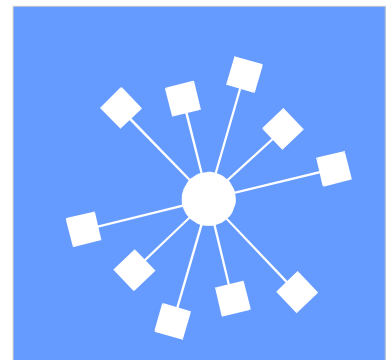




GEH-6393

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Innovation Series



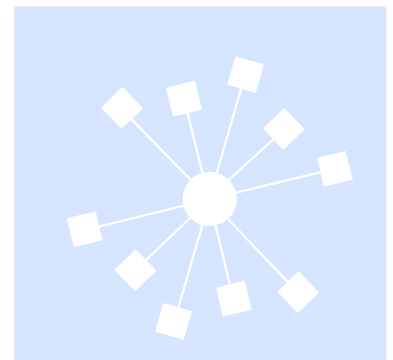
# Innovation Series™

Low Voltage Drives – ACDCFG

Reference and Troubleshooting



**Publication:** GEH-6393  
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# **Innovation Series™**

**Low Voltage Drives – ACDCF-G**

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**Reference and Troubleshooting**

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# Chapter 1 Faults

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## Introduction

The drive software includes selftest diagnostics to aid in troubleshooting. When these tests detect an unfavorable condition, they output fault indications to a display. An operator can then examine the fault and clear it.

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

| <b>Section</b>          | <b>Page</b> |
|-------------------------|-------------|
| Types of Faults.....    | 1           |
| Fault Indication .....  | 2           |
| Fault Descriptions..... | 2           |

**When troubleshooting leads to a hardware inspection or component replacement, be sure to follow the procedures described in the drive User's Guide, GEH-6392.**

---

|                                                                                     |                                                                                                                                                                                                                         |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <p><b>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.</b></p> |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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## Types of Faults

There are currently two types of fault conditions:

- **Trip faults** indicate a serious condition that needs to be corrected. It trips the drive. The condition needs to be corrected before the drive is restarted.
- **Alarm faults** indicate a condition that should be noted, but that is not serious enough to shut down or trip the drive. Some alarm faults clear themselves if the condition goes away on its own. Otherwise, the drive must be stopped and an operator must clear this type of fault.

Most faults can be cleared by selecting *Clear Faults* on the keypad or in the control system toolbox. Listed below are the faults that require either a reboot of the DSPX or a Hard Reset from the control system toolbox to clear them:

| <b>No.</b> | <b>Display Description</b> | <b>Type</b> |
|------------|----------------------------|-------------|
| 9*         | EE flash corrupted         | Trip        |
| 11*        | EE erase failed            | Alarm       |
| 106*       | Ckt board list fail        | Trip        |
| 144*       | Unrecognized IPN           | Trip        |
| 152*       | Invalid time base          | Trip        |
| 157*       | Bic watchdog               | Trip        |

## Fault Indication

When a fault condition occurs, the drive displays an indicator on the two operator interfaces: the local keypad and a connected PC running the control system toolbox.

On the keypad, a fault symbol  displays in the right side of the screen:

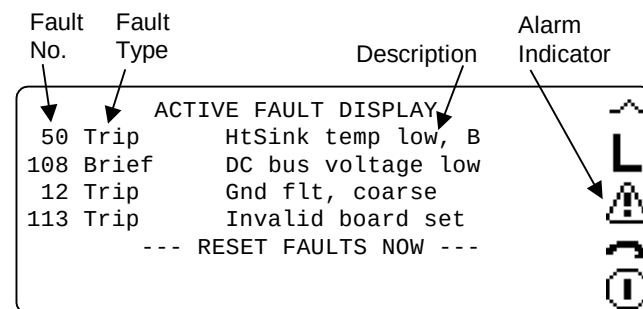
- A steady (not flashing) symbol indicates an alarm.
- A flashing symbol indicates a fault.

The operator can then use the keypad to access the fault/alarm description and to clear the fault.

The **Control System Toolbox** (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.)

## Fault Descriptions

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 or the toolbox. The following figure shows a sample keypad display:



Example of Fault Display Screen on Keypad

The following table lists the drive faults and their probable cause:

#### *Fault Code Descriptions*

| No. | Name                        | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----|-----------------------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2   | <i>Illegal seq state</i>    | Trip  | The <i>Illegal seq state</i> trip fault occurs when the sequencer state (variable <i>Sequencer state</i> ) is unrecognized. This trip may occur during system development but should not occur in the field.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 3   | <i>Cont failed to close</i> | Trip  | <p>The <i>Cont failed to close</i> trip fault occurs when contactor A is commanded to open or close and fails to do so within the allowed time (defined by parameter <i>MA pickup time</i>).</p> <p><b>Primary causes:</b><br/>The contactor A feedback is missing or bad.</p> <p><b>Possible configuration faults:</b><br/>The allowed time for contactor A to open and close is too short. The allowed time is represented by parameter <i>MA pickup time</i>.<br/>Contactor A feedback is enabled when no contactor is present in the system. In the absence of the contactor, parameter <i>MA contactor fbk</i> should be set equal to Disable.</p> <p><b>Related functions:</b><br/><i>Main Contactor Configuration</i></p> |
| 4   | <i>Local flt</i>            | Trip  | <p>The <i>Local flt</i> trip fault occurs when the local permissive circuit is open and a <i>Run request</i>, <i>Jog request</i>, <i>Full flux request</i>, or diagnostic test (cell test, pulse test, autotune) request is issued.</p> <p><b>Possible wiring faults:</b><br/>The connections to ATBA terminal board locations 8 (L115), 10 (L24), and 12 (LCOM) are missing or damaged.<br/>The connection to backplane connector J2 is missing or damaged.</p>                                                                                                                                                                                                                                                                 |
| 6   | <i>Run cmd during init</i>  | Alarm | <p>The <i>Run cmd during init</i> alarm occurs when a <i>Run request</i>, <i>Jog request</i>, <i>Full flux request</i>, 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.</p> <p><b>Primary causes:</b><br/>The external application layer issues a request to perform a drive action during drive initialization.<br/>An external input (such as digital input) used to request a drive action was high during drive initialization.</p>                                                                                                                                                             |
| 7   | <i>Over speed</i>           | Trip  | <p>The <i>Over speed</i> trip fault occurs when the magnitude of speed (variable <i>Speed reg fbk</i>) is greater than the over speed threshold (parameter <i>Over speed flt level</i>).</p> <p><b>Primary causes:</b><br/>Motor speed is too high.</p> <p><b>Possible configuration faults:</b><br/>Parameter <i>Over speed flt level</i> is set too low.</p> <p><b>Related functions:</b><br/><i>Speed Control Fault Check</i></p>                                                                                                                                                                                                                                                                                             |
| 8   | <i>Timed over current</i>   | Trip  | The <i>Timed over current</i> trip fault occurs when one of the squared phase currents (variables <i>Ia^2 filtered</i> , <i>Ib^2 filtered</i> , and <i>Ic^2 filtered</i> ) 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.                                                                                                                                                                                                                                                                                                                                                                                         |

## Fault Code Descriptions

| No. | Name                       | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----|----------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 9   | <i>EE flash corrupted</i>  | Trip  | <p>The <i>EE flash corrupted</i> trip fault occurs when the memory containing the drive parameters is determined to be bad during drive initialization. <i>EE flash corrupted</i> requires a hard reset to clear.</p> <p><b>Possible board failures:</b><br/>DSPX</p>                                                                                                                                                                                                                                                                                                                                                                    |
| 10  | <i>Run cmd w high flux</i> | Alarm | <p>The <i>Run cmd w high flux</i> alarm occurs when a <i>Run request</i>, <i>Jog request</i>, <i>Full flux request</i>, or diagnostic test (cell test, pulse test, autotune) request is issued and the variable <i>Flux reference</i> is greater than 2 percent rated flux (100% <i>Flux</i>).</p> <p><b>Primary causes:</b><br/>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.</p> <p><b>Related functions:</b><br/><i>Sequencer Permissives</i></p>                                                                        |
| 11  | <i>EE erase failed</i>     | Alarm | <p>The <i>EE erase failed</i> 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. <i>EE erase failed</i> requires a hard reset to clear.</p> <p><b>Possible board failures:</b><br/>DSPX</p>                                                                                                                                                                                                                                         |
| 12  | <i>Gnd flt, coarse</i>     | Trip  | <p>The <i>Gnd flt, coarse</i> 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.</p> <p><b>Possible board failures:</b><br/>SHCA<br/>BPIB/BPIA<br/>HFPA (FU4)<br/>DSPX</p> <p><b>Possible wiring faults:</b><br/>Connection between BPIA/BPIB and SHCA.</p>                                                                                                                                                                                                                                                                        |
| 13  | <i>Gnd flt, filtered</i>   | Trip  | <p>The <i>Gnd flt, filtered</i> trip fault occurs when a large ground current is detected. The trip fault occurs when the discriminated ground current (variable <i>Ground current</i>) is greater than the ground current trip fault threshold (parameter <i>Gnd flt trip level</i>).</p> <p><b>Possible configuration faults:</b><br/>The value of the ground current trip fault threshold, represented by parameter <i>Gnd flt trip level</i>, is too low.</p> <p><b>Possible board failures:</b><br/>SHCA<br/>BPIB/BPIA<br/>HFPA (FU4)<br/>DSPX</p> <p><b>Possible wiring faults:</b><br/>Connection between BPIA/BPIB and SHCA.</p> |

## Fault Code Descriptions

| No. | Name                        | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-----|-----------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14  | <i>Gnd flt alarm</i>        | Alarm | <p>The <i>Gnd flt alarm</i> alarm occurs when a large ground current is detected. The fault occurs when the discriminated ground current (variable <i>Ground current</i>) is greater than the ground current alarm level (parameter <i>Gnd flt alm level</i>). The alarm clears when the discriminated ground current drops below the ground current alarm turn off level (parameter <i>Gnd flt alm clr lvl</i>).</p> <p><b>Possible configuration faults:</b><br/>The value of the ground current alarm level, represented by parameter <i>Gnd flt alm level</i>, is too low.</p> <p><b>Possible board failures:</b><br/>SHCA<br/>BPIB/BPIA<br/>HFPA (FU4)<br/>DSPX</p> <p><b>Possible wiring faults:</b><br/>Connection between BPIA/BPIB and SHCA.</p> |
| 18  | <i>Tune up failed</i>       | Trip  | <p>The <i>Tune up failed</i> trip fault occurs when an attempt to run the motor control tune up or the speed regulator tune up fails.</p> <p><b>Primary causes:</b><br/>The external application layer issues an inappropriate motor control tune up request or speed regulator tune up request.<br/>An attempt by the motor control tune up or the speed regulator tune up to initialize the diagnostic message stack fails.</p>                                                                                                                                                                                                                                                                                                                         |
| 20  | <i>TOC pending</i>          | Alarm | <p>The <i>TOC pending</i> alarm occurs when one of the squared phase currents (variables <i>Ia^2 filtered</i>, <i>Ib^2 filtered</i>, and <i>Ic^2 filtered</i>) in the timed over current detection model exceeds the timed over current alarm level.<br/>This alarm indicates that the motor is nearing its thermal limit.</p>                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 21  | <i>System flt</i>           | Trip  | <p>The <i>System flt</i> trip fault occurs when the system permissive circuit is open and a <i>Run request</i>, <i>Jog request</i>, <i>Full flux request</i>, or diagnostic test (cell test, pulse test, autotune) request is issued.</p> <p><b>Possible wiring faults:</b><br/>The connections to ATBA terminal board locations 2 (S115), 4 (S24), and 6 (SCOM) are missing or damaged..</p>                                                                                                                                                                                                                                                                                                                                                             |
| 22  | <i>Run before MA closed</i> | Trip  | <p>The <i>Run before MA closed</i> trip fault occurs when a <i>Run request</i>, <i>Jog request</i>, or <i>Full flux request</i> is issued to the motor control sequencer before contactor A is closed.</p> <p><b>Related functions:</b><br/><i>Sequencer Permissives</i><br/><i>Main Contactor Configuration</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 23  | <i>Flying restrt disabl</i> | Trip  | <p>The <i>Flying restrt disabl</i> trip fault occurs when a <i>Run request</i>, <i>Jog request</i>, <i>Full flux request</i>, or diagnostic test (cell test, pulse test, autotune) request is issued when the motor is not at zero speed.<br/><i>Flying restrt disabl</i> 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 <i>Flying restart</i> equal to <i>Enable fly restart</i>.</p> <p><b>Related functions:</b><br/><i>Sequencer Permissives</i></p>                                                                                                                                                           |

### Fault Code Descriptions

| No. | Name                     | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----|--------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 24  | <i>Power dip</i>         | Trip  | <p>The <i>Power dip</i> trip fault occurs when the DC link voltage feedback (variable <i>DC bus voltage</i>) falls below the power dip level and remains below the power dip level longer than the power dip time.</p> <p>The power dip level is a scaled version of the drive output line-line voltage (parameter <i>Max lineup output</i>).</p> <p>The power dip time is configurable through parameter <i>Power dip control</i>.</p> <p>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, <i>Power dip</i> occurs.</p> <p><b>Possible configuration faults:</b></p> <p>The drive output line-line voltage is specified incorrectly. The output voltage is represented by parameter <i>Max lineup output</i>.</p> <p>Power dip functionality is disabled because parameter <i>Power dip control</i> is set incorrectly. To enable power dip functionality parameter <i>Power dip control</i> should be set equal to 1.0 sec (<i>Enable</i>).</p> <p><b>Related functions:</b></p> <p><i>Power Dip Protection</i></p> |
| 25  | <i>Cur reg in limit</i>  | Alarm | <p>The <i>Cur reg in limit</i> 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.</p> <p><b>Primary causes:</b></p> <p>The tachometer feedback is bad.</p> <p>Large motor parameters errors.</p> <p>Motor inverter connection opens while running.</p> <p>Power dip.</p> <p>Loss of current feedback.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 26  | <i>Volt reg in limit</i> | Alarm | <p>The <i>Volt reg in limit</i> 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.</p> <p><b>Primary causes:</b></p> <p>Motor inverter connection opens while running.</p> <p>Power dip.</p> <p>Loss of voltage feedback.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 28  | <i>R1 meas in limit</i>  | Alarm | <p>The <i>R1 meas in limit</i> 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.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 29  | <i>R2 meas in limit</i>  | Alarm | <p>The <i>R2 meas in limit</i> 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.</p> <p><b>Primary causes:</b></p> <p>The rotor resistance calculation is incorrect due a large error in motor parameters.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## Fault Code Descriptions

| No. | Name                   | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----|------------------------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30  | <i>Tach loss trip</i>  | Trip  | <p>The <i>Tach loss trip</i> fault occurs when the difference between the tachometer feedback (variable <i>Motor speed</i>) and the estimated speed (variable <i>Calculated speed</i>) is too large.</p> <p>The trip fault can be disabled by setting parameter <i>Tach loss fault mode</i> equal to Trip.</p> <p><b>Primary causes:</b><br/> The tachometer feedback is bad.<br/> The estimated speed is incorrect due to large errors in motor parameters.</p> <p><b>Related functions:</b><br/> <i>Tach Loss Detection</i></p>                                                                                                                                                                |
| 31  | <i>Tach loss alarm</i> | Alarm | <p>The <i>Tach loss alarm</i> occurs when the difference between the tachometer feedback (variable <i>Motor speed</i>) and the estimated speed (variable <i>Calculated speed</i>) is too large.</p> <p>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.</p> <p><i>Tach loss fault mode</i> can be used to change the fault behavior to trip if required.</p> <p><b>Primary causes:</b><br/> The tachometer feedback is bad.<br/> The estimated speed is incorrect due to large errors in motor parameters.</p> <p><b>Related functions:</b><br/> <i>Tach Loss Detection</i></p> |
| 32  | <i>IOC phase A</i>     | Trip  | <p>The <i>IOC phase A</i> 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.</p> <p><b>Possible board failures:</b><br/> SHCA<br/> BPIA/BPIB<br/> BICL<br/> HFPA (FU4)</p> <p><b>Possible wiring faults:</b><br/> Connections between BPIA/BPIB and SHCA.</p>                                                  |
| 33  | <i>IOC phase B</i>     | Trip  | <p>The <i>IOC phase B</i> 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.</p> <p><b>Possible board failures:</b><br/> SHCA<br/> BPIA/BPIB<br/> BICL<br/> HFPA (FU4)</p> <p><b>Possible wiring faults:</b><br/> Connections between BPIA/BPIB and SHCA.</p>                                                  |

### Fault Code Descriptions

| No. | Name                 | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----|----------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 34  | <i>IOC phase C</i>   | Trip | <p>The <i>IOC phase C</i> 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.</p> <p><b>Possible board failures:</b><br/>           SHCA<br/>           BPIA/BPIB<br/>           BICL<br/>           HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/>           Connections between BPIA/BPIB and SHCA.</p>                                                                                                                                                                                                                              |
| 35  | <i>IGBT AU desat</i> | Trip | <p>The <i>IGBT AU desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the phase A upper IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V. Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the phase A upper IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/>           The phase A lower IGBT is short circuited.<br/>           The phase A upper IGBT is defective.</p> <p><b>Possible board failures:</b><br/>           DAMA<br/>           BPIA<br/>           BICL<br/>           HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/>           The connections between BPIA and DAMA are missing or damaged.</p> |
| 36  | <i>IGBT AL desat</i> | Trip | <p>The <i>IGBT AL desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the phase A lower IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V. Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the phase A lower IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/>           The phase A upper IGBT is short circuited.<br/>           The phase A lower IGBT is defective.</p> <p><b>Possible board failures:</b><br/>           DAMA<br/>           BPIA<br/>           BICL<br/>           HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/>           The connections between BPIA and DAMA are missing or damaged.</p> |

## Fault Code Descriptions

| No. | Name                 | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----|----------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 37  | <i>IGBT BU desat</i> | Trip | <p>The <i>IGBT BU desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the phase B upper IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V. Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the phase B upper IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The phase B lower IGBT is short circuited.<br/> The phase B upper IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIA<br/> BICL<br/> HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIA and DAMA are missing or damaged.</p> |
| 38  | <i>IGBT BL desat</i> | Trip | <p>The <i>IGBT BL desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the phase B lower IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V. Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the phase B lower IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The phase B upper IGBT is short circuited.<br/> The phase B lower IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIA<br/> BICL<br/> HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIA and DAMA are missing or damaged.</p> |
| 39  | <i>IGBT CU desat</i> | Trip | <p>The <i>IGBT CU desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the phase C upper IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V. Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the phase C upper IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The phase B lower IGBT is short circuited.<br/> The phase B upper IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIA<br/> BICL<br/> HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIA and DAMA are missing or damaged.</p> |

## Fault Code Descriptions

| No. | Name                        | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----|-----------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 40  | <i>IGBT CL desat</i>        | Trip | <p>The <i>IGBT CL desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the phase C lower IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V. Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the phase C lower IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The phase B upper IGBT is short circuited.<br/> The phase B lower IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIA<br/> BICL<br/> HFPA (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIA and DAMA are missing or damaged.</p> |
| 41  | <i>DC bus over voltage</i>  | Trip | <p>The <i>DC bus over voltage</i> trip fault occurs when the DC link voltage feedback (variable <i>DC bus voltage</i>) is too large. The over voltage threshold level is a scaled version of the drive output line-line voltage (parameter <i>Max lineup output</i>).</p> <p>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.</p> <p><b>Possible configuration faults:</b><br/> The drive output line-line voltage is specified incorrectly. The output voltage is represented by parameter <i>Max lineup output</i>.</p> <p><b>Possible board failures:</b><br/> BPIA/BPIB<br/> HFPA (FU4)<br/> DSPX</p>                                                                                                     |
| 42  | <i>DC bus under voltage</i> | Trip | <p>The <i>DC bus under voltage</i> trip fault occurs when the DC link voltage feedback (variable <i>DC bus voltage</i>) is too low. The under voltage threshold level is a scaled version of the drive output line-line voltage (parameter <i>Max lineup output</i>).</p> <p>The trip fault only occurs when the drive is running.</p> <p><b>Possible configuration faults:</b><br/> The drive output line-line voltage is specified incorrectly. The output voltage is represented by parameter <i>Max lineup output</i>.</p> <p><b>Possible board failures:</b><br/> BPIA/BPIB<br/> HFPA (FU4)<br/> DSPX</p>                                                                                                                                                                                                                                           |
| 45  | <i>Motor reac parms bad</i> | Trip | <p>The <i>Motor reac parms bad</i> trip fault occurs when the primary motor reactance parameters have values that are not appropriate relative to one another.</p> <p><b>Primary causes:</b><br/> Internal calculations are performed using <i>Starting react Xst</i>, <i>Magnetizing react Xm</i>, <i>Stator lkg react X1</i>, and <i>Rotor lkg react X2</i>. The relationship between these parameters should be: <math>(\text{Rotor lkg react } X2 \parallel \text{Magnetizing react } X_m) + \text{Stator lkg react } X1 &gt; \text{Starting react } Xst</math>.<br/> This should be corrected before attempting to run the drive.</p>                                                                                                                                                                                                               |

## Fault Code Descriptions

| No. | Name                            | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----|---------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 46  | <i>X stop</i>                   | Trip | <p>The <i>X stop</i> 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 <i>X stop mode</i> is set equal to <i>Trip flt stop</i>. Any other setting for parameter <i>X stop mode</i> disables the X stop trip fault.</p> <p>The state of the X stop circuit is determined by the value of the variable to which parameter <i>X stop request sel</i> points. The X stop trip fault can be disabled, along with all other X stop behavior, by setting parameter <i>X stop request sel</i> equal to Unused.</p> <p><b>Related functions:</b><br/> <i>Stopping Commands and Modes</i></p> |
| 47  | <i>Run req &amp; xstop open</i> | Trip | <p>The <i>Run req &amp; xstop open</i> trip fault occurs when the X stop circuit is open, the drive is stopped, and one of the following requests is issued: <i>Run request</i>, <i>Jog request</i>, or <i>Full flux request</i>.</p> <p>The state of the X stop circuit is determined by the value of the variable to which parameter <i>X stop request sel</i> points. The trip fault can be disabled, along with all other X stop behavior, by setting parameter <i>X stop request sel</i> equal to Unused.</p> <p><b>Related functions:</b><br/> <i>Sequencer Permissives</i><br/> <i>Stopping Commands and Modes</i></p>                                                          |
| 48  | <i>HtSink temp low</i>          | Trip | <p>The <i>HtSink temp low</i> trip fault occurs when the heatsink temperature (variable <i>Heat sink temp</i>) is too low.</p> <p>The main purpose of the trip fault is to detect the absence of the heatsink thermal sensor input.</p> <p><b>Primary causes:</b><br/> The heatsink thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/> BICL</p> <p><b>Possible wiring faults:</b><br/> The thermal sensor input to backplane connector J4 pins 1 and 2 is missing or damaged.</p>                                                                                                                                                                        |
| 49  | <i>HtSink temp low, A</i>       | Trip | <p>The <i>HtSink temp low, A</i> trip fault occurs when the heatsink A temperature (variable <i>Heat sink temp, A</i>) is too low.</p> <p>The main purpose of the trip fault is to detect the absence of the heatsink A thermal sensor input.</p> <p><b>Primary causes:</b><br/> The heatsink A thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/> BICL</p> <p><b>Possible wiring faults:</b><br/> The thermal sensor input to backplane connector J4 pins 1 and 2 is missing or damaged.</p>                                                                                                                                                            |

## Fault Code Descriptions

| No. | Name                      | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----|---------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 50  | <i>HtSink temp low, B</i> | Trip | <p>The <i>HtSink temp low, B</i> trip fault occurs when the heatsink B temperature (variable <i>Heat sink temp, B</i>) is too low.<br/>The main purpose of the trip fault is to detect the absence of the heatsink B thermal sensor input.</p> <p><b>Primary causes:</b><br/>The heatsink B thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 3 and 4 is missing or damaged.</p>                    |
| 51  | <i>HtSink A temp low</i>  | Trip | <p>The <i>HtSink A temp low</i> trip fault occurs when the phase A heatsink temperature (variable <i>Phase A HtSink temp</i>) is too low.<br/>The main purpose of the trip fault is to detect the absence of the phase A heatsink thermal sensor input.</p> <p><b>Primary causes:</b><br/>The phase A heatsink thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is missing or damaged.</p> |
| 52  | <i>HtSink B temp low</i>  | Trip | <p>The <i>HtSink B temp low</i> trip fault occurs when the phase B heatsink temperature (variable <i>Phase B HtSink temp</i>) is too low.<br/>The main purpose of the trip fault is to detect the absence of the phase B heatsink thermal sensor input.</p> <p><b>Primary causes:</b><br/>The phase B heatsink thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 3 and 4 is missing or damaged.</p> |
| 53  | <i>HtSink C temp low</i>  | Trip | <p>The <i>HtSink C temp low</i> trip fault occurs when the phase C heatsink temperature (variable <i>Phase C HtSink temp</i>) is too low.<br/>The main purpose of the trip fault is to detect the absence of the phase C heatsink thermal sensor input.</p> <p><b>Primary causes:</b><br/>The phase C heatsink thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 5 and 6 is missing or damaged.</p> |

## Fault Code Descriptions

| No. | Name                     | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----|--------------------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 54  | <i>Ambient temp low</i>  | Trip  | <p>The <i>Ambient temp low</i> trip fault occurs when the ambient temperature (variable <i>Ambient temp</i>) is too low.<br/>The main purpose of the trip fault is to detect the absence of the ambient thermal sensor input.</p> <p><b>Primary causes:</b><br/>The ambient thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 7 and 8 is missing or damaged.</p>                                                          |
| 55  | <i>HtSink B miswired</i> | Trip  | <p>The <i>HtSink B miswired</i> trip fault occurs when the phase B heatsink temperature (variable <i>Phase B HtSink temp</i>) is high enough to indicate the presence of a thermal sensor input, and the phase B thermal sensor input is expected to be absent.</p> <p><b>Primary causes:</b><br/>The phase B heatsink thermal sensor input is present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 3 and 4 is present or the connector is damaged.</p>  |
| 56  | <i>HtSink C miswired</i> | Trip  | <p>The <i>HtSink C miswired</i> trip fault occurs when the phase C heatsink temperature (variable <i>Phase C HtSink temp</i>) is high enough to indicate the presence of a thermal sensor input, and the phase C thermal sensor input is expected to be absent.</p> <p><b>Primary causes:</b><br/>The phase C heatsink thermal sensor input is present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 5 and 6 is present or the connector is damaged.</p>  |
| 57  | <i>HtSink sensor bad</i> | Alarm | <p>The <i>HtSink sensor bad</i> alarm occurs when the heatsink temperature (variable <i>Heat sink temp</i>) is too far below the ambient temperature (variable <i>Ambient temp</i>).<br/>The main purpose of the alarm is to detect the absence of the heatsink thermal sensor input.</p> <p><b>Primary causes:</b><br/>The heatsink thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is missing or damaged.</p> |

### Fault Code Descriptions

| No. | Name                       | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----|----------------------------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 58  | <i>HtSink sensor A bad</i> | Alarm | <p>The <i>HtSink sensor A bad</i> alarm occurs when the heatsink A temperature (variable <i>Heat sink temp, A</i>) is too far below the ambient temperature (variable <i>Ambient temp</i>).</p> <p>The main purpose of the alarm is to detect the absence of the heatsink A thermal sensor input.</p> <p><b>Primary causes:</b><br/>The heatsink A thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is missing or damaged.</p>                     |
| 59  | <i>HtSink sensor B bad</i> | Alarm | <p>The <i>HtSink sensor B bad</i> alarm occurs when the heatsink B temperature (variable <i>Heat sink temp, B</i>) is too far below the ambient temperature (variable <i>Ambient temp</i>).</p> <p>The main purpose of the alarm is to detect the absence of the heatsink B thermal sensor input.</p> <p><b>Primary causes:</b><br/>The heatsink B thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 3 and 4 is missing or damaged.</p>                     |
| 60  | <i>HtSink A sensor bad</i> | Alarm | <p>The <i>HtSink A sensor bad</i> alarm occurs when the phase A heatsink temperature (variable <i>Phase A HtSink temp</i>) is too far below the ambient temperature (variable <i>Ambient temp</i>).</p> <p>The main purpose of the alarm is to detect the absence of the phase A heatsink thermal sensor input.</p> <p><b>Primary causes:</b><br/>The phase A heatsink thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is missing or damaged.</p> |
| 61  | <i>HtSink B sensor bad</i> | Alarm | <p>The <i>HtSink B sensor bad</i> alarm occurs when the phase B heatsink temperature (variable <i>Phase B HtSink temp</i>) is too far below the ambient temperature (variable <i>Ambient temp</i>).</p> <p>The main purpose of the alarm is to detect the absence of the phase B heatsink thermal sensor input.</p> <p><b>Primary causes:</b><br/>The phase B heatsink thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 3 and 4 is missing or damaged.</p> |

### Fault Code Descriptions

| No. | Name                       | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-----|----------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 62  | <i>HtSink C sensor bad</i> | Alarm | <p>The <i>HtSink C sensor bad</i> alarm occurs when the phase C heatsink temperature (variable <i>Phase C HtSink temp</i>) is too far below the ambient temperature (variable <i>Ambient temp</i>).</p> <p>The main purpose of the alarm is to detect the absence of the phase C heatsink thermal sensor input.</p> <p><b>Primary causes:</b><br/>The phase C heatsink thermal sensor input is not present.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 5 and 6 is missing or damaged.</p>                             |
| 63  | <i>HtSink over temp</i>    | Trip  | <p>The <i>HtSink over temp</i> trip fault occurs when the heatsink temperature (variable <i>Heat sink temp</i>) is too hot.</p> <p>The main purpose of the trip fault is to use the heatsink temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the heatsink temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is damaged.</p>             |
| 64  | <i>HtSink over temp, A</i> | Trip  | <p>The <i>HtSink over temp, A</i> trip fault occurs when the heatsink A temperature (variable <i>Heat sink temp, A</i>) is too hot.</p> <p>The main purpose of the trip fault is to use the heatsink A temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the heatsink A temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is damaged.</p> |
| 65  | <i>HtSink over temp, B</i> | Trip  | <p>The <i>HtSink over temp, B</i> trip fault occurs when the heatsink B temperature (variable <i>Heat sink temp, B</i>) is too hot.</p> <p>The main purpose of the trip fault is to use the heatsink B temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the heatsink B temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 3 and 4 is damaged.</p> |

## Fault Code Descriptions

| No. | Name                      | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----|---------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 66  | <i>HtSink A over temp</i> | Trip  | <p>The <i>HtSink A over temp</i> trip fault occurs when the phase A heatsink temperature (variable <i>Phase A HtSink temp</i>) is too hot. The main purpose of the trip fault is to use the phase A heatsink temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase A heatsink temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is damaged.</p> |
| 67  | <i>HtSink B over temp</i> | Trip  | <p>The <i>HtSink B over temp</i> trip fault occurs when the phase B heatsink temperature (variable <i>Phase B HtSink temp</i>) is too hot. The main purpose of the trip fault is to use the phase B heatsink temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase B heatsink temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 3 and 4 is damaged.</p> |
| 68  | <i>HtSink C over temp</i> | Trip  | <p>The <i>HtSink C over temp</i> trip fault occurs when the phase C heatsink temperature (variable <i>Phase C HtSink temp</i>) is too hot. The main purpose of the trip fault is to use the phase C heatsink temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase C heatsink temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 5 and 6 is damaged.</p> |
| 69  | <i>HtSink temp hot</i>    | Alarm | <p>The <i>HtSink temp hot</i> alarm occurs when the heatsink temperature (variable <i>Heat sink temp</i>) is too hot. The main purpose of the alarm is to use the heatsink temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the heatsink temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is damaged.</p>                                           |

## Fault Code Descriptions

| No. | Name                      | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----|---------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 70  | <i>HtSink temp hot, A</i> | Alarm | <p>The <i>HtSink temp hot, A</i> alarm occurs when the heatsink A temperature (variable <i>Heat sink temp, A</i>) is too hot.<br/>The main purpose of the alarm is to use the heatsink A temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the heatsink A temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is damaged.</p>                    |
| 71  | <i>Htsink temp hot, B</i> | Alarm | <p>The <i>Htsink temp hot, B</i> alarm occurs when the heatsink B temperature (variable <i>Heat sink temp, B</i>) is too hot.<br/>The main purpose of the alarm is to use the heatsink B temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the heatsink B temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 3 and 4 is damaged.</p>                    |
| 72  | <i>HtSink A temp hot</i>  | Alarm | <p>The <i>HtSink A temp hot</i> alarm occurs when the phase A heatsink temperature (variable <i>Phase A HtSink temp</i>) is too hot.<br/>The main purpose of the alarm is to use the phase A heatsink temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase A heatsink temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is damaged.</p> |
| 73  | <i>HtSink B temp hot</i>  | Alarm | <p>The <i>HtSink B temp hot</i> alarm occurs when the phase B heatsink temperature (variable <i>Phase B HtSink temp</i>) is too hot.<br/>The main purpose of the alarm is to use the phase B heatsink temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase B heatsink temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 3 and 4 is damaged.</p> |

### Fault Code Descriptions

| No. | Name                       | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----|----------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 74  | <i>HtSink C temp hot</i>   | Alarm | <p>The <i>HtSink C temp hot</i> alarm occurs when the phase C heatsink temperature (variable <i>Phase C HtSink temp</i>) is too hot.</p> <p>The main purpose of the alarm is to use the phase C heatsink temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase C heatsink temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 5 and 6 is damaged.</p>                                                                                                                                                    |
| 75  | <i>HtSink rise high</i>    | Alarm | <p>The <i>HtSink rise high</i> alarm occurs when the heatsink temperature (variable <i>Heat sink temp</i>) is too far above the ambient temperature (variable <i>Ambient temp</i>).</p> <p>The main purpose of the alarm is to use the heatsink and ambient temperature measurements to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the heatsink temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is damaged.<br/>The thermal sensor input to backplane connector J4 pins 7 and 8 is missing or damaged.</p>             |
| 76  | <i>HtSink rise high, A</i> | Alarm | <p>The <i>HtSink rise high, A</i> alarm occurs when the heatsink A temperature (variable <i>Heat sink temp, A</i>) is too far above the ambient temperature (variable <i>Ambient temp</i>).</p> <p>The main purpose of the alarm is to use the heatsink A and ambient temperature measurements to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the heatsink A temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is damaged.<br/>The thermal sensor input to backplane connector J4 pins 7 and 8 is missing or damaged.</p> |

## Fault Code Descriptions

| No. | Name                       | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----|----------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 77  | <i>HtSink rise high, B</i> | Alarm | <p>The <i>HtSink rise high, B</i> alarm occurs when the heatsink B temperature (variable <i>Heat sink temp, B</i>) is too far above the ambient temperature (variable <i>Ambient temp</i>).</p> <p>The main purpose of the alarm is to use the heatsink B and ambient temperature measurements to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the heatsink B temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 3 and 4 is damaged.<br/>The thermal sensor input to backplane connector J4 pins 7 and 8 is missing or damaged.</p>                    |
| 78  | <i>HtSink A rise high</i>  | Alarm | <p>The <i>HtSink A rise high</i> alarm occurs when the phase A heatsink temperature (variable <i>Phase A HtSink temp</i>) is too far above the ambient temperature (variable <i>Ambient temp</i>).</p> <p>The main purpose of the alarm is to use the phase A heatsink and ambient temperature measurements to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase A heatsink temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is damaged.<br/>The thermal sensor input to backplane connector J4 pins 7 and 8 is missing or damaged.</p> |
| 79  | <i>HtSink B rise high</i>  | Alarm | <p>The <i>HtSink B rise high</i> alarm occurs when the phase B heatsink temperature (variable <i>Phase B HtSink temp</i>) is too far above the ambient temperature (variable <i>Ambient temp</i>).</p> <p>The main purpose of the alarm is to use the phase B heatsink and ambient temperature measurements to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase B heatsink temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 3 and 4 is damaged.<br/>The thermal sensor input to backplane connector J4 pins 7 and 8 is missing or damaged.</p> |

## Fault Code Descriptions

| No. | Name                        | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-----|-----------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 80  | <i>HtSink C rise high</i>   | Alarm | <p>The <i>HtSink C rise high</i> alarm occurs when the phase C heatsink temperature (variable <i>Phase C HtSink temp</i>) is too far above the ambient temperature (variable <i>Ambient temp</i>).</p> <p>The main purpose of the alarm is to use the phase C heatsink and ambient temperature measurements to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase C heatsink temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 5 and 6 is damaged.<br/>The thermal sensor input to backplane connector J4 pins 7 and 8 is missing or damaged.</p>                                                                                                                                                                        |
| 81  | <i>HtSink temp imbalanc</i> | Alarm | <p>The <i>HtSink temp imbalanc</i> alarm occurs when the difference between two of the heatsink temperatures is too large. In the 250, 375, and 620 frame sizes the heatsink temperatures are contained in variables <i>Heat sink temp, A</i> and <i>Heat sink temp, B</i>. In the 1000 and 1800 frame sizes the heatsink temperatures are contained in variables <i>Phase A HtSink temp</i>, <i>Phase B HtSink temp</i>, and <i>Phase C HtSink temp</i>.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the heatsink temperatures to differ by a large amount.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 1 and 2 is missing or damaged.<br/>The thermal sensor input to backplane connector J4 pins 3 and 4 is missing or damaged.<br/>The thermal sensor input to backplane connector J4 pins 5 and 6 is missing or damaged.</p> |
| 82  | <i>HtSink conf invalid</i>  | Trip  | <p>The <i>HtSink conf invalid</i> trip fault occurs when the specified power bridge heatsink configuration is invalid.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 83  | <i>Run permissive lost</i>  | Alarm | <p>The <i>Run permissive lost</i> 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 <i>Run permissive sel</i> points. The alarm can be disabled by setting parameter <i>Run permissive sel</i> equal to <i>Unused</i>.</p> <p><b>Related functions:</b><br/><i>Sequencer Permissives</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| 84  | <i>Cont req while flt</i>   | Alarm | <p>The <i>Cont req while flt</i> alarm occurs when contactor A is commanded to close and a trip fault is present in the drive.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 85  | <i>Flux req while flt</i>   | Alarm | <p>The <i>Flux req while flt</i> 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.</p> <p><b>Primary causes:</b><br/>The external application layer issues an inappropriate flux enable request.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

### Fault Code Descriptions

| No. | Name                     | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----|--------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 86  | <i>IGBT AU over temp</i> | Trip | <p>The <i>IGBT AU over temp</i> trip fault occurs when the phase A upper IGBT junction temperature is too hot.<br/>The main purpose of the trip fault is to use the phase A upper IGBT junction temperature calculated by the bridge thermal model to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase A upper IGBT junction temperature to rise above a safe operating level.</p> |
| 87  | <i>IGBT BU over temp</i> | Trip | <p>The <i>IGBT BU over temp</i> trip fault occurs when the phase B upper IGBT junction temperature is too hot.<br/>The main purpose of the trip fault is to use the phase B upper IGBT junction temperature calculated by the bridge thermal model to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase B upper IGBT junction temperature to rise above a safe operating level.</p> |
| 88  | <i>IGBT CU over temp</i> | Trip | <p>The <i>IGBT CU over temp</i> trip fault occurs when the phase C upper IGBT junction temperature is too hot.<br/>The main purpose of the trip fault is to use the phase C upper IGBT junction temperature calculated by the bridge thermal model to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase C upper IGBT junction temperature to rise above a safe operating level.</p> |
| 89  | <i>IGBT AL over temp</i> | Trip | <p>The <i>IGBT AL over temp</i> trip fault occurs when the phase A lower IGBT junction temperature is too hot.<br/>The main purpose of the trip fault is to use the phase A lower IGBT junction temperature calculated by the bridge thermal model to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase A lower IGBT junction temperature to rise above a safe operating level.</p> |
| 90  | <i>IGBT BL over temp</i> | Trip | <p>The <i>IGBT BL over temp</i> trip fault occurs when the phase B lower IGBT junction temperature is too hot.<br/>The main purpose of the trip fault is to use the phase B lower IGBT junction temperature calculated by the bridge thermal model to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase B lower IGBT junction temperature to rise above a safe operating level.</p> |
| 91  | <i>IGBT CL over temp</i> | Trip | <p>The <i>IGBT CL over temp</i> trip fault occurs when the phase C lower IGBT junction temperature is too hot.<br/>The main purpose of the trip fault is to use the phase C lower IGBT junction temperature calculated by the bridge thermal model to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase C lower IGBT junction temperature to rise above a safe operating level.</p> |

### Fault Code Descriptions

| No. | Name                    | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----|-------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 92  | <i>IGBT AU temp hot</i> | Alarm | <p>The <i>IGBT AU temp hot</i> alarm occurs when the phase A upper IGBT junction temperature is too hot.</p> <p>The main purpose of the alarm is to use the phase A upper IGBT junction temperature calculated by the bridge thermal model to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase A upper IGBT junction temperature to rise above a safe operating level.</p> |
| 93  | <i>IGBT BU temp hot</i> | Alarm | <p>The <i>IGBT BU temp hot</i> alarm occurs when the phase B upper IGBT junction temperature is too hot.</p> <p>The main purpose of the alarm is to use the phase B upper IGBT junction temperature calculated by the bridge thermal model to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase B upper IGBT junction temperature to rise above a safe operating level.</p> |
| 94  | <i>IGBT CU temp hot</i> | Alarm | <p>The <i>IGBT CU temp hot</i> alarm occurs when the phase C upper IGBT junction temperature is too hot.</p> <p>The main purpose of the alarm is to use the phase C upper IGBT junction temperature calculated by the bridge thermal model to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase C upper IGBT junction temperature to rise above a safe operating level.</p> |
| 95  | <i>IGBT AL temp hot</i> | Alarm | <p>The <i>IGBT AL temp hot</i> alarm occurs when the phase A lower IGBT junction temperature is too hot.</p> <p>The main purpose of the alarm is to use the phase A lower IGBT junction temperature calculated by the bridge thermal model to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase A lower IGBT junction temperature to rise above a safe operating level.</p> |
| 96  | <i>IGBT BL temp hot</i> | Alarm | <p>The <i>IGBT BL temp hot</i> alarm occurs when the phase B lower IGBT junction temperature is too hot.</p> <p>The main purpose of the alarm is to use the phase B lower IGBT junction temperature calculated by the bridge thermal model to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase B lower IGBT junction temperature to rise above a safe operating level.</p> |
| 97  | <i>IGBT CL temp hot</i> | Alarm | <p>The <i>IGBT CL temp hot</i> alarm occurs when the phase C lower IGBT junction temperature is too hot.</p> <p>The main purpose of the alarm is to use the phase C lower IGBT junction temperature calculated by the bridge thermal model to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the phase C lower IGBT junction temperature to rise above a safe operating level.</p> |

## Fault Code Descriptions

| No. | Name                      | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-----|---------------------------|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 98  | <i>Ambient over temp</i>  | Trip  | <p>The <i>Ambient over temp</i> trip fault occurs when the ambient temperature (variable <i>Ambient temp</i>) is too high.<br/>The main purpose of the trip fault is to use the ambient temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the ambient temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 7 and 8 is damaged.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 99  | <i>Ambient temp hot</i>   | Alarm | <p>The <i>Ambient temp hot</i> alarm occurs when the ambient temperature (variable <i>Ambient temp</i>) is too high.<br/>The main purpose of the alarm is to use the ambient temperature measurement to detect a condition which could endanger the power bridge.</p> <p><b>Primary causes:</b><br/>The bridge environment and running conditions cause the ambient temperature to rise above a safe operating level.</p> <p><b>Possible board failures:</b><br/>BICL</p> <p><b>Possible wiring faults:</b><br/>The thermal sensor input to backplane connector J4 pins 7 and 8 is damaged.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 100 | <i>Phase A cur offset</i> | Trip  | <p>The <i>Phase A cur offset</i> trip fault occurs when the phase A current offset (variable <i>Phs A current offset</i>) is too large. The current offset threshold level is 1 percent of the rated shunt current (parameter <i>IPN shunt size</i>).<br/><i>Phs A current offset</i> is the output of an automatic current offset calculation. The trip fault only occurs when the offset calculation is not active.<br/><i>Phase A cur offset</i> 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.</p> <p><b>Primary causes:</b><br/>The wire connection between the phase A SHCA board and the BPIA/BPIB board is missing or damaged.<br/>The phase A current feedback VCO on the BPIA/BPIB board is damaged.<br/>Two or more shorted IGBTs in the power bridge exist.<br/>A combination of a shorted IGBT in the power bridge and a ground in the load exists.</p> <p><b>Possible configuration faults:</b><br/>The specified shunt rating, represented by parameter <i>IPN shunt size</i>, is incorrect.</p> <p><b>Possible board failures:</b><br/>SHCA<br/>BPIA/BPIB<br/>HFPA (FU4)<br/>DSPX</p> <p><b>Possible wiring faults:</b><br/>Connection between BPIA/BPIB and SHCA.</p> |

## Fault Code Descriptions

| No. | Name               | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----|--------------------|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 101 | Phase B cur offset | Trip | <p>The <i>Phase B cur offset</i> trip fault occurs when the phase B current offset (variable <i>Phs B current offset</i>) is too large. The current offset threshold level is 1 percent of the rated shunt current (parameter <i>IPN shunt size</i>).</p> <p><i>Phs B current offset</i> is the output of an automatic current offset calculation. The trip fault only occurs when the offset calculation is not active.</p> <p><i>Phase B cur offset</i> 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.</p> <p><b>Primary causes:</b></p> <p>The wire connection between the phase B SHCA board and the BPIA/BPIB board is missing or damaged.</p> <p>The phase B current feedback VCO on the BPIA/BPIB board is damaged.</p> <p>Two or more shorted IGBTs in the power bridge exist.</p> <p>A combination of a shorted IGBT in the power bridge and a ground in the load exists.</p> <p><b>Possible configuration faults:</b></p> <p>The specified shunt rating, represented by parameter <i>IPN shunt size</i>, is incorrect.</p> <p><b>Possible board failures:</b></p> <p>SHCA<br/>BPIA/BPIB<br/>HFPA (FU4)<br/>DSPX</p> <p><b>Possible wiring faults:</b></p> <p>Connection between BPIA/BPIB and SHCA.</p>               |
| 102 | Phase C cur offset | Trip | <p>The <i>Phase C cur offset</i> trip fault occurs when the phase C current offset (variable <i>Phs C current offset</i>) is too large. The current offset threshold level is 1 percent of the rated shunt current, represented by parameter <i>IPN shunt size</i>.</p> <p><i>Phs C current offset</i> is the output of an automatic current offset calculation. The trip fault only occurs when the offset calculation is not active.</p> <p><i>Phase C cur offset</i> 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.</p> <p><b>Primary causes:</b></p> <p>The wire connection between the phase C SHCA board and the BPIA/BPIB board is missing or damaged.</p> <p>The phase C current feedback VCO on the BPIA/BPIB board is damaged.</p> <p>Two or more shorted IGBTs in the power bridge exist.</p> <p>A combination of a shorted IGBT in the power bridge and a ground in the load exists.</p> <p><b>Possible configuration faults:</b></p> <p>The specified shunt rating, represented by parameter <i>IPN shunt size</i>, is incorrect.</p> <p><b>Possible board failures:</b></p> <p>SHCA<br/>BPIA/BPIB<br/>HFPA (FU4)<br/>DSPX</p> <p><b>Possible wiring faults:</b></p> <p>Connection between BPIA/BPIB and SHCA.</p> |

## Fault Code Descriptions

| No. | Name                       | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-----|----------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 103 | <i>A-B voltage offset</i>  | Trip | <p>The <i>A-B voltage offset</i> trip fault occurs when the A-B line-line voltage offset (variable <i>A-B, Voltage offset</i>) is too large.</p> <p><i>A-B, Voltage offset</i> is the output of an automatic voltage offset calculation. The trip fault only occurs when the offset calculation is not active.</p> <p><i>A-B voltage offset</i> 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.</p> <p><b>Primary causes:</b></p> <p>The wire connection between the phase A or phase B SHCA board and the BPIA/BPIB board is missing or damaged.</p> <p>The A-B voltage feedback VCO on the BPIA/BPIB board is damaged.</p> <p>Two or more shorted IGBTs in separate phases of the power bridge exist.</p> <p>A combination of a shorted IGBT in phase A or phase B and a ground in the load exists.</p> <p><b>Possible board failures:</b></p> <p>SHCA<br/>BPIA/BPIB<br/>HFPA (FU4)<br/>DSPX</p> <p><b>Possible wiring faults:</b></p> <p>Connection between BPIA/BPIB and SHCA.</p> |
| 104 | <i>B-C voltage offset</i>  | Trip | <p>The <i>B-C voltage offset</i> trip fault occurs when the B-C line-line voltage offset (variable <i>B-C, Voltage offset</i>) is too large.</p> <p><i>B-C, Voltage offset</i> is the output of an automatic voltage offset calculation. The trip fault only occurs when the offset calculation is not active.</p> <p><i>B-C voltage offset</i> 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.</p> <p><b>Primary causes:</b></p> <p>The wire connection between the phase B or phase C SHCA board and the BPIA/BPIB board is missing or damaged.</p> <p>The B-C voltage feedback VCO on the BPIA/BPIB board is damaged.</p> <p>Two or more shorted IGBTs in separate phases of the power bridge exist.</p> <p>A combination of a shorted IGBT in phase A or phase B and a ground in the load exists.</p> <p><b>Possible board failures:</b></p> <p>SHCA<br/>BPIA/BPIB<br/>HFPA (FU4)<br/>DSPX</p> <p><b>Possible wiring faults:</b></p> <p>Connection between BPIA/BPIB and SHCA.</p> |
| 106 | <i>Ckt board list fail</i> | Trip | <p>The <i>Ckt board list fail</i> 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.</p> <p><i>Ckt board list fail</i> requires a hard reset to clear.</p> <p><b>Primary causes:</b></p> <p>A circuit board is not seated properly in its backplane sockets.</p> <p>The electronic ID part on a circuit board has experienced a failure.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

## Fault Code Descriptions

| No. | Name                        | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----|-----------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 107 | <i>Motor volt offs high</i> | Alarm | <p>The <i>Motor volt offs high</i> 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 <i>A-B, Voltage offset</i> and <i>B-C, Voltage offset</i>. They are the outputs of automatic voltage offset measurements. They are valid for a certain length of time after the measurements are performed.</p> <p>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 <i>Motor volt offs high</i> alarm occurs.</p> <p><b>Related functions:</b><br/> <i>Line-Line Voltage Protection</i></p> |
| 108 | <i>DC bus voltage low</i>   | Alarm | <p>The <i>DC bus voltage low</i> alarm occurs when the DC link voltage feedback (variable <i>DC bus voltage</i>) is too low. The under voltage threshold level is a scaled version of the drive output line-line voltage (parameter <i>Max lineup output</i>).</p> <p>The alarm clears when the DC link voltage feedback rises to an acceptable voltage, which is the under voltage threshold plus a hysteresis voltage. <i>DC bus under voltage</i> only occurs when the drive is stopped.</p> <p><b>Possible configuration faults:</b><br/> The drive output line-line voltage is specified incorrectly. The output voltage is represented by parameter <i>Max lineup output</i>.</p> <p><b>Possible board failures:</b><br/> BPJA/BPIB<br/> HFPA (FU4)<br/> DSPX</p>                                                                                                                                                                                                                                                                                                                                                                                                 |
| 109 | <i>Task 1 exec overrun</i>  | Alarm | <p>The <i>Task 1 exec overrun</i> 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.</p> <p><b>Primary causes:</b><br/> Task 1 contains too much functionality to complete in the specified execution time.</p> <p><b>Possible board failures:</b><br/> DSPX</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 110 | <i>Task 2 exec overrun</i>  | Alarm | <p>The <i>Task 2 exec overrun</i> 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.</p> <p><b>Primary causes:</b><br/> Task 2 contains too much functionality to complete in the specified execution time.<br/> Task 1 contains too much functionality. Although it completes in its specified execution time, it does not allow Task 2 to run to completion.</p> <p><b>Possible board failures:</b><br/> DSPX</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

### Fault Code Descriptions

| No. | Name                       | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-----|----------------------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 111 | <i>Task 3 exec overrun</i> | Alarm | <p>The <i>Task 3 exec overrun</i> 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.</p> <p><b>Primary causes:</b><br/> Task 3 contains too much functionality to complete in the specified execution time.<br/> 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.</p> <p><b>Possible board failures:</b><br/> DSPX</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 112 | <i>ADL msg stack fail</i>  | Alarm | <p>The <i>ADL msg stack fail</i> 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.</p> <p><b>Primary causes:</b><br/> An attempt to allocate or free memory on behalf of the ADL message stack failed.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 113 | <i>Invalid board set</i>   | Trip  | <p>The <i>Invalid board set</i> 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.</p> <p>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.</p> <p><b>Primary causes:</b><br/> A circuit board which is required for the drive to operate properly is not present.<br/> A circuit board which should not be used in the drive is present.<br/> A circuit board is not seated properly in its backplane socket.<br/> The electronic ID part on a circuit board has experienced a failure.</p> |

## Fault Code Descriptions

| No. | Name                      | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----|---------------------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 114 | <i>Ain 1 signal alarm</i> | Alarm | <p>The <i>Ain 1 signal alarm</i> occurs when the level of analog input number 1 (variable <i>Analog input 1</i>) is too low. The alarm level is specified by parameter <i>Analog in 1 flt lev</i>.</p> <p>The alarm can occur only when parameter <i>Analog in 1 flt mode</i> is set equal to Low level alarm. The alarm is disabled for any other setting for parameter <i>Analog in 1 flt mode</i>.</p> <p>The main purpose of <i>Ain 1 signal alarm</i> 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.</p> <p><b>Primary causes:</b><br/>The analog input number 1 signal source is absent or unhealthy.</p> <p><b>Possible configuration faults:</b><br/>The analog input 1 alarm level, represented by parameter <i>Analog in 1 flt lev</i>, is set incorrectly.<br/>The analog input number 1 gain, represented by parameter <i>Analog in 1 gain</i>, is set incorrectly.<br/>The analog input number 1 offset, represented by parameter <i>Analog in 1 offset</i>, is set incorrectly.<br/>The analog input number 1 flt mode, represented by parameter <i>Analog in 1 flt mode</i>, is set incorrectly.</p> <p><b>Possible wiring faults:</b><br/>The connections between the analog signal source and ATBA terminal board locations 38 (AI1P) and 40 (AI1N) are missing or damaged.</p>                        |
| 115 | <i>Ain 1 signal trip</i>  | Trip  | <p>The <i>Ain 1 signal trip</i> fault occurs when the level of analog input number 1 (variable <i>Analog input 1</i>) is too low. The trip fault level is specified by parameter <i>Analog in 1 flt lev</i>.</p> <p>The trip fault can occur only when parameter <i>Analog in 1 flt mode</i> is set equal to Low level trip. The trip fault is disabled for any other setting for parameter <i>Analog in 1 flt mode</i>.</p> <p>The main purpose of <i>Ain 1 signal trip</i> 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.</p> <p><b>Primary causes:</b><br/>The analog input number 1 signal source is absent or unhealthy.</p> <p><b>Possible configuration faults:</b><br/>The analog input 1 trip fault level, represented by parameter <i>Analog in 1 flt lev</i>, is set incorrectly.<br/>The analog input number 1 gain, represented by parameter <i>Analog in 1 gain</i>, is set incorrectly.<br/>The analog input number 1 offset, represented by parameter <i>Analog in 1 offset</i>, is set incorrectly.<br/>The analog input number 1 flt mode, represented by parameter <i>Analog in 1 flt mode</i>, is set incorrectly.</p> <p><b>Possible wiring faults:</b><br/>The connections between the analog signal source and ATBA terminal board locations 38 (AI1P) and 40 (AI1N) are missing or damaged.</p> |

## Fault Code Descriptions

| No. | Name                      | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----|---------------------------|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 116 | <i>Ain 2 signal alarm</i> | Alarm | <p>The <i>Ain 2 signal alarm</i> occurs when the level of analog input number 2 (variable <i>Analog input 2</i>) is too low. The alarm level is specified by parameter <i>Analog in 2 flt lev</i>.</p> <p>The alarm can occur only when parameter <i>Analog in 2 flt mode</i> is set equal to Low level alarm. The fault is disabled for any other setting for parameter <i>Analog in 2 flt mode</i>.</p> <p>The main purpose of <i>Ain 2 signal alarm</i> 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.</p> <p><b>Primary causes:</b><br/>The analog input number 2 signal source is absent or unhealthy.</p> <p><b>Possible configuration faults:</b><br/>The analog input 2 alarm level, represented by parameter <i>Analog in 2 flt lev</i>, is set incorrectly.<br/>The analog input number 2 gain, represented by parameter <i>Analog in 2 gain</i>, is set incorrectly.<br/>The analog input number 2 offset, represented by parameter <i>Analog in 2 offset</i>, is set incorrectly.<br/>The analog input number in 2 flt mode, represented by parameter <i>Analog in 2 flt mode</i>, is set incorrectly.</p> <p><b>Possible wiring faults:</b><br/>The connections between the analog signal source and ATBA terminal board locations 44 (AI2P) and 46 (AI2N) are missing or damaged.</p>                        |
| 117 | <i>Ain 2 signal trip</i>  | Trip  | <p>The <i>Ain 2 signal trip</i> fault occurs when the level of analog input number 2 (variable <i>Analog input 2</i>) is too low. The trip fault level is specified by parameter <i>Analog in 2 flt lev</i>.</p> <p>The trip fault can occur only when parameter <i>Analog in 2 flt mode</i> is set equal to Low level trip. The trip fault is disabled for any other setting for parameter <i>Analog in 2 flt mode</i>.</p> <p>The main purpose of <i>Ain 2 signal trip</i> 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.</p> <p><b>Primary causes:</b><br/>The analog input number 2 signal source is absent or unhealthy.</p> <p><b>Possible configuration faults:</b><br/>The analog input 2 trip fault level, represented by parameter <i>Analog in 2 flt lev</i>, is set incorrectly.<br/>The analog input number 2 gain, represented by parameter <i>Analog in 2 gain</i>, is set incorrectly.<br/>The analog input number 2 offset, represented by parameter <i>Analog in 2 offset</i>, is set incorrectly.<br/>The analog input number in 2 flt mode, represented by parameter <i>Analog in 2 flt mode</i>, is set incorrectly.</p> <p><b>Possible wiring faults:</b><br/>The connections between the analog signal source and ATBA terminal board locations 44 (AI2P) and 46 (AI2N) are missing or damaged.</p> |

### Fault Code Descriptions

| No. | Name                        | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----|-----------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 118 | <i>IGBT AU bridg1 desat</i> | Trip | <p>The <i>IGBT AU bridg1 desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the bridge 1 phase A upper IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V.</p> <p>Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the bridge 1 phase A upper IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The bridge 1 phase A lower IGBT is short circuited.<br/> The bridge 1 phase A upper IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIB<br/> BICL<br/> HFPA (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIB and DAMA are missing or damaged.</p> |
| 119 | <i>IGBT AL bridg1 desat</i> | Trip | <p>The <i>IGBT AL bridg1 desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the bridge 1 phase A lower IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V.</p> <p>Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the bridge 1 phase A lower IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The bridge 1 phase A upper IGBT is short circuited.<br/> The bridge 1 phase A lower IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIB<br/> BICL<br/> HFPA (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIB and DAMA are missing or damaged.</p> |

### Fault Code Descriptions

| No. | Name                        | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----|-----------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 120 | <i>IGBT BU bridg1 desat</i> | Trip | <p>The <i>IGBT BU bridg1 desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the bridge 1 phase B upper IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V.</p> <p>Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the bridge 1 phase B upper IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The bridge 1 phase B lower IGBT is short circuited.<br/> The bridge 1 phase B upper IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIB<br/> BICL<br/> HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIB and DAMA are missing or damaged.</p> |
| 121 | <i>IGBT BL bridg1 desat</i> | Trip | <p>The <i>IGBT BL bridg1 desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the bridge 1 phase B lower IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V.</p> <p>Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the bridge 1 phase B lower IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The bridge 1 phase B upper IGBT is short circuited.<br/> The bridge 1 phase B lower IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIB<br/> BICL<br/> HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIB and DAMA are missing or damaged.</p> |

### Fault Code Descriptions

| No. | Name                        | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----|-----------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 122 | <i>IGBT CU bridg1 desat</i> | Trip | <p>The <i>IGBT CU bridg1 desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the bridge 1 phase C upper IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V.</p> <p>Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the bridge 1 phase C upper IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The bridge 1 phase C lower IGBT is short circuited.<br/> The bridge 1 phase C upper IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIB<br/> BICL<br/> HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIB and DAMA are missing or damaged.</p> |
| 123 | <i>IGBT CL bridg1 desat</i> | Trip | <p>The <i>IGBT CL bridg1 desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the bridge 1 phase C lower IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V.</p> <p>Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the bridge 1 phase C lower IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The bridge 1 phase C upper IGBT is short circuited.<br/> The bridge 1 phase C lower IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIB<br/> BICL<br/> HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIB and DAMA are missing or damaged.</p> |

### Fault Code Descriptions

| No. | Name                        | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----|-----------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 124 | <i>IGBT AU bridg2 desat</i> | Trip | <p>The <i>IGBT AU bridg2 desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the bridge 2 phase A upper IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V.</p> <p>Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the bridge 2 phase A upper IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The bridge 2 phase A lower IGBT is short circuited.<br/> The bridge 2 phase A upper IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIB<br/> BICL<br/> HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIB and DAMA are missing or damaged.</p> |
| 125 | <i>IGBT AL bridg2 desat</i> | Trip | <p>The <i>IGBT AL bridg2 desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the bridge 2 phase A lower IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V.</p> <p>Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the bridge 2 phase A lower IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The bridge 2 phase A upper IGBT is short circuited.<br/> The bridge 2 phase A lower IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIB<br/> BICL<br/> HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIB and DAMA are missing or damaged.</p> |

### Fault Code Descriptions

| No. | Name                        | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----|-----------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 126 | <i>IGBT BU bridg2 desat</i> | Trip | <p>The <i>IGBT BU bridg2 desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the bridge 2 phase B upper IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V.</p> <p>Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the bridge 2 phase B upper IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The bridge 2 phase B lower IGBT is short circuited.<br/> The bridge 2 phase B upper IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIB<br/> BICL<br/> HFPA (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIB and DAMA are missing or damaged.</p> |
| 127 | <i>IGBT BL bridg2 desat</i> | Trip | <p>The <i>IGBT BL bridg2 desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the bridge 2 phase B lower IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V.</p> <p>Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the bridge 2 phase B lower IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The bridge 2 phase B upper IGBT is short circuited.<br/> The bridge 2 phase B lower IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIB<br/> BICL<br/> HFPA (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIB and DAMA are missing or damaged.</p> |

### Fault Code Descriptions

| No. | Name                        | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----|-----------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 128 | <i>IGBT CU bridg2 desat</i> | Trip | <p>The <i>IGBT CU bridg2 desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the bridge 2 phase C upper IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V.</p> <p>Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the bridge 2 phase C upper IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The bridge 2 phase C lower IGBT is short circuited.<br/> The bridge 2 phase C upper IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIB<br/> BICL<br/> HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIB and DAMA are missing or damaged.</p> |
| 129 | <i>IGBT CL bridg2 desat</i> | Trip | <p>The <i>IGBT CL bridg2 desat</i> trip fault is hardware generated. The trip fault occurs when the bridge control commands the bridge 2 phase C lower IGBT to turn on and the measured collector-emitter voltage of the IGBT is greater than 10 V.</p> <p>Under normal conditions when the IGBT is turned on a voltage of 3 V to 5 V develops across the collector-emitter junction. Voltages greater than 10 V across the junction suggest that the bridge 2 phase C lower IGBT is supporting large fault currents and that a serious bridge problem exists.</p> <p><b>Primary causes:</b><br/> The bridge 2 phase C upper IGBT is short circuited.<br/> The bridge 2 phase C lower IGBT is defective.</p> <p><b>Possible board failures:</b><br/> DAMA<br/> BPIB<br/> BICL<br/> HFP4 (FU4)</p> <p><b>Possible wiring faults:</b><br/> The connections between BPIB and DAMA are missing or damaged.</p> |

## Fault Code Descriptions

| No. | Name                       | Type | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----|----------------------------|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 130 | <i>Current imbal phs A</i> | Trip | <p>The <i>Current imbal phs A</i> trip fault is hardware generated. The trip fault occurs when the difference between the bridge 1 and bridge 2 phase A shunt currents over a time interval is too large. A 10 percent imbalance over an 88 microsecond measurement period qualifies as a fault condition. A bridge 1 to bridge 2 shoot through in phase A causes a fault in about 8 microseconds. When the imbalance condition is detected, the power bridge IGBT gating is disabled immediately.</p> <p><b>Primary causes:</b><br/>A short circuit exists across or through one or more of the phase A IGBTs. One of the phase A shunts is reversed.</p> <p><b>Possible board failures:</b><br/>SHCA<br/>BPIB<br/>BICL<br/>HFPA (FU4)</p> <p><b>Possible wiring faults:</b><br/>The connections between BPIB and SHCA are missing or damaged.</p> |
| 131 | <i>Current imbal phs B</i> | Trip | <p>The <i>Current imbal phs B</i> trip fault is hardware generated. The trip fault occurs when the difference between the bridge 1 and bridge 2 phase B shunt currents over a time interval is too large. A 10 percent imbalance over an 88 microsecond measurement period qualifies as a fault condition. A bridge 1 to bridge 2 shoot through in phase B causes a fault in about 8 microseconds. When the imbalance condition is detected, the power bridge IGBT gating is disabled immediately.</p> <p><b>Primary causes:</b><br/>A short circuit exists across or through one or more of the phase B IGBTs. One of the phase B shunts is reversed.</p> <p><b>Possible board failures:</b><br/>SHCA<br/>BPIB<br/>BICL<br/>HFPA (FU4)</p> <p><b>Possible wiring faults:</b><br/>The connections between BPIB and SHCA are missing or damaged.</p> |
| 132 | <i>Current imbal phs C</i> | Trip | <p>The <i>Current imbal phs C</i> trip fault is hardware generated. The trip fault occurs when the difference between the bridge 1 and bridge 2 phase C shunt currents over a time interval is too large. A 10 percent imbalance over an 88 microsecond measurement period qualifies as a fault condition. A bridge 1 to bridge 2 shoot through in phase C causes a fault in about 8 microseconds. When the imbalance condition is detected, the power bridge IGBT gating is disabled immediately.</p> <p><b>Primary causes:</b><br/>A short circuit exists across or through one or more of the phase C IGBTs. One of the phase C shunts is reversed.</p> <p><b>Possible board failures:</b><br/>SHCA<br/>BPIB<br/>BICL<br/>HFPA (FU4)</p> <p><b>Possible wiring faults:</b><br/>The connections between BPIB and SHCA are missing or damaged.</p> |

### Fault Code Descriptions

| No. | Name                       | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----|----------------------------|-------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 135 | <i>Motor over temp</i>     | Trip  | <p>The <i>Motor over temp</i> trip fault occurs when the motor overtemperature circuit is open. The state of the motor overtemperature circuit is selected by parameter <i>Motor OT fault sel</i>. <i>Motor over temp</i> can be disabled by setting parameter <i>Motor OT fault sel</i> equal to Unused.</p> <p><b>Related functions:</b><br/><i>Motor Overtemperature Detection</i></p>                                                                                                                                                                                                                                                                                                           |
| 136 | <i>Motor temp hot</i>      | Alarm | <p>The <i>Motor temp hot</i> trip fault occurs when the motor overtemperature circuit is open. The state of the motor overtemperature circuit is selected by parameter <i>Motor OT fault sel</i>. <i>Motor temp hot</i> can be disabled by setting parameter <i>Motor OT fault sel</i> equal to Unused.</p> <p><b>Related functions:</b><br/><i>Motor Overtemperature Detection</i></p>                                                                                                                                                                                                                                                                                                             |
| 137 | <i>Unrecognized IPN</i>    | Trip  | <p>The <i>Unrecognized IPN</i> 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. <i>Unrecognized IPN</i> requires a hard reset to clear.</p>                                                                                                                                                                                                                                                                                                                                                                                                             |
| 138 | <i>Illegal req for sby</i> | Alarm | <p>The <i>Illegal req for sby</i> alarm occurs when a <i>Standby command</i> is issued and a trip fault is present in the drive. The alarm may also occur when a <i>Standby command</i> is issued at the same time a diagnostic test (cell test, pulse test, autotune) is active.</p> <p><b>Primary causes:</b><br/>The external application layer issues an inappropriate standby request.</p>                                                                                                                                                                                                                                                                                                     |
| 139 | <i>Customer use NC flt</i> | Trip  | <p>The <i>Customer use NC flt</i> trip fault occurs when the customer normally closed circuit is open. The state of the normally closed circuit is selected by parameter <i>User NC fault sel</i>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 140 | <i>Customer use NC alm</i> | Alarm | <p>The <i>Customer use NC alm</i> alarm occurs when the customer normally closed circuit is open. The state of the normally closed circuit is selected by parameter <i>User NC fault sel</i>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| 141 | <i>Customer use NO flt</i> | Trip  | <p>The <i>Customer use NO flt</i> trip fault occurs when the customer normally open circuit is closed. The state of the normally open circuit is selected by parameter <i>User NO fault sel</i>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 142 | <i>Customer use NO alm</i> | Alarm | <p>The <i>Customer use NO alm</i> alarm occurs when the customer normally open circuit is closed. The state of the normally open circuit is selected by parameter <i>User NO fault sel</i>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 143 | <i>Sat curve data bad</i>  | Trip  | <p>The <i>Sat curve data bad</i> trip fault occurs when the flux saturation curve is not monotonic.</p> <p><b>Primary causes:</b><br/>The saturation curve data entered by the operator is bad.<br/>The saturation curve data calculated by autotune is bad.</p> <p><b>Possible configuration faults:</b><br/>One or more of the saturation curve parameters is bad. The saturation curve parameters are <i>Flux curve amps 1</i>, <i>Flux curve amps 2</i>, <i>Flux curve amps 3</i>, <i>Flux curve amps 4</i>, <i>Flux curve amps 5</i>, <i>Flux curve voltage 1</i>, <i>Flux curve voltage 2</i>, <i>Flux curve voltage 3</i>, <i>Flux curve voltage 4</i>, and <i>Flux curve voltage 5</i>.</p> |
| 144 | <i>Rated flux data bad</i> | Trip  | <p>The <i>Rated flux data bad</i> trip fault occurs when the motor control calculation of rated flux (variable <i>100% Flux</i>) does not converge to a stable value.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## Fault Code Descriptions

| No. | Name                        | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----|-----------------------------|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 145 | <i>Leakage curve bad</i>    | Trip  | <p>The <i>Leakage curve bad</i> trip fault occurs when the leakage flux curve is not monotonic (such as Point 1 &lt; point 2 &lt; point 3 &lt; point 4 &lt; point 5).</p> <p><b>Primary causes:</b><br/> The calculated leakage curve has been derived from bad motor reactance data.<br/> The leakage curve data entered by the operator is bad.<br/> The leakage curve data calculated by autotune is bad.</p> <p><b>Possible configuration faults:</b><br/> When the leakage curve is not entered specifically point-by-point (see below) one is calculated from <i>Starting react Xst</i>, <i>Magnetizing react Xm</i>, <i>Stator lkg react X1</i>, and <i>Rotor lkg react X2</i>. The relationship between these parameters should be: <math>(\text{Rotor lkg react } X2 \parallel \text{Magnetizing react } Xm) + \text{Stator lkg react } X1 &gt; \text{Starting react } Xst</math>. If <i>Motor reac parms bad</i> fault is also present, this is the likely cause.<br/> 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 <i>Lkg flux current 1</i>, <i>Lkg flux current 2</i>, <i>Lkg flux current 3</i>, <i>Lkg flux current 4</i>, <i>Lkg flux current 5</i>, <i>Lkg flux voltage 1</i>, <i>Lkg flux voltage 2</i>, <i>Lkg flux voltage 3</i>, <i>Lkg flux voltage 4</i>, and <i>Lkg flux voltage 5</i>. If the leakage parameters are not set, the leakage curve is determined as above, or as the results of autotune.</p> |
| 146 | <i>Start permissive bad</i> | Alarm | <p>The <i>Start permissive bad</i> 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 <i>Start permissive sel</i> selects. The alarm can be disabled by setting parameter <i>Start permissive sel</i> equal to Unused.</p> <p><b>Related functions:</b><br/> <i>Sequencer Permissives</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| 147 | <i>Invalid Time Base</i>    | Trip  | <p>The <i>Invalid Time Base</i> trip fault occurs when the execution time base is invalid. Parameter <i>Exec time/Chop freq</i> contains valid choices for the time base.<br/> <i>Invalid Time Base</i> requires a hard reset to clear.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 148 | <i>Bic Watchdog</i>         | Trip  | <p>The <i>Bic Watchdog</i> trip fault occurs when the BICL stops seeing a watchdog toggle bit from the DSPX. When the drive is running, BICL monitors a toggle bit being manipulated by DSPX. If DSPX does not toggle the bit on BICL within a predefined time interval, the BICL declares a fault and disables the bridge. This indicates that the processor cannot communicate reliably with the bridge interface board.<br/> <i>Bic Watchdog</i> requires a hard reset to clear.</p> <p><b>Possible configuration faults:</b><br/> The connected drive is a simulator but <i>Simulate mode act</i> is equal to <i>False</i>. Set <i>Simulate mode</i> equal to <i>Yes</i> to correct the problem.</p> <p><b>Possible board failures:</b><br/> BICL<br/> DSPX<br/> CABP (backplane)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 149 | <i>DSPx Watchdog</i>        | Trip  | <p>The <i>DSPx Watchdog</i> 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.<br/> <i>DSPx Watchdog</i> requires a hard reset to clear.</p> <p><b>Possible board failures:</b><br/> DSPX</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

### Fault Code Descriptions

| No. | Name                        | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-----|-----------------------------|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 151 | <i>Reverse rotation</i>     | Trip  | <p>The <i>Reverse rotation</i> trip fault occurs when the motor shaft is rotating opposite to the requested direction.</p> <p><b>Related functions:</b><br/> <i>Speed Control Fault Check</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 152 | <i>Failure to rotate</i>    | Trip  | <p>The <i>Failure to rotate</i> trip fault occurs when speed regulator error grows large while the speed feedback is small.</p> <p><b>Related functions:</b><br/> <i>Speed Control Fault Check</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 153 | <i>Loss of spd control</i>  | Trip  | <p>The <i>Loss of spd control</i> trip fault occurs when the speed regulator error is too large.</p> <p><b>Related functions:</b><br/> <i>Speed Control Fault Check</i></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| 154 | <i>Bic watchdog echo</i>    | Trip  | <p>The <i>Bic watchdog echo</i> trip fault occurs when the DSPX stops seeing the echo of the watchdog toggle bit that it writes to the BICL. This indicates that the processor cannot communicate reliably with the bridge interface board.</p> <p><b>Primary Causes:</b><br/> Bent backplane connector pins or poorly seated boards.</p> <p><b>Possible board failures:</b><br/> BICL<br/> DSPX<br/> CABP (backplane)</p>                                                                                                                                                                                                                                                                                                                                                                                                 |
| 156 | <i>LAN trip request</i>     | Trip  | <p>The <i>LAN trip request</i> trip fault occurs when a request for a trip fault is received from the LAN by assertion of the reference Boolean signal <i>Trip request, lan</i>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| 157 | <i>LAN alarm request</i>    | Alarm | <p>The <i>LAN alarm request</i> alarm occurs when a request for an alarm is received from the LAN by assertion of the reference Boolean signal <i>Alarm request, lan</i>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 158 | <i>LAN watchdog alarm</i>   | Alarm | <p>The <i>LAN watchdog alarm</i> 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 <i>Network interface</i>:</p> <p>The Application/LAN interface Dual-Port RAM watchdog stops.<br/> The ISBus frames stop.<br/> The alarm is declared after the condition persists for several hundred microseconds.</p>                                                                                                                                                                                                                                                                                                                                                                                          |
| 159 | <i>Restrictd fcn enabld</i> | Alarm | <p>The <i>Restrictd fcn enabld</i> alarm occurs when the selected execution time base in the parameter <i>Exec time/Chop freq</i> restricts certain drive functionality due to timing limitations, or the ISBus network is selected by the <i>Network interface</i> parameter and the DSPX hardware does not support ISBus. Certain functions that are presently enabled will not run.</p> <p><b>Possible configuration faults:</b><br/> Execution time base is too low. Choose alternate time base in parameter <i>Exec time/Chop freq</i>.<br/> LAN is enabled, but will not operate. Disable LAN by setting parameter <i>Network interface</i> to <i>None</i>.<br/> ISBus is selected, but will not operate. Deselect ISBus by setting parameter <i>Network interface</i>, or replace the DSPX HIA with a DSPX H1B.</p> |
| 160 | <i>LAN heartbeat trip</i>   | Trip  | <p>The <i>LAN heartbeat trip</i> occurs when all of the following conditions are present:</p> <p>Non-zero value is entered in Parameter <i>LAN heartbeat time</i>.<br/> The signal (<i>Heartbeat ref, lan</i>) fails to transition within that time.<br/> The trip behavior is enabled by Parameter <i>LAN trips inhibit</i>.<br/> The <i>LAN connection ok</i> condition was previously detected.</p>                                                                                                                                                                                                                                                                                                                                                                                                                     |

### Fault Code Descriptions

| No. | Name                        | Type  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----|-----------------------------|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 161 | <i>LAN heartbeat alarm</i>  | Alarm | <p>The <i>LAN heartbeat alarm</i> occurs when all of the following conditions are present:</p> <ul style="list-style-type: none"> <li>Non-zero value is entered in Parameter <i>LAN heartbeat time</i>.</li> <li>The signal (<i>Heartbeat ref, lan</i>) fails to transition within in that time.</li> <li>Either the trip behavior is inhibited by Parameter <i>LAN trips inhibit</i>, or the trip behavior is enabled but the <i>LAN connection ok</i> condition was not previously detected.</li> </ul>                                                                                                                                                                                                                                                                                                          |
| 166 | <i>Requird Parm Missing</i> | Trip  | <p>The <i>Requird Parm Missing</i> 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.</p> <p><b>Primary causes:</b></p> <ul style="list-style-type: none"> <li><i>Motor rated voltage</i>, Not entered</li> <li><i>Motor rated freq</i>, Not entered</li> <li><i>Motor rated current</i>, Not entered</li> <li><i>Motor rated rpm</i>, Not entered</li> <li><i>Motor rated power</i>, Not entered</li> <li><i>Motor service factor</i>, Not entered</li> </ul>                                                                                                                                                                                                            |
| 168 | <i>Version mismatch</i>     | Trip  | <p>The <i>Version mismatch</i> 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.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 173 | <i>System ISBus error</i>   | Alarm | <p>The <i>System ISBus error</i> alarm occurs when an ISBus fault is detected in the DSPX control. The variable <i>Sys ISBus error reg</i> contains the bit-coded value of the last ISBus fault detected; each bit indicates a particular ISBus fault seen by the control. The variable <i>Sys ISBus error cnt</i> increments upon fault detection.</p> <p>Record the value of <i>Sys ISBus error reg</i> to assist factory troubleshooting efforts. Monitor the progression of <i>Sys ISBus error cnt</i> to obtain an indication of the rate of occurrence of fault conditions.</p> <p>Transient occurrence of this alarm upon initialization of the interface is expected.</p>                                                                                                                                  |
| 174 | <i>Frame PLL not OK</i>     | Alarm | <p>The <i>Frame PLL not OK</i> 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 <i>Network interface</i> is configured to choose an interface for which synchronized operation is supported. The presence of this alarm indicates that data coherency is compromised.</p> <p>Verify the integrity of ISBus connections and configurations. If this alarm persists in the absence of any other interface faults, then verify that <i>LAN frame time</i> is consistent with that of the host, and confirm the absence of overrides, particularly regarding the Frame phaselock loop and DSPX timebase.</p> <p>Transient occurrence of this alarm upon initialization of the interface is expected.</p> |

# Chapter 2 Parameters/Functions

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## Introduction

The following is a list of parameters and functions encountered within the drive. It is organized as following:

| <b>Section</b>                        | <b>Page</b> |
|---------------------------------------|-------------|
| Diagnostic and Utility Functions..... | 1           |
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## 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 four channels of coherent data at a specified rate in the drive. The capture buffer is circular, and will collect 512 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. 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.

| <b>Parameter</b>           | <b>Description</b>                          |
|----------------------------|---------------------------------------------|
| <i>Capture trig select</i> | Selects capture buffer trigger variable.    |
| <i>Capture ch1 select</i>  | Selects capture buffer channel #1 variable. |
| <i>Capture ch2 select</i>  | Selects capture buffer channel #2 variable. |
| <i>Capture ch3 select</i>  | Selects capture buffer channel #3 variable. |
| <i>Capture ch4 select</i>  | Selects capture buffer channel #4 variable. |

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

| <b>Variable</b>             | <b>Description</b>                                      |
|-----------------------------|---------------------------------------------------------|
| <i>Capture buffer ready</i> | Enables or disables the capture buffer data collection. |

### Function Outputs

The following table specifies the output variable of the *Capture Buffer* function.

| <b>Variable</b>            | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Capture buffer stat</i> | Indicates the status of the capture buffer.<br>Possible values are: <ul style="list-style-type: none"><li>• <i>Complete</i> - Capture buffer has completed its collection of data and is disabled.</li><li>• <i>Wait for trigger</i> - The capture buffer is waiting for the evaluation of the trigger condition to go True.</li><li>• <i>Post trigger capt</i> - Capture buffer has been triggered and is collecting post trigger data.</li></ul> |
| <i>Capture sample time</i> | Indicates the interval at which the capture buffer collects data based on the values of the parameters <i>Capture period</i> and <i>Capture period gain</i> . Seconds                                                                                                                                                                                                                                                                              |
| <i>Capture triggered</i>   | Indicates if the capture buffer has been triggered. True/False                                                                                                                                                                                                                                                                                                                                                                                     |

## Function Configuration

The following table specifies the parameters that configure the execution rate of the capture buffer:

| <b>Parameter</b>           | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Capture period</i>      | <p>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:</p> <ul style="list-style-type: none"><li>• <i>Disable</i> - Disables the capture buffer from collecting data.</li><li>• <i>Task 1 rate</i> - Collects data at the fastest execution rate of the processor.</li><li>• <i>Task 2 rate</i> - Collects data at n times slower than Task 1 rate. (n Task 1's are executed every 1 Task 2).</li><li>• <i>Task 3 rate</i> - Collects data at m times slower than Task 2 rate. (m Task 2's are executed every 1 Task 3).</li></ul> <p>Note: Whenever this parameter is modified, the capture buffer must be re-enabled to collect data at the new rate.</p> |
| <i>Capture period gain</i> | <p>Increases the collection period of the capture buffer (data is collected at a slower rate). For an integer value, n (&gt;1), the capture buffer would collect data every n<sup>th</sup> execution of the <i>Capture period</i>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |

The following table specifies the parameters that configure the capture buffer.

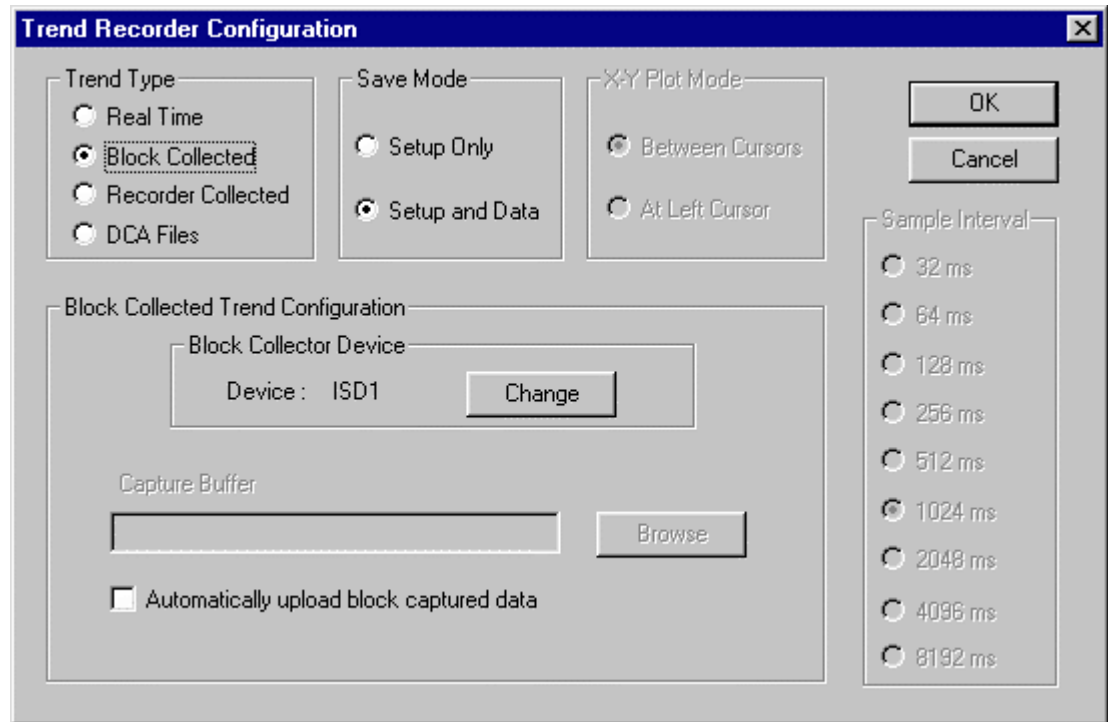
| <b>Parameter</b>            | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Capture pre trigger</i>  | <p>Specifies the number of pre-trigger samples to be collected by the capture buffer.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <i>Capture trigger mode</i> | <p>Specifies the type of comparison against the variable selected in <i>Capture trig select</i>. Note: In level trigger mode, the capture buffer will trigger when the specified comparison is satisfied. If the trigger condition is satisfied when the capture buffer is enabled, it will trigger immediately and collect post-trigger data. Possible values are:</p> <ul style="list-style-type: none"><li>• <i>Boolean</i> - Triggers when variable is a 1. Variable in <i>Capture trig select</i> must be of Boolean type.</li><li>• <i>Inverted Boolean</i> - Triggers when variable is a 0. Variable in <i>Capture trig select</i> must be of Boolean type.</li><li>• <i>Equal to level</i> - Triggers when variable is equal to value in <i>Capture trig level</i>.</li><li>• <i>Not equal to level</i> - Triggers when variable is not equal to value in <i>Capture trig level</i>.</li></ul> |

|                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                             | <ul style="list-style-type: none"> <li>• <i>Greater than level</i> - Triggers when variable is greater than value in <i>Capture trig level</i>.</li> <li>• <i>Less than level</i> - Triggers when variable is equal to value in <i>Capture trig level</i>.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <i>Capture trigger type</i> | <p>Specifies the type of triggering used in the capture buffer. Possible values are:</p> <ul style="list-style-type: none"> <li>• <i>Level Triggering</i> - Level trigger mode will trigger when the evaluation of the trigger condition is True. If the trigger condition is satisfied when the capture buffer is enabled, it will trigger immediately and collect post-trigger data.</li> <li>• <i>Edge Triggering</i> - Edge trigger mode will trigger when the evaluation of the trigger condition changes from False to True. An exception is under initialization when the capture buffer will trigger when the evaluation of the trigger condition is True. If the capture buffer is enabled while the trigger condition is True, the capture buffer will wait for the trigger condition to go False and trigger when the evaluation of the trigger condition changes from False to True.</li> </ul> |
| <i>Capture trig level</i>   | <p>Specifies the threshold level for level-based trigger comparisons.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

## Function description

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

- From the *View* menu, select *Trend Recorder* OR select the Trend Recorder button on the toolbar: .
- To enable the Innovation Series capture buffer from the Trend Recorder:
- From the *Edit* menu, select *Configure* OR select the *Configure* button from the Trend Recorder toolbar: .
- Select *Block Collected* as the *Trend Type* in the 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” indication:



to a “Waiting” indication:



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

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

## 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.

| <b>Parameter</b>     | <b>Description</b>      |
|----------------------|-------------------------|
| <i>GP Constant 1</i> | User defined constant 1 |
| <i>GP Constant 2</i> | User defined constant 2 |
| <i>GP Constant 3</i> | User defined constant 3 |

## Function outputs

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

| <b>Variable</b>      | <b>Description</b>      |
|----------------------|-------------------------|
| <i>GP Constant 1</i> | User defined constant 1 |
| <i>GP Constant 2</i> | User defined constant 2 |
| <i>GP Constant 3</i> | 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.

| <b>Parameter</b>       | <b>Description</b>                        |
|------------------------|-------------------------------------------|
| <i>GP filter 1 sel</i> | Selects input to general purpose filter 1 |
| <i>GP filter 2 sel</i> | Selects input to general purpose filter 2 |
| <i>GP filter 3 sel</i> | Selects input to general purpose filter 3 |
| <i>GP filter 4 sel</i> | Selects input to general purpose filter 4 |

## Function outputs

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

| <b>Variable</b>           | <b>Description</b>              |
|---------------------------|---------------------------------|
| <i>GP filter 1 output</i> | General purpose filter 1 output |
| <i>GP filter 2 output</i> | General purpose filter 2 output |
| <i>GP filter 3 output</i> | General purpose filter 3 output |
| <i>GP filter 4 output</i> | General purpose filter 4 output |

## Function configuration

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

| <b>Parameter</b>          | <b>Description</b>                 |
|---------------------------|------------------------------------|
| <i>GP filter 1 bndwth</i> | General purpose filter 1 bandwidth |
| <i>GP filter 2 bndwth</i> | General purpose filter 2 bandwidth |
| <i>GP filter 3 bndwth</i> | General purpose filter 3 bandwidth |
| <i>GP filter 4 bndwth</i> | 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:

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

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.

| <b>Variable</b>            | <b>Description</b>            |
|----------------------------|-------------------------------|
| <i>Sqr wave osc output</i> | Oscillator square wave output |

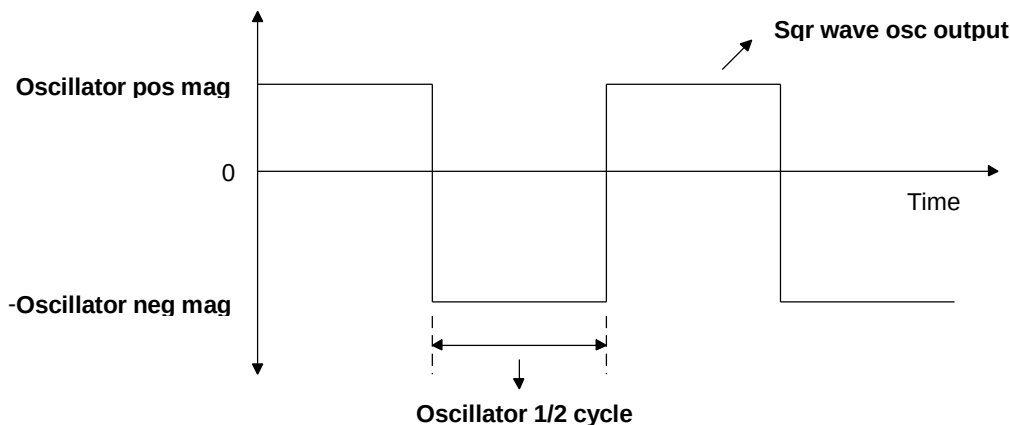
### Function configuration

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

| <b>Parameter</b>            | <b>Description</b>                                     |
|-----------------------------|--------------------------------------------------------|
| <i>Oscillator neg mag</i>   | Magnitude of the negative portion of oscillator output |
| <i>Oscillator pos mag</i>   | Magnitude of the positive portion of oscillator output |
| <i>Oscillator 1/2 cycle</i> | Time that defines half of the oscillation period, sec  |
| <i>Oscillator enable</i>    | 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.

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

| <b><i>Parameter</i></b>    | <b><i>Description</i></b>  |
|----------------------------|----------------------------|
| <i>SLD1 input 1 select</i> | Selects SLD1 input 1 value |
| <i>SLD1 input 2 select</i> | Selects SLD1 input 2 value |
| <i>SLD2 input 1 select</i> | Selects SLD2 input 1 value |
| <i>SLD2 input 2 select</i> | Selects SLD2 input 2 value |
| <i>SLD3 input 1 select</i> | Selects SLD3 input 1 value |
| <i>SLD3 input 2 select</i> | Selects SLD3 input 2 value |

## Function outputs

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

| <b>Variable</b>    | <b>Description</b>        |
|--------------------|---------------------------|
| <i>SLD1 status</i> | Status of SLD1 comparison |
| <i>SLD2 status</i> | Status of SLD2 comparison |
| <i>SLD3 status</i> | Status of SLD3 comparison |

## Function configuration

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

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

| <b><i>SLD1 input 1 abs val</i></b> | <b><i>SLD1 Input Values</i></b>                                                                                            |
|------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| <i>False</i>                       | Input 1 = <i>SLD1 input 1 select</i> pointer value<br>Input 2 = <i>SLD1 input 2 select</i> pointer value                   |
| <i>True</i>                        | Input 1 = Absolute value of <i>SLD1 input 1 select</i> pointer value<br>Input 2 = <i>SLD1 input 2 select</i> 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   | $(\text{Input 1} - \text{Input 2}) > \text{SLD1 sensitivity}$                                                        |
| Turn on delay time  | Turn on condition must remain valid for <i>SLD1 pick up delay</i> .<br>After the delay <i>SLD1 status</i> = True.    |
| Turn off condition  | $(\text{Input 1} - \text{Input 2}) \leq (\text{SLD1 sensitivity} - \text{SLD1 hysteresis})$                          |
| Turn off delay time | Turn off condition must remain valid for <i>SLD1 drop out delay</i> .<br>After the delay <i>SLD1 status</i> = False. |

***SLD1 compare mode = In1-In2<Sen***

|                     |                                                                                                                      |
|---------------------|----------------------------------------------------------------------------------------------------------------------|
| Turn on condition   | $(\text{Input 1} - \text{Input 2}) < \text{SLD1 sensitivity}$                                                        |
| Turn on delay time  | Turn on condition must remain valid for <i>SLD1 pick up delay</i> .<br>After the delay <i>SLD1 status</i> = True.    |
| Turn off condition  | $(\text{Input 1} - \text{Input 2}) \geq (\text{SLD1 sensitivity} + \text{SLD1 hysteresis})$                          |
| Turn off delay time | Turn off condition must remain valid for <i>SLD1 drop out delay</i> .<br>After the delay <i>SLD1 status</i> = False. |

***SLD1 compare mode = In1<>In2***

|                    |                                                                                                                   |
|--------------------|-------------------------------------------------------------------------------------------------------------------|
| Turn on condition  | Absolute value of $(\text{Input 1} - \text{Input 2}) > \text{SLD1 sensitivity}$                                   |
| Turn on delay time | Turn on condition must remain valid for <i>SLD1 pick up delay</i> .<br>After the delay <i>SLD1 status</i> = True. |
| Turn off condition | Absolute value of $(\text{Input 1} - \text{Input 2}) \leq (\text{SLD1 sensitivity} - \text{SLD1 hysteresis})$     |

|                                                           |                                                                                                                                                                                                               |
|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                           | <i>hysteresis)</i>                                                                                                                                                                                            |
| Turn off delay time                                       | Turn off condition must remain valid for <i>SLD1 drop out delay</i> .<br>After the delay <i>SLD1 status</i> = False.                                                                                          |
| <b><i>SLD1 compare mode = In1=In2</i></b>                 |                                                                                                                                                                                                               |
| Turn on condition                                         | Absolute value of (Input 1 - Input 2) <= <i>SLD1 sensitivity</i>                                                                                                                                              |
| Turn on delay time                                        | Turn on condition must remain valid for <i>SLD1 pick up delay</i> .<br>After the delay <i>SLD1 status</i> = True.                                                                                             |
| Turn off condition                                        | Absolute value of (Input 1 - Input 2) > ( <i>SLD1 sensitivity</i> + <i>SLD1 hysteresis</i> )                                                                                                                  |
| Turn off delay time                                       | Turn off condition must remain valid for <i>SLD1 drop out delay</i> .<br>After the delay <i>SLD1 status</i> = False.                                                                                          |
| <b><i>SLD1 compare mode = In1-In2&gt;Sen one shot</i></b> |                                                                                                                                                                                                               |
| Turn on condition                                         | (Input 1 - Input 2) > <i>SLD1 sensitivity</i>                                                                                                                                                                 |
| 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.<br>After <i>SLD1 pick up delay</i> expires <i>SLD1 status</i> = True.            |
| Turn off condition                                        | After <i>SLD1 status</i> goes True a timer begins.<br>After <i>SLD1 drop out delay</i> expires <i>SLD1 status</i> = False.<br><br>The minimum time <i>SLD1 status</i> is True is approximately 1 millisecond. |
| Reset condition                                           | SLD 1 becomes active again when<br>(Input 1 - Input 2) <= ( <i>SLD1 sensitivity</i> - <i>SLD1 hysteresis</i> )                                                                                                |
| <b><i>SLD1 compare mode = In1-In2&lt;Sen one shot</i></b> |                                                                                                                                                                                                               |
| Turn on condition                                         | (Input 1 - Input 2) < <i>SLD1 sensitivity</i>                                                                                                                                                                 |
| 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.<br>After <i>SLD1 pick up delay</i> expires <i>SLD1 status</i> = True.            |
| Turn off condition                                        | After <i>SLD1 status</i> goes True a timer begins.<br>After <i>SLD1 drop out delay</i> expires <i>SLD1 status</i> = False.                                                                                    |

|                 |                                                                                                                |
|-----------------|----------------------------------------------------------------------------------------------------------------|
|                 | The minimum time <i>SLD1 status</i> is True is approximately 1 millisecond.                                    |
| Reset condition | SLD 1 becomes active again when<br>(Input 1 - Input 2) >= ( <i>SLD1 sensitivity</i> + <i>SLD1 hysteresis</i> ) |

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.

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

Function outputs

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

| <i>Variable</i>        | <i>Description</i>          |
|------------------------|-----------------------------|
| <i>Simulated speed</i> | Motor speed. Radians/second |

## Function configuration

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

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

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## 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 low voltage drive with torque control and general industrial application pattern takes the following form:

ACDCFG-*FRAM*-*VOLT*-*AMPS*-xxx-xxxxx-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 ACDCFG. The characters have the following meanings:

|     |                   |
|-----|-------------------|
| AC  | AC inverter drive |
| DCF | DC fed            |

#### Pattern field

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

|   |                                                           |
|---|-----------------------------------------------------------|
| G | Torque control and general industrial application pattern |
|---|-----------------------------------------------------------|

#### Frame size field (IPN frame size )

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

|      |                   |
|------|-------------------|
| FRAM | Bridge frame size |
|------|-------------------|

The following low voltage drive frame sizes are supported:  
0065, 0092, 0125, 0180, 0250, 0375, 0620, 1000, 1800

### System voltage field (IPN volt rating )

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

VOLT            Maximum lineup output AC voltage

The low voltage drive supports the following system voltages:  
0575

### Shunt rating field (IPN shunt size )

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

AMPS            Total shunt amp rating per phase

The low voltage drive supports the following shunt ratings:

| <b><i>IPN frame size</i></b> | <b><i>IPN shunt size</i></b>                               |
|------------------------------|------------------------------------------------------------|
| 0065                         | 0001, 0002, 0005, 0008, 0010, 0015, 0025, 0040, 0050, 0075 |
| 0092                         | 0035, 0050, 0075, 0100                                     |
| 0125                         | 0050, 0075, 0100, 0150                                     |
| 0180                         | 0075, 0100, 0150, 0200                                     |
| 0250                         | 0100, 0150, 0200, 0250, 0300                               |
| 0375                         | 0150, 0200, 0300, 0400                                     |
| 0620                         | 0200, 0300, 0400, 0500, 0600, 0800                         |
| 1000                         | 0300, 0400, 0500, 0600, 0800, 1000, 1200                   |
| 1800                         | 1200, 1600, 2000, 2400                                     |

NOTE: For the 1800 frame size there are two shunts per phase because of the parallel bridge configuration. The shunt rating is the sum of the two shunts that exist in each phase. For example, if two 1200A shunts exist in each phase, the entered shunt rating should be 2400.

## Primary Motor & Application Data

### User entered parameters

Seven 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:

| <b>Parameter</b>           | <b>Description</b>                                 |
|----------------------------|----------------------------------------------------|
| <i>Motor rated current</i> | Motor nameplate current. Amps                      |
| <i>Motor rated voltage</i> | Motor nameplate voltage. Volts                     |
| <i>Crossover Voltage</i>   | Voltage at which field weakening begins. RMS volts |
| <i>Motor rated power</i>   | Motor nameplate power. Kilowatts or Horsepower     |
| <i>Motor rated freq</i>    | Motor nameplate frequency. Hertz                   |
| <i>Motor rated rpm</i>     | Motor nameplate speed. RPM                         |
| <i>Applied top RPM</i>     | 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:

| <b>Variable</b>           | <b>Description</b>                                                                             |
|---------------------------|------------------------------------------------------------------------------------------------|
| <i>100% Motor current</i> | Motor nameplate current. RMS amps                                                              |
| <i>100% Motor voltage</i> | Voltage at which field weakening begins. RMS volts                                             |
| <i>100% Motor power</i>   | Motor nameplate power. Kilowatts or Horsepower                                                 |
| <i>100% Applied RPM</i>   | 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:

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

## Display meter scaling parameters

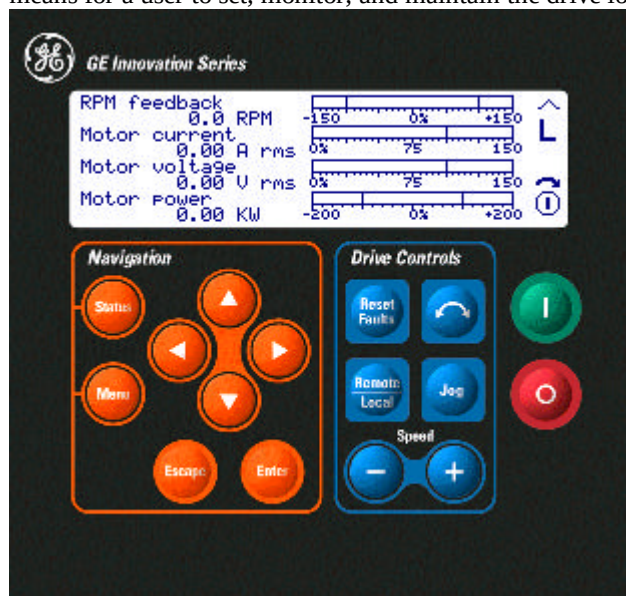
The Innovation Series drive contains a set of parameters that specify the scaling for the DDI and toolbox display meters. These parameters are calculated from the primary motor and application parameters. They are calculated within the *Drive Commissioning* wizard or the *Per Unit Setup* wizard. If any 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 select a Screen Contrast Adjustment under one of the menus on the Menu screen.

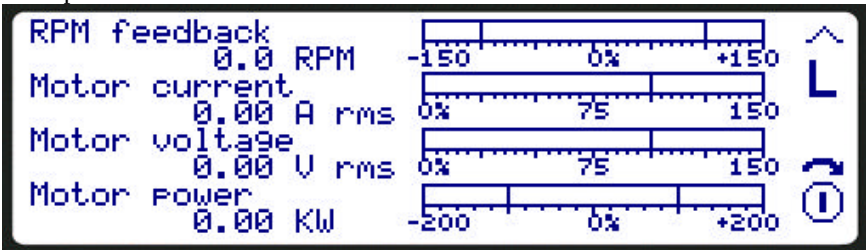
However, there may be situations where the DDI contrast is too light or too dark for the user to navigate through the menus. If this occurs, the *Keypad contrast adj* parameter may be adjusted from the toolbox.

**Function configuration**

| <i>Parameter</i>           | <i>Description</i>                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Keypad contrast adj</i> | Adjusts the contrast of the DDI LCD screen. Values are from 0 to 63 where 63 is the darkest contrast. Setting <i>Keypad contrast adj</i> to 0 will cause the DDI to adjust the contrast to a middle value.<br><br><i>Note:</i> Once <i>Keypad contrast adj</i> 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

| <i>Parameter</i>            | <i>Description</i>                                                                                                                                                                                                                                                                                                                                                |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Keypad meter 1 sel</i>   | Selects a floating-point variable that is displayed in Meter #1 on the DDI Status screen.                                                                                                                                                                                                                                                                         |
| <i>Keypad meter 2 sel</i>   | Selects a floating-point variable that is displayed in Meter #2 on the DDI Status screen.                                                                                                                                                                                                                                                                         |
| <i>Keypad meter 3 sel</i>   | Selects a floating-point variable that is displayed in Meter #3 on the DDI Status screen.                                                                                                                                                                                                                                                                         |
| <i>Keypad meter 4 sel</i>   | Selects a floating-point variable that is displayed in Meter #4 on the DDI Status screen.                                                                                                                                                                                                                                                                         |
| <i>Keypad meter 1 range</i> | Selects the bar graph meter scaling for Meter #1.<br><br>Possible values are as follows (note that all bar graphs are scaled in percent (%)): <ul style="list-style-type: none"><li>• 0 to +100</li><li>• -100 to +100</li><li>• 0 to +150</li><li>• -150 to +150</li><li>• 0 to +200</li><li>• -200 to +200</li><li>• 0 to +300</li><li>• -300 to +300</li></ul> |
| <i>Keypad meter 2 range</i> | Selects the bar graph meter scaling for Meter #2. See <i>Keypad meter 1 range</i> for possible values.                                                                                                                                                                                                                                                            |
| <i>Keypad meter 3 range</i> | Selects the bar graph meter scaling for Meter #3. See <i>Keypad meter 1 range</i> for possible values.                                                                                                                                                                                                                                                            |
| <i>Keypad meter 4 range</i> | Selects the bar graph meter scaling for Meter #4. See <i>Keypad meter 1 range</i> for possible values.                                                                                                                                                                                                                                                            |

**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

| <i>Parameter</i>        | <i>Description</i>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Keypad privilege</i> | Selects the privilege level in the DDI. Possible levels are: <ul style="list-style-type: none"><li>• <i>Read only</i> - Disables both drive controls and configuration functions. Allows user to view but not edit parameters.</li><li>• <i>Operate &amp; read only</i> - Enables drive controls, but disables configuration functions. Allows user to view but not edit parameters.</li><li>• <i>Configure &amp; operate</i> - Enables both drive controls and configuration functions.</li></ul> |

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 (i.e. *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 | Configure & operate |
| <b>Drive control functions</b>          |                 |                     |                     |
| Stop                                    | ✓               | ✓                   | ✓                   |
| Start                                   |                 | ✓                   | ✓                   |
| Reset faults                            | ✓               | ✓                   | ✓                   |
| Change direction                        |                 | ✓                   | ✓                   |
| Remote/Local                            |                 | ✓                   | ✓                   |
| Jog                                     |                 | ✓                   | ✓                   |
| Speed Increment                         |                 | ✓                   | ✓                   |
| Speed Decrement                         |                 | ✓                   | ✓                   |
| <b>Menu functions</b>                   |                 |                     |                     |
| 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.

| <i>Display units</i>      | <i>Length</i> | <i>Power</i> | <i>Torque</i> | <i>Flux</i> |
|---------------------------|---------------|--------------|---------------|-------------|
| <i>Imperial (English)</i> | Feet          | Horsepower   | Foot-pounds   | Volts/hertz |
| <i>Metric (SI)</i>        | Meters        | Kilowatts    | Newton-meters | Volts/hertz |
| <i>Native (Platform)</i>  | 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.

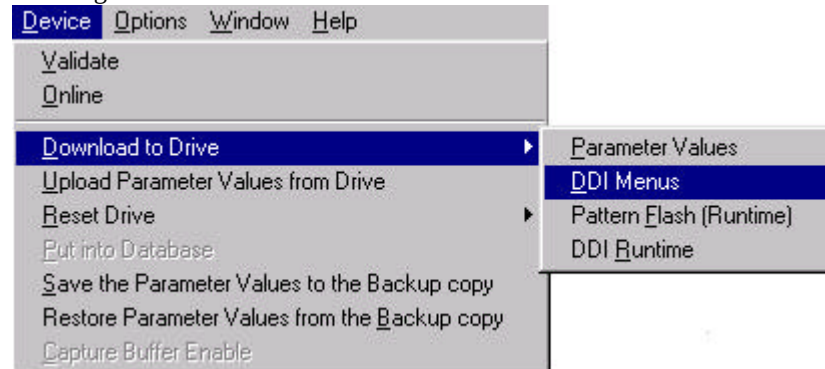
**Note:** *Presently this function is not yet operational.*

### Function configuration

| <i>Parameter</i> | <i>Description</i>                                                                                                                                                                                                                                                                                                                              |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Language</i>  | Selects the language in which to display all information in the DDI. Possible selections are: <ul style="list-style-type: none"><li>• <i>English</i> - Displays DDI text in English.</li><li>• <i>Native</i> - Displays DDI text in the native language that is specified when DDI Menus are downloaded from the toolbox (see below).</li></ul> |

## 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.

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## 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>I/O test mode req</i> | Hardware I/O test request. |
| <i>Simulate mode</i>     | 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.

| <b>Variable</b>             | <b>Description</b>                         |
|-----------------------------|--------------------------------------------|
| <i>Analog input 1 volts</i> | Voltage of analog input 1 source. DC volts |
| <i>Analog input 2 volts</i> | Voltage of analog input 2 source. DC volts |

### Digital inputs

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

| <b>Variable</b>             | <b>Description</b>                   |
|-----------------------------|--------------------------------------|
| <i>Digital input 1 test</i> | Unfiltered value of digital input 1. |
| <i>Digital input 2 test</i> | Unfiltered value of digital input 2. |
| <i>Digital input 3 test</i> | Unfiltered value of digital input 3. |
| <i>Digital input 4 test</i> | Unfiltered value of digital input 4. |
| <i>Digital input 5 test</i> | Unfiltered value of digital input 5. |
| <i>Digital input 6 test</i> | Unfiltered value of digital input 6. |

### Hi-fi counters

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

| <b>Variable</b>         | <b>Description</b>   |
|-------------------------|----------------------|
| <i>VCO 1 unfiltered</i> | VCO 1 counter value. |
| <i>VCO 2 unfiltered</i> | VCO 1 counter value. |
| <i>VCO 3 unfiltered</i> | VCO 1 counter value. |

### Local and system fault strings

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

| <b>Variable</b>          | <b>Description</b>                       |
|--------------------------|------------------------------------------|
| <i>Local fault test</i>  | Unfiltered value of local fault string.  |
| <i>System fault test</i> | Unfiltered value of system fault string. |

### Contactors status

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

| <b>Variable</b>          | <b>Description</b>                         |
|--------------------------|--------------------------------------------|
| <i>MA cont test mode</i> | 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.

| <b>Parameter</b>           | <b>Description</b>                       |
|----------------------------|------------------------------------------|
| <i>Analog out 1 test</i>   | DAC 1 output voltage. DC volts           |
| <i>Analog out 1 test</i>   | DAC 2 output voltage. DC volts           |
| <i>Analog out 1 test</i>   | DAC 3 / Meter 1 output voltage. DC volts |
| <i>Analog out 1 test</i>   | DAC 4 / Meter 2 output voltage. DC volts |
| <i>Analog meter 3 test</i> | Meter 3 output voltage. DC volts         |
| <i>Analog meter 4 test</i> | Meter 4 output voltage. DC volts         |

## Relay outputs

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

| <b>Parameter</b>            | <b>Description</b> |
|-----------------------------|--------------------|
| <i>Relay 1 test</i>         | Relay 1 output.    |
| <i>Relay 2 test</i>         | Relay 2 output.    |
| <i>Relay 3 test</i>         | Relay 3 output.    |
| <i>SS relay driver test</i> | 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 Vdc, 10mA 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.

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)

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# 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.

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

| <b>Parameter</b>         | <b>Description</b>                                                                                                                                                                                                                                                                                                                |
|--------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Network interface</i> | Network interface type. Specifies one of the following interface types: <ul style="list-style-type: none"><li>• No interface</li><li>• ACL dual port memory (synchronous operation supported)</li><li>• ISBus (synchronous operation supported)</li><li>• DRIVENET - Optional LAN modules such as Genius &amp; Profibus</li></ul> |
| <i>LAN frame time</i>    | 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.

| <b>Parameter</b>         | <b>Description</b>                                                                                                                                                                                                                                                |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Network interface</i> | Network interface type. Specifies one of the following interface types: <ul style="list-style-type: none"><li>• No interface</li><li>• ACL dual port memory</li><li>• ISBus</li><li>• DRIVENET - Other optional LAN modules such as Genius and Profibus</li></ul> |
| <i>LAN frame time</i>    | Expected communication frame period. Allowed frame periods are 1, 2, 4, and 8 milliseconds.                                                                                                                                                                       |
| <i>LAN fbk avg time</i>  | Period over which feedback signals are sequentially averaged. The <i>LAN Signal Map</i> help topic describes which feedback signals are averaged. If <i>LAN fbk avg time</i> is zero, no averaging occurs.                                                        |

|                                                 |                                                                                                                                                                                                                                                             |
|-------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>LAN cmds inhibit</i>                         | 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.                                                                                                   |
| <i>LAN trips inhibit</i>                        | Disables LAN heartbeat trip fault ( <i>LAN heartbeat trip</i> ), and enable the corresponding alarm ( <i>LAN heartbeat alarm</i> ).                                                                                                                         |
| <i>LAN heartbeat time</i>                       | Period within which transition must be detected in the LAN heartbeat signal ( <i>Heartbeat ref, lan</i> ) to satisfy the local heartbeat timeout check.                                                                                                     |
| <i>Sys ISBus node #</i>                         | ISBus node for the Innovation Series Drive device. Each device on the ISBus bus should be assigned a unique node between 1 and 31.                                                                                                                          |
| <i>LAN parameter 1 through LAN parameter 16</i> | 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.

| <b>Variable</b>            | <b>Description</b>                                                                                                                                                                                                                               |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>LAN connection ok</i>   | Indicates that the health of the LAN connection is good, such that the LAN watchdog function is satisfied.                                                                                                                                       |
| <i>LAN commands OK</i>     | Indicates that the health of the LAN references is good, based upon detection of two successive <i>LAN connection ok</i> indications.                                                                                                            |
| <i>Heartbeat ref, lan</i>  | LAN heartbeat signal that proceeds from the application layer to the local device, used locally for <i>LAN heartbeat trip</i> ) and <i>LAN heartbeat alarm</i> ) detection, and as the source of the reflected <i>Heartbeat fbk, lan</i> signal. |
| <i>Heartbeat fbk, lan</i>  | Local device reflection of the <i>Heartbeat ref, lan</i> signal that is sent back to the application layer.                                                                                                                                      |
| <i>Sys ISBus error cnt</i> | Counter signal which provides an indication of the rate of occurrence of ISBus fault conditions.                                                                                                                                                 |
| <i>Sys ISBus error reg</i> | Bit-coded value of the last ISBus fault detected; each bit indicates a particular ISBus fault seen by the control.                                                                                                                               |
| <i>Frame PLL OK status</i> | Boolean signal indicating the lock status of the <i>Frame Phaselock Loop</i> .                                                                                                                                                                   |
| <i>FPLL Phase error</i>    | Phase error signal for the <i>Frame Phaselock Loop</i> . 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.

| <i>Page &amp; Element</i> | <i>Signal</i>              | <i>Data Type</i> | <i>Description</i>                                                                                           |
|---------------------------|----------------------------|------------------|--------------------------------------------------------------------------------------------------------------|
| 1 1                       |                            | Boolean bits     | Boolean requests. See following table for definition of request bits.                                        |
| 1 2                       | <i>Auto speed ref, lan</i> | Floating point   | Auto speed reference that can be used in the <i>Speed Reference Generation</i> function. RPM                 |
| 1 3                       | <i>Spd ref offset, lan</i> | Floating point   | Speed reference offset that can be used prior to the <i>Speed/Torque Regulator</i> function. RPM             |
| 1 4                       | <i>Torque ref, lan</i>     | Floating point   | Torque reference that can be used in the <i>Speed/Torque Regulator</i> function. Newton-meters or Pound-feet |
| 1 5                       | Unused                     |                  |                                                                                                              |
| 1 6                       | Unused                     |                  |                                                                                                              |
| 1 7                       | <i>GP lan ref 1</i>        | Floating point   | General purpose reference that can be used by a number of functions.                                         |
| 1 8                       | <i>GP lan ref 2</i>        | Floating         | General purpose                                                                                              |

|   |   |                            |                |                                                                                                                           |
|---|---|----------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------|
|   |   |                            | point          | reference that can be used by a number of functions.                                                                      |
| 2 | 1 | <i>Torque fdfwd, lan</i>   | Floating point | Torque feed forward reference that can be used in the <i>Speed/Torque Regulator</i> function. Newton-meters or Pound-feet |
| 2 | 2 | <i>Flux reference, lan</i> | Floating point | Flux scale that can be used in the <i>Motor Control Interface</i> function.                                               |
| 2 | 3 | <i>Droop comp ref, lan</i> | Floating point | Droop compensation reference that can be used in the <i>Droop</i> function. Per unit torque                               |
| 2 | 4 | Unused                     |                |                                                                                                                           |
| 2 | 5 | Unused                     |                |                                                                                                                           |
| 2 | 6 | Unused                     |                |                                                                                                                           |
| 2 | 7 | <i>GP lan ref 3</i>        | Floating point | General purpose reference that can be used by a number of functions.                                                      |
| 2 | 8 | <i>GP lan ref 4</i>        | 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.

| <b>Bit</b> | <b>Signal</b>               | <b>Description</b>                                                         |
|------------|-----------------------------|----------------------------------------------------------------------------|
| 0          | <i>Heartbeat ref, lan</i>   | Heartbeat signal to validate LAN health.                                   |
| 1          | <i>Fault reset req, lan</i> | Request to reset drive faults. Functionality is always enabled.            |
| 2          | <i>Trip request, lan</i>    | Request to trip the drive. Functionality is always enabled.                |
| 3          | <i>Alarm request, lan</i>   | Request to declare an alarm in the drive. Functionality is always enabled. |
| 4          | Unused                      |                                                                            |
| 5          | Unused                      |                                                                            |
| 6          | Unused                      |                                                                            |
| 7          | Unused                      |                                                                            |
| 8          | <i>Run request, lan</i>     | Request to run the drive. Functionality is always enabled.                 |

|    |                             |                                                                                                                  |
|----|-----------------------------|------------------------------------------------------------------------------------------------------------------|
| 9  | <i>Jog request, lan</i>     | Request to jog the drive. Functionality is always enabled.                                                       |
| 10 | <i>X stop request, lan</i>  | Request to perform an X stop in the drive. Functionality is always enabled.                                      |
| 11 | <i>Full flux req, lan</i>   | Request to flux the drive. Functionality is always enabled.                                                      |
| 12 | <i>Rev mode req, lan</i>    | Request to reverse the direction of rotation that can be used in the <i>Speed Reference Generation</i> function. |
| 13 | <i>Torque mode req, lan</i> | Request to enable torque mode that can be used in the <i>Speed/Torque Regulator</i> function.                    |
| 14 | <i>Droop disab req, lan</i> | Request to inhibit droop functionality that can be used in the <i>Droop</i> function.                            |
| 15 | <i>Trq lim 2 sel, lan</i>   | Request to choose between torque limits that can be used in the <i>Motor Control Interface</i> function.         |
| 16 | <i>Ramp rate 2 sel, lan</i> | Request to choose between ramp rates that can be used in the <i>Speed Reference Ramp</i> function.               |
| 17 | Unused                      |                                                                                                                  |
| 18 | <i>Auto mode req, lan</i>   | Request to enable auto reference mode that can be used in the <i>Speed Reference Generation</i> function.        |
| 19 | Unused                      |                                                                                                                  |
| 20 | Unused                      |                                                                                                                  |
| 21 | Unused                      |                                                                                                                  |
| 22 | Unused                      |                                                                                                                  |
| 23 | Unused                      |                                                                                                                  |
| 24 | <i>GP lan req bit 1</i>     | General purpose request that can be used by a number of functions.                                               |
| 25 | <i>GP lan req bit 2</i>     | General purpose request that can be used by a number of functions.                                               |
| 26 | <i>GP lan req bit 3</i>     | General purpose request that can be used by a number of functions.                                               |
| 27 | <i>GP lan req bit 4</i>     | General purpose request that can be used by a number of functions.                                               |
| 28 | <i>GP lan req bit 5</i>     | General purpose request that can be used by a number of functions.                                               |
| 29 | <i>GP lan req bit 6</i>     | General purpose request that can be used by a number of functions.                                               |
| 30 | <i>GP lan req bit 7</i>     | General purpose request that can be used by a number of functions.                                               |
| 31 | <i>GP lan req bit 8</i>     | 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.

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

|   |   |                         |                |                                                                    |
|---|---|-------------------------|----------------|--------------------------------------------------------------------|
| 2 | 5 | Unused                  |                |                                                                    |
| 2 | 6 | Unused                  |                |                                                                    |
| 2 | 7 | <i>GP lan fbk reg 3</i> | Floating point | General purpose feedback selected by <i>GP lan fbk reg 3 sel</i> . |
| 2 | 8 | <i>GP lan fbk reg 4</i> | Floating point | General purpose feedback selected by <i>GP lan fbk reg 4 sel</i> . |

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.

| <b>Bit</b> | <b>Signal</b>              | <b>Description</b>                                       |
|------------|----------------------------|----------------------------------------------------------|
| 0          | <i>Heartbeat fbk, lan</i>  | Heartbeat signal to validate LAN health.                 |
| 1          | <i>No faults active</i>    | No trip faults or alarms are active in the drive.        |
| 2          | <i>Trip fault active</i>   | Trip fault is active in the drive.                       |
| 3          | <i>Local fault string</i>  | Local hardware permissive fault is active in the drive.  |
| 4          | <i>System fault string</i> | System hardware permissive fault is active in the drive. |
| 5          | <i>Ready to run</i>        | Drive is ready and will respond to a run request.        |
| 6          | <i>Bridge is on</i>        | Bridge power is enabled.                                 |
| 7          | <i>Running</i>             | Drive is running; References and regulators are enabled. |
| 8          | <i>Run active</i>          | Drive is running in response to a run request.           |
| 9          | <i>Jog active</i>          | Drive is running in response to a jog request.           |
| 10         | <i>X stop active</i>       | Result of X stop requests.                               |
| 11         | <i>Flux enable status</i>  | Net commanded flux is established.                       |
| 12         | <i>Reverse mode active</i> | Result of reverse mode requests.                         |

|    |                            |                                                                                                |
|----|----------------------------|------------------------------------------------------------------------------------------------|
| 13 | <i>Torque mode active</i>  | <i>Speed/Torque Regulator</i> function is regulating torque.                                   |
| 14 | <i>Speed mode active</i>   | <i>Speed/Torque Regulator</i> function is regulating speed.                                    |
| 15 | <i>In cur or trq limit</i> | Inner torque regulator is in limit.                                                            |
| 16 | Unused                     |                                                                                                |
| 17 | <i>MA cont enable stat</i> | Real or modeled contactor status.                                                              |
| 18 | <i>Auto mode active</i>    | Speed reference source is auto reference.                                                      |
| 19 | <i>Zero speed active</i>   | Speed feedback ( <i>Speed reg fbk</i> ) is below zero speed level ( <i>Zero speed level</i> ). |
| 20 | Unused                     |                                                                                                |
| 21 | Unused                     |                                                                                                |
| 22 | Unused                     |                                                                                                |
| 23 | <i>Lan diag fbk bit 1</i>  | Drive has diagnostic information for the diagnostic master.                                    |
| 24 | <i>GP lan fbk bit 1</i>    | General purpose feedback selected by <i>GP lan fbk bit 1 sel</i> .                             |
| 25 | <i>GP lan fbk bit 2</i>    | General purpose feedback selected by <i>GP lan fbk bit 2 sel</i> .                             |
| 26 | <i>GP lan fbk bit 3</i>    | General purpose feedback selected by <i>GP lan fbk bit 3 sel</i> .                             |
| 27 | <i>GP lan fbk bit 4</i>    | General purpose feedback selected by <i>GP lan fbk bit 4 sel</i> .                             |
| 28 | <i>GP lan fbk bit 5</i>    | General purpose feedback selected by <i>GP lan fbk bit 5 sel</i> .                             |
| 29 | <i>GP lan fbk bit 6</i>    | General purpose feedback selected by <i>GP lan fbk bit 6 sel</i> .                             |
| 30 | <i>GP lan fbk bit 7</i>    | General purpose feedback selected by <i>GP lan fbk bit 7 sel</i> .                             |
| 31 | <i>GP lan fbk bit 8</i>    | General purpose feedback selected by <i>GP lan fbk bit 8 sel</i> .                             |

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)

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## ***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
- On-line 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*.

| <b>Parameter</b>            | <b>Description</b>                          |
|-----------------------------|---------------------------------------------|
| <i>Flux curve voltage 1</i> | No load voltage for data point 1. RMS volts |
| <i>Flux curve voltage 2</i> | No load voltage for data point 2. RMS volts |
| <i>Flux curve voltage 3</i> | No load voltage for data point 3. RMS volts |
| <i>Flux curve voltage 4</i> | No load voltage for data point 4. RMS volts |
| <i>Flux curve voltage 5</i> | No load voltage for data point 5. RMS volts |
| <i>Flux curve amps 1</i>    | No load current for data point 1. RMS amps  |

|                          |                                            |
|--------------------------|--------------------------------------------|
| <i>Flux curve amps 2</i> | No load current for data point 2. RMS amps |
| <i>Flux curve amps 3</i> | No load current for data point 3. RMS amps |
| <i>Flux curve amps 4</i> | No load current for data point 4. RMS amps |
| <i>Flux curve amps 5</i> | 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*.

## 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*.

| <b>Parameter</b>            | <b>Description</b>             |
|-----------------------------|--------------------------------|
| <i>Stator hot res R1</i>    | Stator hot resistance. Ohms    |
| <i>Stator cold res R1</i>   | Stator cold resistance. Ohms   |
| <i>Rotor hot res R2</i>     | Rotor hot resistance. Ohms     |
| <i>Rotor cold res R2</i>    | Rotor cold resistance. Ohms    |
| <i>Magnetizing react Xm</i> | Magnetizing reactance. Ohms    |
| <i>Stator lkg react X1</i>  | Stator leakage reactance. Ohms |

|                           |                                                   |
|---------------------------|---------------------------------------------------|
| <i>Rotor lkg react X2</i> | Rotor leakage reactance. Ohms                     |
| <i>Starting react Xst</i> | Starting reactance. Ohms                          |
| <i>Rated rotor temp</i>   | Rated rotor temperature. Degrees C or Degrees F   |
| <i>Motor ambient temp</i> | 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*.

| <b>Variable</b>    | <b>Description</b>                                   |
|--------------------|------------------------------------------------------|
| <i>Rotor temp</i>  | Estimated rotor temperature. Degrees C or Degrees F  |
| <i>Stator temp</i> | 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.

| <b>Variable</b>        | <b>Description</b>        |
|------------------------|---------------------------|
| <i>DC bus feedback</i> | DC link voltage. DC volts |

### Function configuration

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

| <b>Parameter</b> | <b>Description</b> |
|------------------|--------------------|
|------------------|--------------------|

|                            |                                                                                                                                                                                           |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Power dip control</i>   | Specifies one of three functional modes: <ul style="list-style-type: none"> <li>• Disabled</li> <li>• Enabled with standard operation</li> <li>• Enabled with custom operation</li> </ul> |
| <i>Custom pwr dip time</i> | 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.

| <b>Fault</b>     | <b>Description</b>                                                                                                                                         |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Power dip</i> | 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

$$80\% \times \sqrt{2} \times \text{Max lineup output.}$$

*Max lineup output* depends on the voltage characteristics of the DC source which supplies voltage to the drive. Its value 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:

| <b>Value of <i>Power dip control</i></b> | <b>Expiration time</b>                             |
|------------------------------------------|----------------------------------------------------|
| <i>0.008 sec (Disable)</i>               | 0.008 seconds                                      |
| <i>1.0 sec (Enable)</i>                  | 1.0 seconds                                        |
| <i>Custom: Specify time</i>              | User specified value of <i>Custom pwr dip time</i> |

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*).

## 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.

| <b>Variable</b>           | <b>Description</b>                        |
|---------------------------|-------------------------------------------|
| <i>Output freq, unfil</i> | Motor electrical frequency. Hertz         |
| <i>Tach speed, instr.</i> | Tachometer speed feedback. Radians/second |

## Function configuration

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

| <b>Parameter</b>            | <b>Description</b>                                                                                           |
|-----------------------------|--------------------------------------------------------------------------------------------------------------|
| <i>Tach loss fault mode</i> | 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.

| <b>Fault</b>           | <b>Description</b>                                                                                                  |
|------------------------|---------------------------------------------------------------------------------------------------------------------|
| <i>Tach loss alarm</i> | Alarm that occurs when a loss of tachometer feedback is detected. Drive will continue run in tachless control mode. |
| <i>Tach loss trip</i>  | 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.

| <b>Parameter</b>         | <b>Description</b>                                       |
|--------------------------|----------------------------------------------------------|
| <i>User NC fault sel</i> | Selects the source of the normally closed circuit input. |
| <i>User NO fault sel</i> | 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.

| <b>Fault/Alarm</b>         | <b>Description</b>                                                                                          |
|----------------------------|-------------------------------------------------------------------------------------------------------------|
| <i>Customer use NC flt</i> | Trip fault that occurs when the normally closed circuit input is False, indicating that the circuit is open |
| <i>Customer use NO flt</i> | 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.

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

## Function configuration

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

| <b>Parameter</b>         | <b>Description</b>                                               |
|--------------------------|------------------------------------------------------------------|
| <i>DC bus region max</i> | High boundary of user specified DC link voltage region. DC volts |
| <i>DC bus region min</i> | 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*.

| <b>Fault/Alarm</b>          | <b>Description</b>                                           |
|-----------------------------|--------------------------------------------------------------|
| <i>DC bus over voltage</i>  | Trip fault that occurs when the DC link voltage is too high. |
| <i>DC bus under voltage</i> | Trip fault that occurs when the DC link voltage is too low.  |
| <i>DC bus voltage low</i>   | 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

$$123\% \times \sqrt{2} \times \text{Max lineup output.}$$

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

$$50\% \times \sqrt{2} \times \text{Max lineup output.}$$

*Max lineup output* depends on the voltage characteristics of the DC source which supplies voltage to the drive. Its value is specified during the drive commissioning process and should not be changed to alter the behavior of the DC link faults and alarms.

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  $DC\ bus\ region\ min \leq DC\ bus\ feedback \leq DC\ bus\ region\ max$ ,

$$DC\ bus\ excursion = 0.$$

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.

| <b>Parameter</b>       | <b>Description</b>             |
|------------------------|--------------------------------|
| <i>Phase A current</i> | Phase A current feedback. Amps |
| <i>Phase B current</i> | Phase B current feedback. Amps |
| <i>Phase C current</i> | Phase C current feedback. Amps |

### Function outputs

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

| <b>Variable</b>            | <b>Description</b>             |
|----------------------------|--------------------------------|
| <i>Gnd current, coarse</i> | Ground current, filtered. Amps |

### Function configuration

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

| <b>Parameter</b>           | <b>Description</b>                                                        |
|----------------------------|---------------------------------------------------------------------------|
| <i>Gnd flt coarse trip</i> | Current level at which the <i>Gnd flt, coarse</i> trip fault occurs. Amps |

### Faults and alarms

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

| <b>Fault / Alarm</b>   | <b>Description</b>                            |
|------------------------|-----------------------------------------------|
| <i>Gnd flt, coarse</i> | 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*.

## Ground Fault Protection (Slow)

The *Ground Fault Protection (Slow)* 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 (Slow)* function.

| <b>Parameter</b>       | <b>Description</b>             |
|------------------------|--------------------------------|
| <i>Phase A current</i> | Phase A current feedback. Amps |
| <i>Phase B current</i> | Phase B current feedback. Amps |
| <i>Phase C current</i> | Phase C current feedback. Amps |

### Function outputs

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

| <b>Variable</b>       | <b>Description</b>                              |
|-----------------------|-------------------------------------------------|
| <i>Ground current</i> | Ground current, averaged and filtered. RMS amps |

### Function configuration

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

| <b>Parameter</b>           | <b>Description</b>                                                              |
|----------------------------|---------------------------------------------------------------------------------|
| <i>Gnd flt trip level</i>  | Current level at which the <i>Gnd flt, filtered trip</i> fault occurs. RMS amps |
| <i>Gnd flt alm level</i>   | Current level at which the <i>Gnd flt alarm</i> alarm occurs. RMS amps          |
| <i>Gnd flt alm clr lvl</i> | Current level at which the <i>Gnd flt alarm</i> alarm clears. RMS amps          |

### Faults and alarms

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

| <b>Fault / Alarm</b>     | <b>Description</b>                                                                                                                 |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------|
| <i>Gnd flt, filtered</i> | Occurs when <i>Ground current</i> > <i>Gnd flt trip level</i> .                                                                    |
| <i>Gnd flt alarm</i>     | Occurs when <i>Ground current</i> > <i>Gnd flt alm level</i> .<br>Clears when <i>Ground current</i> < <i>Gnd flt alm clr lvl</i> . |

## Function description

*Ground current* is determined by summing, averaging, and filtering the phase currents *Phase A current*, *Phase B current*, and *Phase C current*.

The configuration parameters *Gnd flt trip level*, *Gnd flt alm level*, and *Gnd flt alm clr lvl* can be set to default values 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.

| <b>Variable</b>            | <b>Description</b>                        |
|----------------------------|-------------------------------------------|
| <i>Local fault string</i>  | State of the local fault string circuit.  |
| <i>System fault string</i> | State of the system fault string circuit. |

### Function configuration

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

| <b>Parameter</b>           | <b>Description</b>                                                     |
|----------------------------|------------------------------------------------------------------------|
| <i>Inh sim Loc/Sys flt</i> | 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*.

| <b>Fault/Alarm</b> | <b>Description</b>                                                   |
|--------------------|----------------------------------------------------------------------|
| <i>Local flt</i>   | Trip fault that occurs when the local fault string circuit is open.  |
| <i>System flt</i>  | 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 safe operating levels.

Different bridge frame sizes require different sets of hardware thermal inputs and generate different sets of temperature variables and faults. Click on one of the frame sizes below for more information on the *Heatsink Thermal Protection* function.

### **Frame sizes 65, 92, 125, 180**

The *Heatsink Thermal Protection* function measures one power bridge heatsink temperature and one ambient temperature for frame sizes 65, 92, 125, and 180.

### **Function inputs**

The inputs to the *Heatsink Thermal Protection* function are hardware thermal sensor connections. The following table specifies the required thermal sensor connections to backplane connector J4.

| <b><i>J4 pins</i></b> | <b><i>Required connection</i></b> |
|-----------------------|-----------------------------------|
| 1 & 2                 | Heatsink thermal sensor           |
| 3 & 4                 | Open                              |
| 5 & 6                 | Open                              |
| 7 & 8                 | Ambient thermal sensor            |

### **Function outputs**

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

| <b><i>Variable</i></b> | <b><i>Description</i></b>                             |
|------------------------|-------------------------------------------------------|
| <i>Heat sink temp</i>  | Measured heatsink temperature. Degrees C or Degrees F |

*Ambient temp*                      Measured bridge ambient temperature. Degrees C or Degrees F

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

### Related faults and alarms

The following faults and alarms are declared by the *Heatsink Thermal Protection* function.

- *HtSink over temp*
- *Ambient over temp*
- *HtSink temp hot*
- *Ambient temp hot*
- *HtSink temp low*
- *Ambient temp low*
- *HtSink sensor bad*
- *HtSink rise high*
- *HtSink B miswired*
- *HtSink C miswired*

### Frame sizes 250, 375, 620

The *Heatsink Thermal Protection* function measures two power bridge heatsink temperatures and one ambient temperature for frame sizes 250, 375, and 620.

### Function inputs

The inputs to the *Heatsink Thermal Protection* function are hardware thermal sensor connections. The following table specifies the required thermal sensor connections to backplane connector J4.

| <b><i>J4 pins</i></b> | <b><i>Required connection</i></b> |
|-----------------------|-----------------------------------|
| 1 & 2                 | Heatsink A thermal sensor         |
| 3 & 4                 | Heatsink B thermal sensor         |
| 5 & 6                 | Open                              |
| 7 & 8                 | Ambient thermal sensor            |

### Function outputs

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

| <b>Variable</b>          | <b>Description</b>                                          |
|--------------------------|-------------------------------------------------------------|
| <i>Heat sink temp, A</i> | Measured heatsink A temperature. Degrees C or Degrees F     |
| <i>Heat sink temp, B</i> | Measured heatsink B temperature. Degrees C or Degrees F     |
| <i>Ambient temp</i>      | Measured bridge ambient temperature. Degrees C or Degrees F |

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

### **Related faults and alarms**

The following faults and alarms are declared by the *Heatsink Thermal Protection* function.

- *HtSink over temp, A*
- *HtSink over temp, B*
- *Ambient over temp*
- *HtSink temp hot, A*
- *Htsink temp hot, B*
- *Ambient temp hot*
- *HtSink temp low, A*
- *HtSink temp low, B*
- *Ambient temp low*
- *HtSink sensor A bad*
- *HtSink sensor B bad*
- *HtSink rise high, A*
- *HtSink rise high, B*
- *HtSink temp imbalanc*
- *HtSink C miswired*

## Frame sizes 1000, 1800

The *Heatsink Thermal Protection* function measures three power bridge heatsink temperatures and one ambient temperature for frame sizes 1000 and 1800.

### Function inputs

The inputs to the *Heatsink Thermal Protection* function are hardware thermal sensor connections. The following table specifies the required thermal sensor connections to backplane connector J4.

| <b>J4 pins</b> | <b>Required connection</b> |
|----------------|----------------------------|
| 1 & 2          | Heatsink A thermal sensor  |
| 3 & 4          | Heatsink B thermal sensor  |
| 5 & 6          | Heatsink C thermal sensor  |
| 7 & 8          | Ambient thermal sensor     |

### Function outputs

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

| <b>Variable</b>            | <b>Description</b>                                          |
|----------------------------|-------------------------------------------------------------|
| <i>Phase A HtSink temp</i> | Measured heatsink A temperature. Degrees C or Degrees F     |
| <i>Phase B HtSink temp</i> | Measured heatsink B temperature. Degrees C or Degrees F     |
| <i>Phase C HtSink temp</i> | Measured heatsink C temperature. Degrees C or Degrees F     |
| <i>Ambient temp</i>        | Measured bridge ambient temperature. Degrees C or Degrees F |

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

### Related faults and alarms

The following faults and alarms are declared by the *Heatsink Thermal Protection* function.

- *HtSink A over temp*
- *HtSink B over temp*
- *HtSink C over temp*
- *Ambient over temp*
- *HtSink A temp hot*
- *HtSink B temp hot*

- *HtSink C temp hot*
- *Ambient temp hot*
- *HtSink A temp low*
- *HtSink B temp low*
- *HtSink C temp low*
- *Ambient temp low*
- *HtSink A sensor bad*
- *HtSink B sensor bad*
- *HtSink C sensor bad*
- *HtSink A rise high*
- *HtSink B rise high*
- *HtSink C rise high*
- *HtSink temp imbalanc*

## IGBT Thermal Protection

The *IGBT Thermal Protection* function implements a thermal model of the power bridge to determine the IGBT junction temperatures. It verifies the IGBTs are operating at a safe temperature.

### Function inputs

The *IGBT Thermal Protection* function calculates the IGBT junction temperatures from the measured heatsink temperatures and phase currents.

The following table specifies the heatsink temperature variables according to bridge frame size.

| <b><i>Frame size</i></b> | <b><i>Heatsink temperature variables</i></b>                         |
|--------------------------|----------------------------------------------------------------------|
| 65, 92, 125, 180         | <i>Heat sink temp</i>                                                |
| 250, 375, 620            | <i>Heat sink temp, A, Heat sink temp, B</i>                          |
| 1000, 1800               | <i>Phase A HtSink temp, Phase B HtSink temp, Phase C HtSink temp</i> |

The following table specifies the phase current variables.

| <b>Variable</b>        | <b>Description</b>             |
|------------------------|--------------------------------|
| <i>Phase A current</i> | Phase A current feedback. Amps |
| <i>Phase B current</i> | Phase B current feedback. Amps |
| <i>Phase C current</i> | Phase C current feedback. Amps |

### Function outputs

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

| <b>Variable</b>       | <b>Description</b>                                        |
|-----------------------|-----------------------------------------------------------|
| <i>Peak IGBT temp</i> | Maximum IGBT junction temperature. Degrees C or Degrees F |

### Related faults and alarms

The following faults and alarms are declared by the *IGBT Thermal Protection* function.

- *IGBT AL temp hot*
- *IGBT AU temp hot*
- *IGBT BL temp hot*
- *IGBT BU temp hot*
- *IGBT CL temp hot*
- *IGBT CU temp hot*
- *IGBT AL over temp*
- *IGBT AU over temp*
- *IGBT BL over temp*
- *IGBT BU over temp*
- *IGBT CL over temp*
- *IGBT CU over temp*

## 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.

| <b>Variable</b>            | <b>Description</b>                              |
|----------------------------|-------------------------------------------------|
| <i>Output volts, A-B</i>   | Filtered A-B line-line voltage. Line-line volts |
| <i>Output volts, B-C</i>   | Filtered B-C line-line voltage. Line-line volts |
| <i>A-B, Voltage offset</i> | Calculated A-B voltage offset. Line-line volts  |
| <i>B-C, Voltage offset</i> | 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*.

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

| <b>Parameter</b> | <b>Description</b> |
|------------------|--------------------|
|------------------|--------------------|

|                           |                                                          |
|---------------------------|----------------------------------------------------------|
| <i>Motor OT fault sel</i> | Selects the source of the motor overtemperature circuit. |
|---------------------------|----------------------------------------------------------|

## Function configuration

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

| <b>Parameter</b>           | <b>Description</b>                                                            |
|----------------------------|-------------------------------------------------------------------------------|
| <i>Motor OT fault mode</i> | 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.

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

## 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.

| <b>Variable</b>             | <b>Description</b>                      |
|-----------------------------|-----------------------------------------|
| <i>Phase A current</i>      | Filtered phase A current. Amps          |
| <i>Phase B current</i>      | Filtered phase B current. Amps          |
| <i>Phase C current</i>      | Filtered phase C current. Amps          |
| <i>Phs A current offset</i> | Calculated phase A current offset. Amps |
| <i>Phs B current offset</i> | Calculated phase B current offset. Amps |
| <i>Phs C current offset</i> | Calculated phase C current offset. Amps |

### Faults and alarms

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

| <b><i>Fault/Alarm</i></b> | <b><i>Description</i></b>                                           |
|---------------------------|---------------------------------------------------------------------|
| <i>Phase A cur offset</i> | Trip fault that occurs when the phase A current offset is too high. |
| <i>Phase B cur offset</i> | Trip fault that occurs when the phase B current offset is too high. |
| <i>Phase C cur offset</i> | 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.

| <b><i>Variable</i></b> | <b><i>Description</i></b> |
|------------------------|---------------------------|
| <i>Phase A current</i> | Phase A current. Amps     |
| <i>Phase B current</i> | Phase B current. Amps     |
| <i>Phase C current</i> | Phase C current. Amps     |

### Function outputs

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

| <b><i>Variable</i></b> | <b><i>Description</i></b>                                   |
|------------------------|-------------------------------------------------------------|
| <i>Ia^2 filtered</i>   | Squared and filtered phase A current. RMS amps <sup>2</sup> |
| <i>Ib^2 filtered</i>   | Squared and filtered phase B current. RMS amps <sup>2</sup> |
| <i>Ic^2 filtered</i>   | Squared and filtered phase C current. RMS amps <sup>2</sup> |

### Function configuration

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

| <b><i>Parameter</i></b> | <b><i>Description</i></b> |
|-------------------------|---------------------------|
|-------------------------|---------------------------|

|                            |                                                                                      |
|----------------------------|--------------------------------------------------------------------------------------|
| <i>Disable TOC profile</i> | Disables the application of the motor cooling profile to the squared phase currents. |
| <i>Motor protect class</i> | Motor protection class.                                                              |

## Faults and alarms

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

| <b><i>Fault/Alarm</i></b> | <b><i>Description</i></b>                                                                                         |
|---------------------------|-------------------------------------------------------------------------------------------------------------------|
| <i>Timed over current</i> | Trip fault that occurs when one or more of the squared phase currents is too high for an extended period of time. |
| <i>TOC pending</i>        | 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<sup>2</sup> filtered*, *Ib<sup>2</sup> filtered*, and *Ic<sup>2</sup> 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.

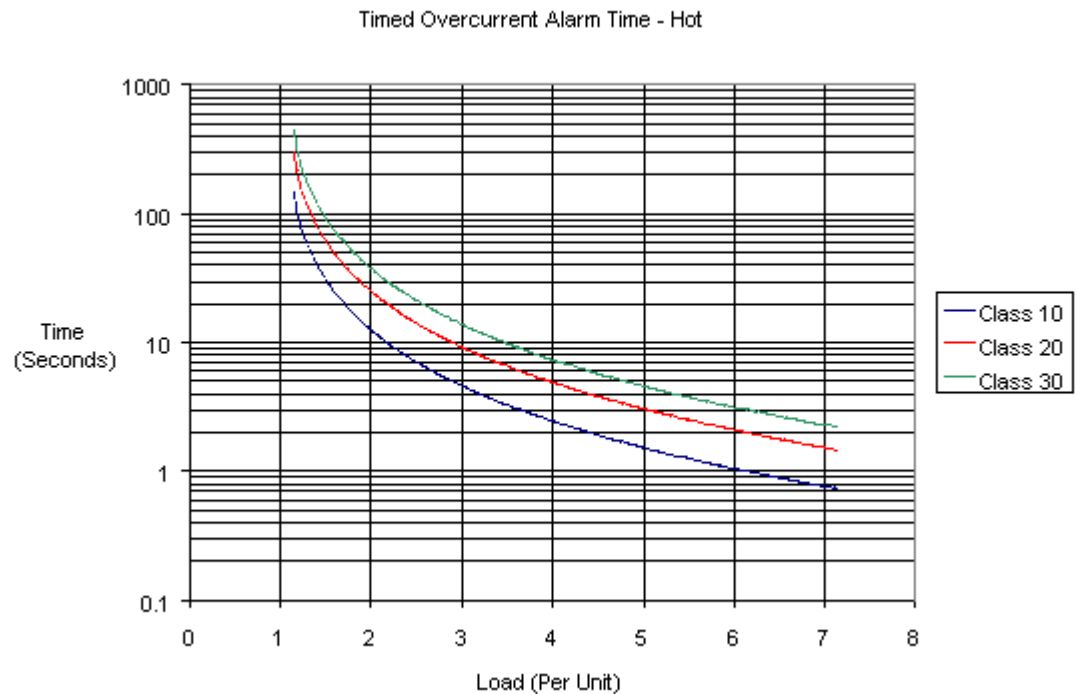
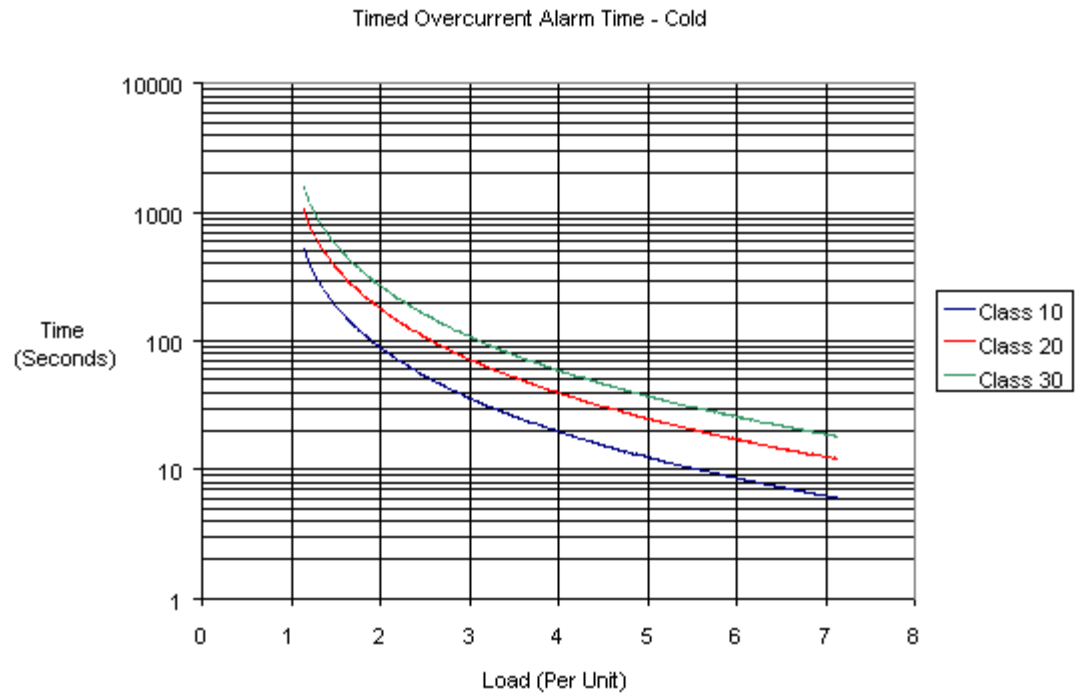
The following values are available for *Motor protect class*:

- *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.

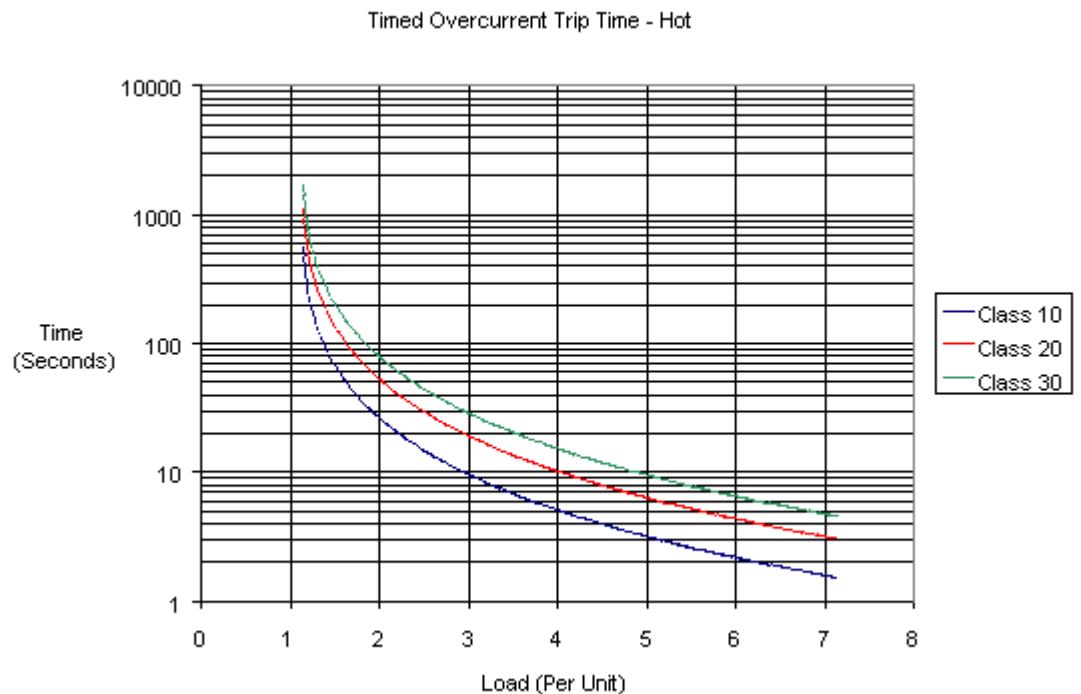
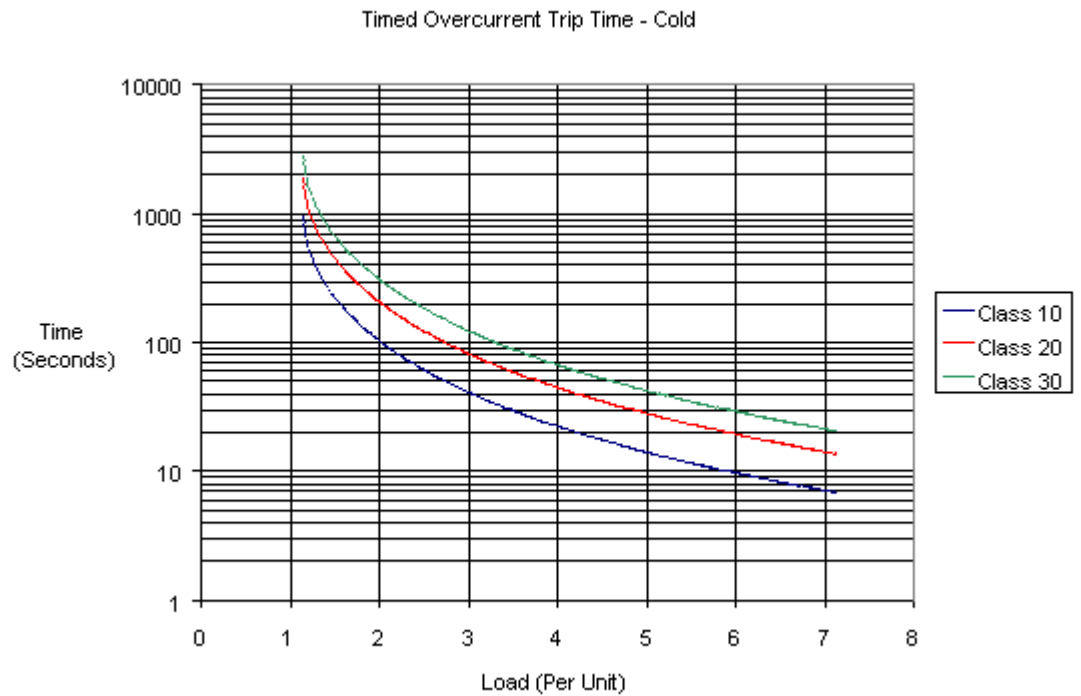
The following graphs show the time a motor of each of the protection classes can operate before reaching alarm conditions. The time is a function of the load applied

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.

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# 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*

*Fault reset select*

*Variable*

*Description*

Specifies a Boolean variable that requests a fault reset, when the variable transitions from a 0 to a 1 (Positive edge detected).

*Description*

|                             |                                                                                                                                                                                                                             |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Fault reset req, lan</i> | Requests a fault reset when the LAN is active and variable transitions from a 0 to a 1 (positive edge detected). Refer to <i>LAN Signal Map</i> . This variable must be selected in <i>Fault reset select</i> to be active. |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                           |                                      |
|-------------------------------------------|--------------------------------------|
| <b>DDI “Reset Faults”<br/>Push Button</b> | Requests a fault reset when pressed. |
|-------------------------------------------|--------------------------------------|

## Function outputs

| <i>Variable</i>          | <i>Description</i>                                                                                                                                                                                          |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Trip fault active</i> | Indicates when a Trip fault is present. <i>Trip fault active</i> is True when a Trip fault exists. It is a NC contact in the <i>Ready to run</i> permissive string. Refer to <i>Sequencer Permissives</i> . |
| <i>No trip fault</i>     | Indicates when a Trip fault is NOT present. Is True when there is no Trip fault. (Alarm may exist).                                                                                                         |
| <i>No faults active</i>  | 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

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

### Internal Permissive Inputs

| <b>Variable</b>           | <b>Description</b>                                                                                |
|---------------------------|---------------------------------------------------------------------------------------------------|
| <i>Local fault string</i> | Local hardware permissive. When <i>Local fault string</i> is True, it will prevent the drive from |

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

## Function outputs

| <b>Variable</b>             | <b>Description</b>                                                                                                                                                                                                                                          |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Ready to run</i>         | 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 <i>Ready to run</i> is True.                              |
| <i>Run ready and fluxed</i> | Indicates that the drive is fluxed and ready to run. This permissive can be used in coordination with <i>Full flux request</i> as a ready to run signal for applications that keep the drive fluxed for fast restarts. Refer to <i>Sequencer Commands</i> . |

## Function configuration

| <b>Parameter</b>       | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Bypass Q/C stop</i> | This parameter removes <i>Coast stop active</i> and <i>Quick stop active</i> from the <i>Ready to run</i> permissive, when they are normally included. <i>Bypass Q/C stop</i> should be set to Yes if <i>Normal stop mode</i> is set to <i>Quick stop</i> or <i>Coast stop</i> . (Also see <i>Stopping Commands and Modes</i> .)                                                                                                                                                                                                                                                                                                               |
| <i>Flying restart</i>  | This parameter has the following possible values: <ul style="list-style-type: none"> <li>• <i>Enable fly restart</i>: Allows the drive to restart while the motor speed is above the <i>Zero speed level</i>.</li> <li>• <i>Disable fly restart</i>: The motor speed must be below the <i>Zero speed level</i> before the drive can be restarted, otherwise a trip fault, <i>Flying restrt disabl</i>, will be generated.</li> <li>• <i>Locked shaft restart</i>: 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</li> </ul> |

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:

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

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

| <b>Variable</b>                           | <b>Description</b>                                                                                                                            |
|-------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Run request</i> and <i>Jog request</i> | A normal stop is generated when <i>Run request</i> and <i>Jog request</i> are both False. (See also <i>Sequencer Commands</i> .)              |
| <i>Stop PB request</i>                    | This input is driven by <i>Stop PB select</i> or <i>Stop PB select, lan</i> . A normal stop is generated when <i>Stop PB request</i> is True. |
| <i>Run permissive</i>                     | 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

| <i>Parameter</i>           | <i>Description</i>                                                                                                                                                                                   |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Normal stop mode</i>    | Selects the behavior of a normal stop. Possible choices are: <ul style="list-style-type: none"><li>• <i>Ramp stop</i></li><li>• <i>Quick stop</i></li><li>• <i>Coast stop</i></li></ul> (See below.) |
| <i>Flux off delay time</i> | 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

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

## Function output

| <b>Variable</b>      | <b>Description</b>                                                                                                                   |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <i>X stop active</i> | Causes drive to perform an X-stop as configured by <i>X stop mode</i> . It also drops out the <i>Ready to run</i> permissive string. |

## Function configuration

| <b>Parameter</b>   | <b>Description</b>                                                                                                                                                                                                                                                            |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>X stop mode</i> | Selects the behavior of an X-stop. Possible choices are: <ul style="list-style-type: none"> <li>• <i>Nrml (ramp) stop</i></li> <li>• <i>Quick stop</i></li> <li>• <i>Coast stop</i></li> <li>• <i>Trip flt stop</i></li> <li>• <i>Emerg ramp stop</i></li> </ul> (See below.) |

## Function description

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

|                         |                                                                                                                                                                                                                                                                                           |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Nrml (ramp) stop</i> | The drive follows a linear speed deceleration ramp down to zero speed as configured by the <i>Speed Reference Ramp</i> function. Once the drive detects that <i>Speed reg fbk</i> has reached the <i>Zero speed level</i> , the sequencer disables the regulators and stops the drive.    |
| <i>Quick stop</i>       | 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 <i>Speed reg fbk</i> has reached the <i>Zero speed level</i> , the sequencer disables the regulators and stops the drive. |
| <i>Coast stop</i>       | 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

*Run request select*

### Description

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

*Run request, lan*

### Description

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

*Run request*

### Description

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

*Full flux req sel*

### Description

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

*Full flux req, lan*

### Description

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

*Full flux request*

### Description

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 a 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 *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.

## 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*.)

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

|                         |                                                                                                                                                                    |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | <i>active</i> goes True after a delay time set by <i>Zero speed delay</i> .                                                                                        |
| <b>Parameter</b>        | <b>Description</b>                                                                                                                                                 |
| <i>Zero speed level</i> | The level below which the drive is considered to be at zero speed as indicated by the variable, <i>Zero speed active</i> .                                         |
| <i>Zero speed delay</i> | Once <i>Speed reg fbk</i> is below the <i>Zero speed level</i> , this parameter specifies the time for which <i>Zero speed active</i> 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.

|                            |                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Variable</b>            | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                    |
| <i>Sequencer state</i>     | Internal sequencer state variable that indicates what mode the sequencer is in. Possible values include: <ul style="list-style-type: none"> <li>• Stopped</li> <li>• Enable flux</li> <li>• Enable torque</li> <li>• Enable speed regulator</li> <li>• Running</li> <li>• Zero speed (waiting for zero speed)</li> <li>• Disable torque</li> <li>• Standby</li> </ul> |
| <i>MA cont enable req</i>  | Request to pick up (drop out) the MA contactor. (See <i>Main Contactor Configuration</i> .)                                                                                                                                                                                                                                                                           |
| <i>MA cont enable stat</i> | Indicates that the MA contactor has been picked up (dropped out).                                                                                                                                                                                                                                                                                                     |
| <i>Flux enable request</i> | Request to enable (disable) bridge power and the inner regulators and to pre-flux the drive.                                                                                                                                                                                                                                                                          |
| <i>Flux enable status</i>  | Status that the bridge power and inner regulators are enabled (disabled) and the drive is pre-fluxed.                                                                                                                                                                                                                                                                 |
| <i>Torque enable req</i>   | Request to enable (disable) the torque reference                                                                                                                                                                                                                                                                                                                      |
| <i>Torque reg enabled</i>  | Status that the torque reference is enabled (disabled).                                                                                                                                                                                                                                                                                                               |
| <i>Sreg enable request</i> | Request to enable (disable) the speed regulator. (See <i>Speed/Torque Regulator</i> ).                                                                                                                                                                                                                                                                                |
| <i>Sreg enable status</i>  | Status that the speed regulator is enabled (disabled).                                                                                                                                                                                                                                                                                                                |
| <i>Ref enable request</i>  | Request to enable (disable) the speed reference.                                                                                                                                                                                                                                                                                                                      |

|                            |                                                                            |
|----------------------------|----------------------------------------------------------------------------|
| <i>Speed ref enabled</i>   | Status that the speed reference is enabled (disabled).                     |
| <i>Standby enable req</i>  | Request to enable (disable) standby mode (See <i>Sequencer Commands</i> ). |
| <i>Standby enable stat</i> | 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

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

### Function output

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

### Function configuration

| <i>Parameter</i>           | <i>Description</i>                               |
|----------------------------|--------------------------------------------------|
| <i>MA contactor absent</i> | Specifies whether a contactor is absent. If this |

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                         | parameter is not set correctly, the contactor sequencing will not work properly.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <i>MA contactor fbk</i> | Enables the sequencing logic to look at contactor feedback to determine if the contactor status meets the request. (See <i>MA pickup time</i> below.)                                                                                                                                                                                                                                                                                                                                                                                                                |
| <i>MA pickup time</i>   | <p>If <i>MA contactor fbk</i> 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 <i>Cont failed to close</i> trip fault.</p> <p>If <i>MA contactor fbk</i> 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 <i>MA contactor fbk</i> is enabled.</p> |

### 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)

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## 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.

| <b>Variable</b>             | <b>Description</b>                                                                                                      |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------|
| <i>Speed avd func input</i> | Speed reference which is the output of the <i>Minimum Speed Limit</i> function (variable <i>Min speed output</i> ). RPM |

### Function outputs

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

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

### Function configuration

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

| <b>Parameter</b>            | <b>Description</b>                                                  |
|-----------------------------|---------------------------------------------------------------------|
| <i>Crit speed avoidance</i> | Enables the <i>Critical Speed Avoidance</i> function.               |
| <i>Critical speed 1</i>     | Speed at center of speed avoidance zone 1. RPM                      |
| <i>Critical speed 2</i>     | Speed at center of speed avoidance zone 2. RPM                      |
| <i>Critical speed 3</i>     | Speed at center of speed avoidance zone 3. RPM                      |
| <i>Critical speed hys</i>   | 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.

| <b>Speed Avoidance Zone</b> | <b>Center Speed</b>          |
|-----------------------------|------------------------------|
| Positive zone 1             | <i>Critical speed 1</i>      |
| Positive zone 2             | <i>Critical speed 2</i>      |
| Positive zone 3             | <i>Critical speed 3</i>      |
| Negative zone 1             | -1 x <i>Critical speed 1</i> |
| Negative zone 2             | -1 x <i>Critical speed 2</i> |
| Negative zone 3             | -1 x <i>Critical speed 3</i> |

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.

| <b>Variable</b>          | <b>Description</b>                                                  |
|--------------------------|---------------------------------------------------------------------|
| <i>Local inc command</i> | Signal that is True when the DDI speed increment button is pressed. |
| <i>Local dec command</i> | Signal that is True when the DDI speed decrement button is pressed. |
| <i>Jog request</i>       | 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.

| <b>Parameter</b>          | <b>Description</b>                                                                    |
|---------------------------|---------------------------------------------------------------------------------------|
| <i>Local speed</i>        | Initial value of local speed reference. RPM                                           |
| <i>Local jog speed</i>    | Jog speed that becomes the local speed reference when <i>Jog request</i> is True. RPM |
| <i>Local Inc/Dec rate</i> | 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.

| <b>Variable</b>        | <b>Description</b>                                                                                                     |
|------------------------|------------------------------------------------------------------------------------------------------------------------|
| <i>Min speed input</i> | Speed reference which is the possibly reversed local or remote speed reference (variable <i>Speed reference</i> ). RPM |

### Function outputs

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

| <b>Variable</b>         | <b>Description</b>                                                                                                                                                                      |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Min speed output</i> | Speed reference whose magnitude has been clamped to a minimum value and which is the input to the <i>Critical Speed Avoidance</i> function (variable <i>Speed avd func input</i> ). RPM |

### Function configuration

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

| <b>Parameter</b>     | <b>Description</b>                     |
|----------------------|----------------------------------------|
| <i>Minimum speed</i> | 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.

| <b>Parameter</b>           | <b>Description</b>                                                                                       |
|----------------------------|----------------------------------------------------------------------------------------------------------|
| <i>Auto analog ref sel</i> | Selects the automatic speed reference.                                                                   |
| <i>Man analog ref sel</i>  | Selects the manual speed reference when <i>Manual speed ref sel</i> is False.                            |
| <i>Auto mode select</i>    | 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.

| <b>Variable</b>    | <b>Description</b>                  |
|--------------------|-------------------------------------|
| <i>Jog request</i> | Sequencer request to jog the drive. |

### Function configuration

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

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

| <b>Variable</b>            | <b>Description</b>                                                                                                             |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <i>Speed ref, pre ramp</i> | Speed reference that is the output of the <i>Critical Speed Avoidance</i> function (variable <i>Spd avd func output</i> ). RPM |
| <i>Speed reg fbk</i>       | Speed feedback that in some conditions becomes the output of the ramp. RPM                                                     |
| <i>Ramp ref enabled</i>    | Enables the speed reference input to the ramp.                                                                                 |
| <i>Emergency stop act</i>  | A <i>Stopping Commands and Modes</i> 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.

| <b>Variable</b>          | <b>Description</b>                                                  |
|--------------------------|---------------------------------------------------------------------|
| <i>Speed ref, ramped</i> | 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.

| <b>Parameter</b>       | <b>Description</b>                                                                                 |
|------------------------|----------------------------------------------------------------------------------------------------|
| <i>Ramp bypass</i>     | Disables the <i>Speed Reference Ramp</i> function.                                                 |
| <i>Ramp rate mode</i>  | Specifies whether the speed independent ramp rate mode or the programmed ramp rate mode is active. |
| <i>Emerg ramp rate</i> | 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*.

| <b>Parameter</b>           | <b>Description</b>                                                                                                                   |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <i>Acceleration rate 1</i> | Ramp rate that is effective when the magnitude of <i>Speed ref, pre ramp</i> is increasing and ramp rate set 1 is active. RPM/second |
| <i>Acceleration rate 2</i> | Ramp rate that is effective when the magnitude of                                                                                    |

|                            |                                                                                                                                      |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
|                            | <i>Speed ref, pre ramp</i> is increasing and ramp rate set 2 is active. RPM/second                                                   |
| <i>Deceleration rate 1</i> | Ramp rate that is effective when the magnitude of <i>Speed ref, pre ramp</i> is decreasing and ramp rate set 1 is active. RPM/second |
| <i>Deceleration rate 2</i> | Ramp rate that is effective when the magnitude of <i>Speed ref, pre ramp</i> is decreasing and ramp rate set 2 is active. RPM/second |
| <i>Ramp rate 2 select</i>  | 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*.

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

| <b>Ramp rate</b>           | <b>Active region</b>                                                                                  |
|----------------------------|-------------------------------------------------------------------------------------------------------|
| <i>Acceleration rate 1</i> | $\text{Abs}(\text{Speed ref, pre ramp}) \leq \text{Accel break point 1}$                              |
| <i>Acceleration rate 2</i> | $\text{Accel break point 1} < \text{Abs}(\text{Speed ref, pre ramp}) \leq \text{Accel break point 2}$ |
| <i>Acceleration rate 3</i> | $\text{Accel break point 2} < \text{Abs}(\text{Speed ref, pre ramp})$                                 |
| <i>Deceleration rate 1</i> | $\text{Abs}(\text{Speed ref, pre ramp}) \leq \text{Decel break point 1}$                              |
| <i>Deceleration rate 2</i> | $\text{Decel break point 1} < \text{Abs}(\text{Speed ref, pre ramp}) \leq \text{Decel break point 2}$ |
| <i>Deceleration rate 3</i> | $\text{Decel break point 2} < \text{Abs}(\text{Speed ref, pre ramp})$                                 |

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.

| <b>Parameter</b>      | <b>Description</b>                                                       |
|-----------------------|--------------------------------------------------------------------------|
| <i>Reverse select</i> | Selects the user reverse request when <i>Local mode active</i> is False. |

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

| <b>Variable</b>          | <b>Description</b>                                                                                    |
|--------------------------|-------------------------------------------------------------------------------------------------------|
| <i>Local rev request</i> | User reverse request when <i>Local mode active</i> is True, changes as DDI reverse button is pressed. |

### Function outputs

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

| <b>Variable</b>        | <b>Description</b>                                                                                        |
|------------------------|-----------------------------------------------------------------------------------------------------------|
| <i>Speed reference</i> | Speed reference which is the local or remote speed reference and which has possibly been reversed.<br>RPM |

### Diagnostic variables

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

| <b>Variable</b>            | <b>Description</b>                                             |
|----------------------------|----------------------------------------------------------------|
| <i>Reverse mode active</i> | 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)

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## 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.

| <b>Parameter</b>          | <b>Description</b>                                    |
|---------------------------|-------------------------------------------------------|
| <i>Droop comp ref sel</i> | Selects the load torque compensation. Per unit torque |

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

| <b>Variable</b>       | <b>Description</b>                                                                                                        |
|-----------------------|---------------------------------------------------------------------------------------------------------------------------|
| <i>Droop feedback</i> | Averaged, normalized, and filtered version of the actual torque reference ( <i>Torque ref post lim</i> ). Per unit torque |

#### Function outputs

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

| <b>Variable</b>     | <b>Description</b>              |
|---------------------|---------------------------------|
| <i>Droop output</i> | Speed reference adjustment. RPM |

#### Function configuration

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

| <b>Parameter</b>           | <b>Description</b>                        |
|----------------------------|-------------------------------------------|
| <i>Droop feedback fil</i>  | Feedback filter bandwidth. Radians/second |
| <i>Droop deadband, neg</i> | Negative deadband level. Per unit torque  |

|                            |                                                                                              |
|----------------------------|----------------------------------------------------------------------------------------------|
| <i>Droop deadband, pos</i> | Positive deadband level. Per unit torque                                                     |
| <i>Droop gain</i>          | Scale factor that specifies speed droop for 1 pu torque.<br>Per unit speed / Per unit torque |
| <i>Droop disable sel</i>   | 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.

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

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

| <b>Variable</b>             | <b>Description</b>                                                                                                                                            |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Torque ref pre limit</i> | Primary torque reference signal from the application layer of drive functionality prior to motor control interface torque limits. Newton-meters or Pound-feet |
| <i>Torque enable req</i>    | 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.

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

## Function configuration

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

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

| <b>Parameter</b>            | <b>Description</b>         |
|-----------------------------|----------------------------|
| <i>Over speed flt level</i> | Overspeed fault level. RPM |

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

$$ABS(\text{Speed reg fbk}) > \text{Over speed flt level}$$

### Failure to rotate configuration and operation

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

| <b>Parameter</b>           | <b>Description</b>                                                                          |
|----------------------------|---------------------------------------------------------------------------------------------|
| <i>Rotate fail flt lvl</i> | The level which the speed regulator error must exceed for the fault condition to exist. RPM |
| <i>Rotate fail spd lim</i> | 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*.

$ABS(\text{Speed reg error}) \geq \text{Rotate fail flt lvl}$

$ABS(\text{Speed reg fbk}) \leq \text{Rotate fail spd lim}$

### **Loss of spd control configuration and operation**

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

| <b>Parameter</b>            | <b>Description</b>                                                                          |
|-----------------------------|---------------------------------------------------------------------------------------------|
| <i>Spd ctl loss flt lvl</i> | The level which the speed regulator error must exceed for the alarm condition to exist. RPM |
| <i>Spd ctl loss delay</i>   | 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*.

$ABS(\text{Speed reg error}) \geq \text{Spd ctl loss flt lvl}$

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

$ABS(\text{Speed reg error}) < 90\% \times \text{Spd ctl loss flt lvl}$

### **Reverse rotation configuration and operation**

The following parameter configures the *Reverse rotation* fault.

| <b>Parameter</b>          | <b>Description</b>                         |
|---------------------------|--------------------------------------------|
| <i>Rev rotation fault</i> | Enables the <i>Reverse rotation</i> 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.

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

### **Function control outputs**

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

| <b>Variable</b>      | <b>Description</b>                                                                                                        |
|----------------------|---------------------------------------------------------------------------------------------------------------------------|
| <i>Speed reg fbk</i> | Speed feedback for the speed regulator.<br>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.

| <b>Variable</b>         | <b>Description</b>                                                 |
|-------------------------|--------------------------------------------------------------------|
| <i>Motor speed</i>      | Display version of either tachometer speed or simulated speed. RPM |
| <i>Speed feedback</i>   | Display version of speed regulator feedback. RPM                   |
| <i>Calculated speed</i> | Display version of estimated speed feedback. RPM                   |
| <i>Output frequency</i> | Display version of the estimated electrical frequency. Hertz       |

### Function configuration

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

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

| <b>Parameter</b>          | <b>Description</b>                                                                                     |
|---------------------------|--------------------------------------------------------------------------------------------------------|
| <i>Speed loop sum sel</i> | Selects speed reference signal to add to output of the <i>Speed Reference Generation</i> 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.

| <b>Parameter</b>         | <b>Description</b>                                            |
|--------------------------|---------------------------------------------------------------|
| <i>Speed ref, ramped</i> | Output of the <i>Speed Reference Generation</i> 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.

| <b>Parameter</b>         | <b>Description</b>                                    |
|--------------------------|-------------------------------------------------------|
| <i>Max forward speed</i> | Maximum forward reference to the speed regulator. RPM |
| <i>Max forward speed</i> | 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).

| <b>Variable</b>            | <b>Description</b>                                                                          |
|----------------------------|---------------------------------------------------------------------------------------------|
| <i>Speed reg reference</i> | Speed regulator reference, the net result of all reference selections and conditioning. RPM |

|                            |                                                                                                                                                      |
|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Speed reg fbk</i>       | Speed regulator feedback, filtered and selected between motor tachometer speed feedback and estimated speed feedback. RPM                            |
| <i>Sreg enable request</i> | Boolean signal from the core drive sequencer which requests enabling of the <i>Speed/Torque Regulator</i> function.                                  |
| <i>Torque ctl pos frz</i>  | Boolean signal from the motor control interface indicating that a positive inner limit is encountered; used for speed regulator anti-windup control. |
| <i>Torque ctl neg frz</i>  | 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.

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

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

| <b>Variable</b>             | <b>Description</b>                                                                                                             |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <i>Speed reg mode</i>       | Primary state variable which reflects the active regulation state of the drive.                                                |
| <i>Enable spd reg out</i>   | Boolean signal from the primary regulator control logic which enables active signals to the variable <i>Speed reg output</i> . |
| <i>Torque mode sel</i>      | Boolean signal from the primary regulator control logic which gates the variable <i>Torque ref input</i> .                     |
| <i>Speed reg antiwindup</i> | 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.

| <b>Parameter</b>            | <b>Description</b>                                                                                                                                                                                                                                                        |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Torque mode sel</i>      | Selects the Boolean variable used to enable <i>Torque ref input</i> in <i>Speed</i> and <i>Torque</i> modes, and to control entry & exit of <i>Ovrd/Spd forced</i> mode within <i>Torque</i> , <i>spd override</i> modes.                                                 |
| <i>Torque ref select</i>    | Selects the signal used as the <i>Torque ref input</i> 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).                   |
| <i>Torque feed fwd sel</i>  | Selects the signal used as a torque feedforward signal, summed to the <i>Torque ref pre limit</i> in all states.                                                                                                                                                          |
| <i>Spd reg init val sel</i> | Selects the signal used to define preconditioning of internal state variables while in the <i>Off/Precond</i> state. The value of the signal determines the target value of <i>Speed reg output</i> to appear when the <i>Speed/Torque Regulator</i> function is enabled. |
| <i>Variable inertia sel</i> | Selects the signal used to dynamically define the <i>Inertia</i> compensation variable instead of being defined by the constant <i>Fixed inertia</i> parameter.                                                                                                           |

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

| <b>Parameter</b>            | <b>Description</b>                                                                                                                                                                      |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Regulator type</i>       | Primary selector which configures the basic regulation mode of the drive (see below).                                                                                                   |
| <i>Torque reg stop mode</i> | Boolean which enables the option to the <i>Torque with Spillover Speed</i> mode in which speed regulation mode is dynamically forced ( <i>Ovrd/Spd forced</i> ) during a stop sequence. |
| <i>Spd reg prop cmd gn</i>  | Proportional gain affecting only the command path                                                                                                                                       |

|                            |                                                                                                                                                               |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                            | of the speed regulator compensation network.                                                                                                                  |
| <i>Spd reg prop fbk gn</i> | Proportional gain affecting only the feedback path of the speed regulator compensation network.                                                               |
| <i>Spd reg prop filter</i> | Bandwidth of the first-order lowpass filter applied to the net proportional path of the Speed regulator.                                                      |
| <i>Spd reg integral gn</i> | Integral gain of the speed regulator compensation network.                                                                                                    |
| <i>Spd reg net gain</i>    | Common gain (inner loop gain) of the speed regulator compensation network.                                                                                    |
| <i>Fixed inertia</i>       | Fixed inertia compensation term of the speed regulator compensation network. Kilogram-meters <sup>2</sup> or Pound-feet <sup>2</sup>                          |
| <i>Spd reg pos err lim</i> | Limit which defines the positive speed error tolerance for activation of spillover speed mode (transition from <i>Ovrd/Trq act</i> to <i>Ovrd/Spd Low</i> ).  |
| <i>Spd reg neg err lim</i> | Limit which defines the negative speed error tolerance for activation of spillover speed mode (transition from <i>Ovrd/Trq act</i> to <i>Ovrd/Spd High</i> ). |

## 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:

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

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:

|                         |                                                                                                                                                                                                                                                                                                                  |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Off/Precond</i>      | Regulator is disabled by the sequencer:<br><i>Speed reg output</i> is zeroed, and <i>Torque ref input</i> is disabled. Internal states are continuously preconditioned based upon the signal specified by parameter <i>Spd reg init val sel</i> .                                                                |
| <i>Torque regulator</i> | Active <i>Torque</i> mode:<br><br><i>Torque ref input</i> is conditionally enabled to the output <i>Torque ref pre limit</i> , based upon the value of the Boolean signal specified by the parameter <i>Torque mode sel</i> . The speed regulator core is disabled, therefore <i>Speed reg output</i> is zero.   |
| <i>Speed regulator</i>  | Active <i>Speed</i> mode:<br><br><i>Speed reg output</i> responds "normally" to the core speed regulator. Based upon the value of the Boolean signal specified by the parameter <i>Torque mode sel</i> , the <i>Torque ref input</i> signal is conditionally added into the output <i>Torque ref pre limit</i> . |
| <i>Ovrd/Trq act</i>     | Active <i>Torque, spd override</i> mode:<br><br>Torque mode allowed since <i>Speed reg error</i> is within limits and the value of the signal specified by the parameter <i>Torque mode sel</i> is True; spillover speed action is "armed".                                                                      |
| <i>Ovrd/Spd forced</i>  | Forced <i>Torque, spd override</i> mode:<br><br>Speed regulation mode dynamically forced because either the value of the signal specified by <i>Torque mode sel</i> is False, or the <i>Torque reg stop mode</i> is commanded by the sequencer.                                                                  |
| <i>Ovrd/Spd Low</i>     | Active <i>Torque, spd override</i> mode:<br><br>Speed regulation mode dynamically overrides torque mode due to <i>Speed reg error</i> having exceeded limit specified by <i>Spd reg pos err lim</i> .                                                                                                            |
| <i>Ovrd/Spd High</i>    | Active <i>Torque, spd override</i> mode:<br><br>Speed regulation mode dynamically overrides torque mode due to <i>Speed reg error</i> having exceeded limit specified by <i>Spd reg neg err lim</i> .                                                                                                            |
| <i>Lcl mode/Spd reg</i> | Active <i>Local speed</i> mode:<br><br>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 <i>Regulator type</i> . The <i>Torque ref input</i> 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<sup>2</sup>), although the product human interfaces (Tool & DDI) allow treatment in (lb-ft<sup>2</sup>) 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<sup>2</sup> can be entered directly; data expressed in GD<sup>2</sup> 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*:

| <b>Parameter Selection</b> | <b>Exec Time (usec)</b> | <b>Chop Freq (KHz)</b> | <b>Fund Freq (Hz)</b> | <b>Power Derate (%)</b> | <b>Comments</b> |
|----------------------------|-------------------------|------------------------|-----------------------|-------------------------|-----------------|
| 333 usec, 1.5 KHz          | 333.3                   | 1.5                    | 200                   | 100                     | Full features   |
| 333 usec, 3.0 KHz          | 333.3                   | 3.0                    | 200                   | 85                      | Full features   |
| 333 usec, 6.0 KHz          | 333.3                   | 6.0                    | 200                   | 65                      | Full features   |
| 250 usec,                  | 250.0                   | 2.0                    | 266                   | ?                       | Evaluation      |

## NOTES

# Chapter 3 Wizards

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## Introduction

This chapter contains descriptions and help items associated with configuring diagnosing the Innovation Series Low Voltage – ACDCFG drives. They are organized in the following manner:

The *Cell Test* checks the integrity of the power bridge, its internal connections, and its connections to a load.

The following topics explain the operation of the *Cell Test* in detail. They are accessible from the *Cell Test* wizard pages.

| <b>Section</b>                  | <b>Page</b> |
|---------------------------------|-------------|
| Cell Test.....                  | 1           |
| DAC Setup.....                  | 6           |
| Drive Commissioning.....        | 6           |
| Ground Fault Setup .....        | 23          |
| Motor Control Tuneup.....       | 24          |
| Panel Meter Setup .....         | 25          |
| Per Unit Setup .....            | 25          |
| Pulse Test.....                 | 25          |
| Remaining Parameter Setup ..... | 28          |
| Simulator Setup.....            | 28          |
| Speed Regulator Tuneup.....     | 29          |

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## Cell Test

The *Cell Test* checks the integrity of the power bridge, its internal connections, and its connections to a load.

The following topics explain the operation of the *Cell Test* in detail. They are accessible from the *Cell Test* wizard pages.

### Cell Test: Introduction

The *Cell Test* checks the integrity of the power bridge, its internal connections, and its connections to a load.

For the *Cell Test* to produce valid results, the motor nameplate parameters must be correct for the load connected to the inverter drive output. If the *Drive Commissioning* wizard has been completed successfully, then the motor nameplate parameters should be valid.

## Cell Test: Operation

The *Cell Test* checks the integrity of the power bridge, its internal connections, and its connections to a load.

For the *Cell Test* to produce valid results, the motor nameplate parameters must be correct for the load connected to the inverter drive output. If the *Drive Commissioning* wizard has been completed successfully, then the motor nameplate parameters should be valid.

The *Cell Test* consists of three parts:

- The Short Circuit Detection Test
- The Open Circuit Detection Test
- The Voltage Feedback Evaluation

The Short Circuit Detection Test verifies that there are no undesired conduction paths in the power bridge and load. The Open Circuit Detection Test verifies that current does flow in all expected conduction paths. The Voltage Feedback Evaluation verifies that the line-line voltage feedback circuits work correctly.

The three parts of the cell test run in order. If one of the parts detects a bridge failure, the parts that follow do not run.

To invoke the cell test, click on the Execute button. The *Cell Test* runs, and a message window appears containing the results of the *Cell Test*.

## Cell Test: Results

The *Cell Test* consists of three parts:

- The Short Circuit Detection Test
- The Open Circuit Detection Test
- The Voltage Feedback Evaluation

The message window displays the *Cell Test* results. The success or failure of each part of the *Cell Test* is reported.

### Short Circuit Detection Test

The Short Circuit Detection Test checks for undesired conduction paths in the power bridge and load. It fires one IGBT at a time and checks for currents and faults in the bridge. A failure occurs if it detects any currents or faults.

If the Short Circuit Detection Test fails, then it produces a table containing the current feedbacks and bridge faults it collected during the course of the test. It also gives a bridge diagnosis after the table.

The following is an example table and bridge diagnosis produced during a Short Circuit Detection Test failure:

| Device | Ia | Ib | Ic | Fault    |
|--------|----|----|----|----------|
| AU     | +I | -I | 0  | No Fault |
| AL     | 0  | 0  | 0  | No Fault |
| BU     | 0  | 0  | 0  | Desat BU |
| BL     |    |    |    | Not Done |
| CU     | 0  | -I | +I | No Fault |
| CL     | 0  | 0  | 0  | No Fault |

Probable cause of failure: Short across or through B lower IGBT.

The rows of the table present the current feedbacks and bridge faults that were collected for each IGBT.

The column in the table labeled Device indicates which IGBT was fired for the particular set of feedbacks and faults. The following table provides the meaning for the codes in the Device column.

**Device column entries**

| Code | Meaning            |
|------|--------------------|
| AU   | Phase A upper IGBT |
| AL   | Phase A lower IGBT |
| BU   | Phase B upper IGBT |
| BL   | Phase B lower IGBT |
| CU   | Phase C upper IGBT |
| CL   | Phase C lower IGBT |

The columns in the table labeled Ia, Ib, and Ic represent the phase A, phase B, and phase C current feedbacks. The following table provides a list of codes that may appear in the Ia, Ib, and Ic columns and their meanings.

**Ia, Ib, Ic column entries**

| Code | Meaning                   |
|------|---------------------------|
| +I   | Positive current detected |
| -I   | Negative current detected |
| 0    | No current detected       |

The column in the table labeled Fault contains the bridge faults. Most (but not all) of the codes that appear in the Fault column correspond to actual trip faults that can occur during the operation of the inverter drive. The following table provides a list of codes that may appear in the Fault column and their meanings.

**Fault column entries**

| Code     | Meaning                         |
|----------|---------------------------------|
| Desat AL | Trip fault IGBT AL desat        |
| DesatAL1 | Trip fault IGBT AL bridg1 desat |
| DesatAL2 | Trip fault IGBT AL bridg2 desat |
| Desat AU | Trip fault IGBT AU desat        |
| DesatAU1 | Trip fault IGBT AU bridg1 desat |

|          |                                                                                        |
|----------|----------------------------------------------------------------------------------------|
| DesatAU2 | Trip fault <i>IGBT AU bridg2 desat</i>                                                 |
| Desat BL | Trip fault <i>IGBT BL desat</i>                                                        |
| DesatBL1 | Trip fault <i>IGBT BL bridg1 desat</i>                                                 |
| DesatBL2 | Trip fault <i>IGBT BL bridg2 desat</i>                                                 |
| Desat BU | Trip fault <i>IGBT BU desat</i>                                                        |
| DesatBU1 | Trip fault <i>IGBT BU bridg1 desat</i>                                                 |
| DesatBU2 | Trip fault <i>IGBT BU bridg2 desat</i>                                                 |
| Desat CL | Trip fault <i>IGBT CL desat</i>                                                        |
| DesatCL1 | Trip fault <i>IGBT CL bridg1 desat</i>                                                 |
| DesatCL2 | Trip fault <i>IGBT CL bridg2 desat</i>                                                 |
| Desat CU | Trip fault <i>IGBT CU desat</i>                                                        |
| DesatCU1 | Trip fault <i>IGBT CU bridg1 desat</i>                                                 |
| DesatCU2 | Trip fault <i>IGBT CU bridg2 desat</i>                                                 |
| I Decay  | Current feedbacks did not decay to zero with the bridge turned off in a timely fashion |
| Imbal A  | Trip fault <i>Current imbal phs A</i>                                                  |
| Imbal B  | Trip fault <i>Current imbal phs B</i>                                                  |
| Imbal C  | Trip fault <i>Current imbal phs C</i>                                                  |
| IOC A    | Trip fault <i>IOC phase A</i>                                                          |
| IOC B    | Trip fault <i>IOC phase B</i>                                                          |
| IOC C    | Trip fault <i>IOC phase C</i>                                                          |
| No Fault | No bridge faults detected                                                              |
| Not Done | IGBT was not fired                                                                     |

### Open Circuit Detection Test

The Open Circuit Detection Test verifies that current flows in all the expected conduction paths. It fires pairs of IGBTs and checks the power bridge currents and faults. A failure occurs if it does not measure current in the expected phases, if it does measure current in unexpected phases, or if it collects any bridge faults.

If the Open Circuit Detection Test fails, then it produces a table containing the current feedbacks and bridge faults it collected during the course of the test. It also gives a bridge diagnosis after the table.

The following is an example table and bridge diagnosis produced during an Open Circuit Detection Test failure.

| Device | Ia | Ib | Ic | Fault    |
|--------|----|----|----|----------|
| AU/BL  | +I | 0  | -I | No Fault |
| BU/CL  | 0  | -I | +I | No Fault |
| CU/AL  | -I | +I | 0  | No Fault |
| AL/BU  | -I | 0  | +I | No Fault |
| BL/CU  | 0  | +I | -I | No Fault |
| CL/AU  | +I | -I | 0  | No Fault |

Probable cause of failure: Phase B,C shunt connections Reversed.

The rows of the table present the current feedbacks and bridge faults that were collected for each pair of IGBTs.

The column in the table labeled Device indicates which pair of IGBTs was fired for the particular set of feedbacks and faults. The following table provides the meaning for the codes in the Device column.

**Device column entries**

| <b>Code</b> | <b>Meaning</b>                          |
|-------------|-----------------------------------------|
| AU/BL       | Phase A upper IGBT / Phase B lower IGBT |
| BU/CL       | Phase B upper IGBT / Phase C lower IGBT |
| CU/AL       | Phase C upper IGBT / Phase A lower IGBT |
| AL/BU       | Phase A lower IGBT / Phase B upper IGBT |
| BL/CU       | Phase B lower IGBT / Phase C upper IGBT |
| CL/AU       | Phase C lower IGBT / Phase A upper IGBT |

The columns in the table labeled Ia, Ib, Ic, and Fault have the same meaning as the similarly labeled columns in the Short Circuit Detection Test table. Refer to the Short Circuit Detection Test description above for details on the Ia, Ib, Ic, and Fault column entries.

## Voltage Feedback Evaluation

The Voltage Feedback Evaluation verifies that the line-line voltage feedback circuits work correctly. It checks the line-line voltage feedbacks collected when pairs of IGBTs are fired. A failure occurs if an unexpected line-line voltage feedback is measured across the phases that are turned on.

If the Voltage Feedback Evaluation fails, then it produces a table containing the line-line voltage feedbacks it collected during the course of the test. It also gives a bridge diagnosis after the table.

The following is an example table and bridge diagnosis produced during a Voltage Feedback Evaluation failure.

| <b>Device</b> | <b>Vab</b> | <b>Vbc</b> | <b>Vca</b> |
|---------------|------------|------------|------------|
| AU/BL         | -V         |            |            |
| BU/CL         |            | 0          |            |
| CU/AL         |            |            | 0          |
| AL/BU         | +V         |            |            |
| BL/CU         |            | 0          |            |
| CL/AU         |            |            | 0          |

Probable cause of failure: Check voltage feedback circuitry.

The rows of the table present the voltage feedbacks that were collected for each pair of IGBTs.

The column in the table labeled Device has the same meaning as the similarly labeled columns in the Open Circuit Detection Test table. Refer to the Open Circuit Detection Test description above for details on the Device column entries.

The columns in the table labeled Vab, Vbc, and Vca represent the A-B, B-C, and C-A line-line voltage feedbacks. For each row of the table, only one of these columns

contains voltage feedback information, the column that corresponds to the phases in which the IGBTs were fired. The following table provides a list of codes that may appear in the Vab, Vbc, and Vca columns and their meanings.

***Vab, Vbc, Vca column entries***

| <b><i>Code</i></b> | <b><i>Meaning</i></b>     |
|--------------------|---------------------------|
| +V                 | Positive voltage detected |
| -V                 | Negative voltage detected |
| 0                  | No voltage detected       |
| Blank              | Feedback not examined     |

---

## 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 frame version*
- *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: DC Source Selection

The power for this Innovation Series drive is supplied by a DC voltage source. The DC source type must be specified so that protective functions for the drive can be set up correctly.

Three different DC source types are compatible with the drive:

- Fully regenerative PWM source (*PWM voltage src*)
- Rectifier with dynamic braking resistor (*Rectifier with DB*)
- Rectifier without dynamic braking resistor (*Rectifier without DB*)

Select the DC source type that matches the voltage source supplying power to the drive.

## Drive Commissioning: Rectifier Max Lineup Output Voltage

*Max lineup output* specifies the maximum AC voltage that exists in the system containing the DC source, drive, and motors. This voltage must be specified so that protective functions for the drive can be set up correctly. When a rectifier supplies power to the drive, the rectifier input voltage is the maximum AC voltage in the system.

The value of *Max lineup output* for the drive should match the value of *Max lineup output* for the source that supplies power to the drive.

Set *Max lineup output* to the line-line voltage input to the rectifier.

### Related functions

- *Max lineup output*

## Drive Commissioning: PWM Source Max Lineup Output Voltage

*Max lineup output* specifies the maximum AC voltage that exists in the system containing the DC source, drive, and motors. This voltage must be specified so that protective functions for the drive can be set up correctly. When a PWM voltage source supplies power to the drive, *Max lineup output* should be determined in the following manner:

- If the line-line voltage input to the PWM source is greater than or equal to the line-line voltage rating of the motors powered by the drive, then *Max lineup output* should be set to the line-line voltage input to the PWM source.
- If the line-line voltage input to the PWM source is less than the line-line voltage rating of the motors powered by the drive, then *Max lineup output* should be set to the line-line voltage rating of the motors.

The value of *Max lineup output* for the drive should match the value of *Max lineup output* for the source that supplies power to the drive.

Set *Max lineup output* to the appropriate voltage level.

### Related functions

- *Max lineup output*

## 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.

|                               |                    |                           |                              |
|-------------------------------|--------------------|---------------------------|------------------------------|
| MODEL                         |                    | SER. NO.                  |                              |
| HP                            | DEG C<br>MAX AMB @ | SF                        | DEG C<br>MAX AMB @ 1.0 SF    |
| RPM                           | HERTZ              | 3 PHASE                   | ENCL TEFC MAX KUAR           |
| VOLTS                         | AMPS               | CONTINUOUS DUTY           |                              |
| FRAME                         | TYPE               | NEMA DESIGN               | CODE INS CLASS F             |
| NEMA NOM EFF                  | GUAR MIN EFF       | 3/4 LOAD EFF              | LR 40951                     |
| MAX WEIGHT                    |                    | LB                        | POLYUREA GREASE POWER FACTOR |
| PRECISION BALANCED            |                    | IPS IEEE RP 841           |                              |
| OPP DRIVE END REPLACEMENT BRG |                    | DRIVE END REPLACEMENT BRG |                              |
| CAT NO.                       |                    | CSA                       |                              |
| Energy Saver®<br>XSD™         |                    | GE Motors                 |                              |
| EXTRA SEVERE DUTY AC MOTOR    |                    | MADE IN U.S.A.            |                              |
| NP249A5456                    |                    | FORT WAYNE, IN            |                              |

ROTATION ↑ PHASE SEQUENCE T3, T2, T1  
ROTATION ↓ PHASE SEQUENCE T1, T2, T3

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 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.

|                       |       |        |        |             |       |             |        |
|-----------------------|-------|--------|--------|-------------|-------|-------------|--------|
| MODEL NO.:            |       |        |        | FRAME: 5011 |       | ITEM(S) 2,3 |        |
| DESIGN NO.: 50DS3639A |       |        |        | POLES: 6    |       |             |        |
| HP:                   | 250.0 | RPM:   | 1200   | PH:         | 3     | VNL         | INL    |
| FLA:                  | 284.0 | RQWDG: | 75.0   | XST:        | 0.296 | 460         | 98.90  |
| FLS:                  | 1195  | R1:    | 0.0221 | XR:         | 0.539 | 403         | 77.84  |
| E-LN:                 | 460   | R2:    | 0.0145 | X1R:        | 0.211 | 345         | 64.06  |
| E-PH:                 | 460   | IM:    | 57.098 | X2R:        | 0.328 | 288         | 52.21  |
| FREQ:                 | 60    | XM:    | 7.815  |             |       |             |        |
|                       |       |        |        |             |       | LOAD *      | 1.00   |
|                       |       |        |        |             |       | EFF.:       | 0.9632 |
|                       |       |        |        |             |       | P.F.:       | 0.8670 |
|                       |       |        |        |             |       | IL:         | 280.07 |
|                       |       |        |        |             |       | SLIP:       | 0.0048 |

## 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.

The following is an example of a motor data sheet:

|                       |       |        |        |             |       |             |        |
|-----------------------|-------|--------|--------|-------------|-------|-------------|--------|
| MODEL NO.:            |       |        |        | FRAME: 5011 |       | ITEM(S) 2,3 |        |
| DESIGN NO.: 50DS3639A |       |        |        | POLES: 6    |       |             |        |
| HP:                   | 250.0 | RPM:   | 1200   | PH:         | 3     | VNL         | INL    |
| FLA:                  | 284.0 | RQWDG: | 75.0   | XST:        | 0.296 | 460         | 98.90  |
| FLS:                  | 1195  | R1:    | 0.0221 | XR:         | 0.539 | 403         | 77.84  |
| E-LN:                 | 460   | R2:    | 0.0145 | X1R:        | 0.211 | 345         | 64.06  |
| E-PH:                 | 460   | IM:    | 57.098 | X2R:        | 0.328 | 288         | 52.21  |
| FREQ:                 | 60    | XM:    | 7.815  |             |       |             |        |
|                       |       |        |        |             |       | LOAD *      | 1.00   |
|                       |       |        |        |             |       | EFF.:       | 0.9632 |
|                       |       |        |        |             |       | P.F.:       | 0.8670 |
|                       |       |        |        |             |       | IL:         | 280.07 |
|                       |       |        |        |             |       | SLIP:       | 0.0048 |

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  $E-PH = E-LN \div \sqrt{3}$ .

**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 following example 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.
- *Tachless 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*.

| <b>Value of<br/><i>Normal stop<br/>mode</i></b> | <b>Behavior</b>                                                                                                                                                                                                                                                                        |
|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Ramp stop</i>                                | The drive follows a linear speed deceleration ramp down to zero speed as configured by the <i>Speed Reference Ramp</i> function. Once the drive detects that <i>Speed reg fbk</i> has reached the <i>Zero speed level</i> , the sequencer disables the regulators and stops the drive. |

|                   |                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Quick stop</i> | 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 <i>Speed reg fbk</i> has reached the <i>Zero speed level</i> , the sequencer disables the regulators and stops the drive.                                                                                                 |
| <i>Coast stop</i> | 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 <i>Speed reg fbk</i> has reached the <i>Zero speed level</i> , unless <i>Flying restart</i> is enabled.<br><br>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 restrtr 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*.

| <b>Value of X stop mode</b> | <b>Behavior</b>                                                                                                                                                                                                                                                                        |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Nrml (ramp) stop</i>     | The drive follows a linear speed deceleration ramp down to zero speed as configured by the <i>Speed Reference Ramp</i> function. Once the drive detects that <i>Speed reg fbk</i> has reached the <i>Zero speed level</i> , the sequencer disables the regulators and stops the drive. |

|                        |                                                                                                                                                                                                                                                                                                                            |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Quick stop</i>      | 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 <i>Speed reg fbk</i> has reached the <i>Zero speed level</i> , the sequencer disables the regulators and stops the drive.                                  |
| <i>Coast stop</i>      | 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 <i>Speed reg fbk</i> has reached the <i>Zero speed level</i> , unless <i>Flying restart</i> is enabled.                                      |
| <i>Trip flt stop</i>   | Behavior is similar to that of a Coast stop, except that a Trip fault, <i>X stop</i> , is also generated.                                                                                                                                                                                                                  |
| <i>Emerg ramp stop</i> | The drive follows a linear speed deceleration ramp down to zero as configured by the parameter <i>Emerg ramp rate</i> . (See also the <i>Speed Reference Ramp</i> .) Once the drive detects that <i>Speed reg fbk</i> has reached the <i>Zero speed level</i> , 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

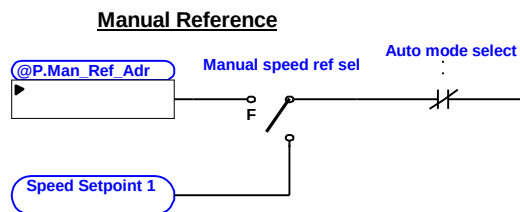
Select the signals used to drive the following functions:

| <b>Parameter</b>          | <b>Description</b>                                                                                                                                                                           |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Run permissive sel</i> | When used, this parameter selects a variable that populates <i>Run permissive</i> .<br><br>When unused, <i>Run permissive</i> is always set to <i>True</i> .                                 |
| <i>Run request select</i> | Selects the variable that drives <i>Run request</i> . This input is only active in “Remote mode” ( <i>Local mode active</i> is <i>False</i> ). The sequencer normally treats the signal as a |

|                           |                                                                                                                                                                                  |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                           | +/- edge-triggered input to set <i>Run request</i> . However, if <i>Stop PB select</i> is used, the sequencer looks only at the + edge of the signal to set <i>Run request</i> . |
| <i>Jog request select</i> | Selects the variable that drives <i>Jog request</i> . This input is only active in “Remote mode.” It is treated as a +/- edge-triggered input.                                   |
| <i>Reverse select</i>     | 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

| <i>Parameter</i>         | <i>Description</i>                                                                                                                                                                              |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Max forward speed</i> | 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. |
| <i>Max reverse speed</i> | 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 Override* 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

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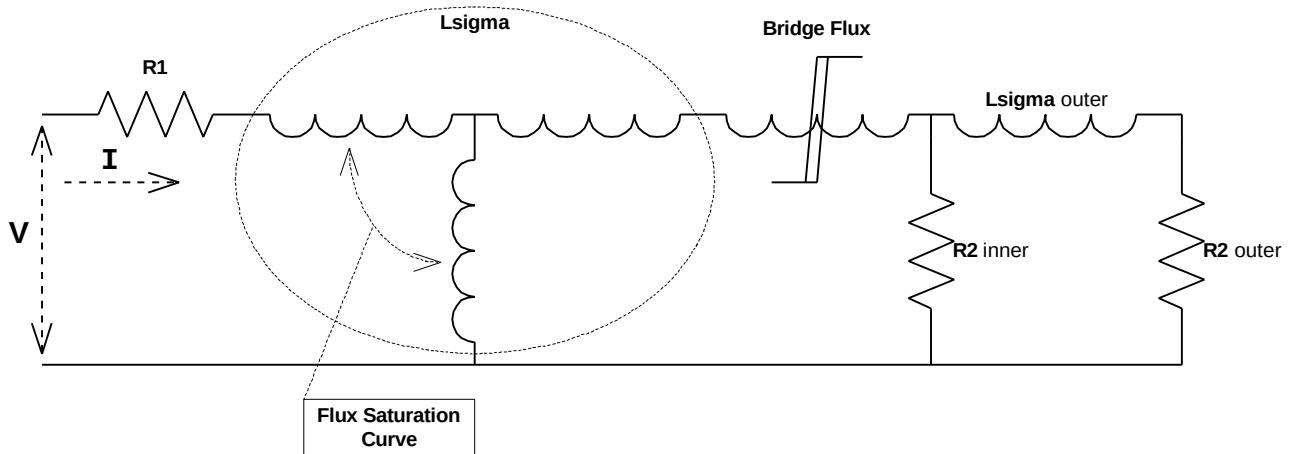
## Ground Fault Setup

The *Ground Fault Setup* directs configuration of the ground fault protection. It is recommended that the control be allowed to calculate the default ground fault parameter settings. For more information on the ground fault parameters, see the *Ground Fault Protection (Slow)* and *Ground Fault Protection (Fast)* function helps.

# 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.

---

## 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.

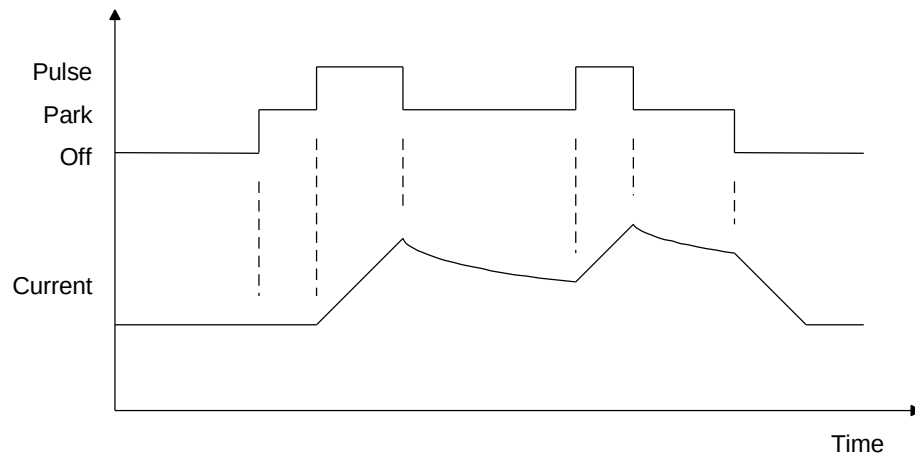
During the course of the Pulse Test it is often useful to observe certain drive variables, such as phase currents (variables *Phase A current*, *Phase B current*, and *Phase C current*) and line-line voltages (variables *Output volts, A-B* and *Output volts, B-C*).

### 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 following diagram 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:

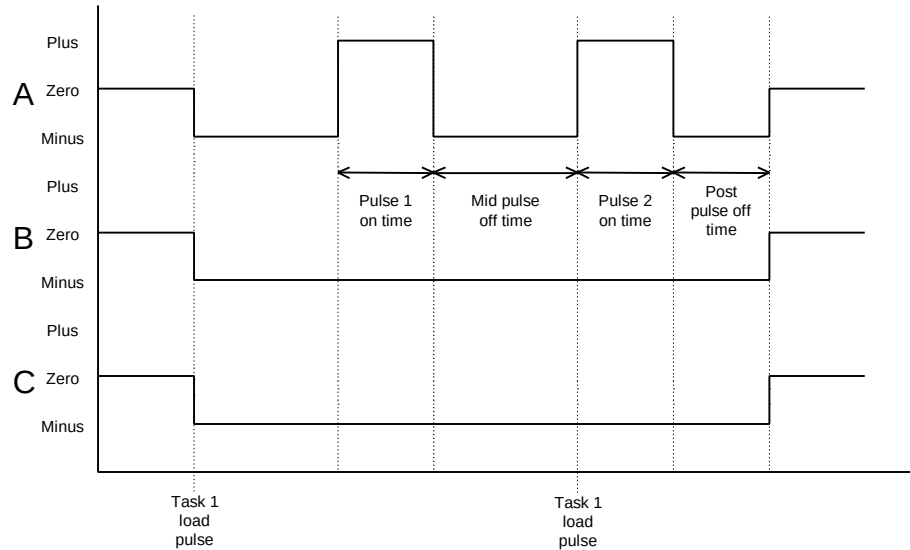
| <b>Bridge State</b> | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Off state           | All the IGBTs in the bridge are turned off. Due to the nature of the IGBTs 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 IGBTs in the bridge are turned on in such a way as to impress no voltage between the selected drive terminals. IGBTs are turned on such that the selected drive terminals are all connected to the same DC voltage potential within the bridge (MINUS 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 IGBTs 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 IGBTs 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 or 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:

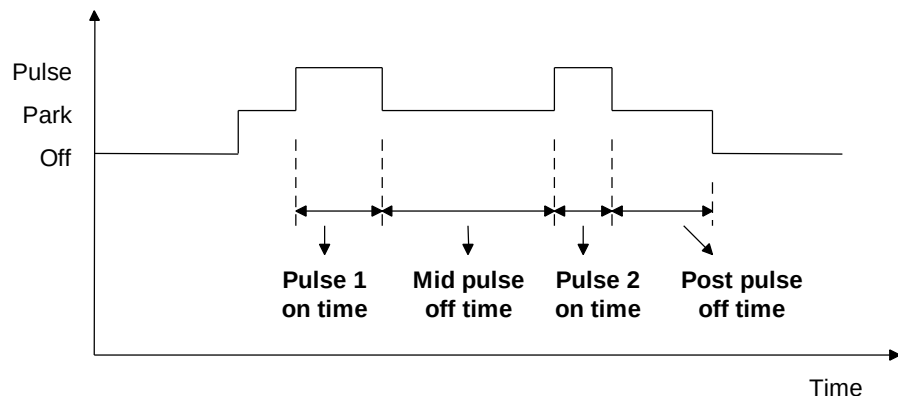
*Park phase* = A, B, C  
*Park level* = MINUS  
*Pulse phase* = A  
*Pulse level* = PLUS



## 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 following diagram 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

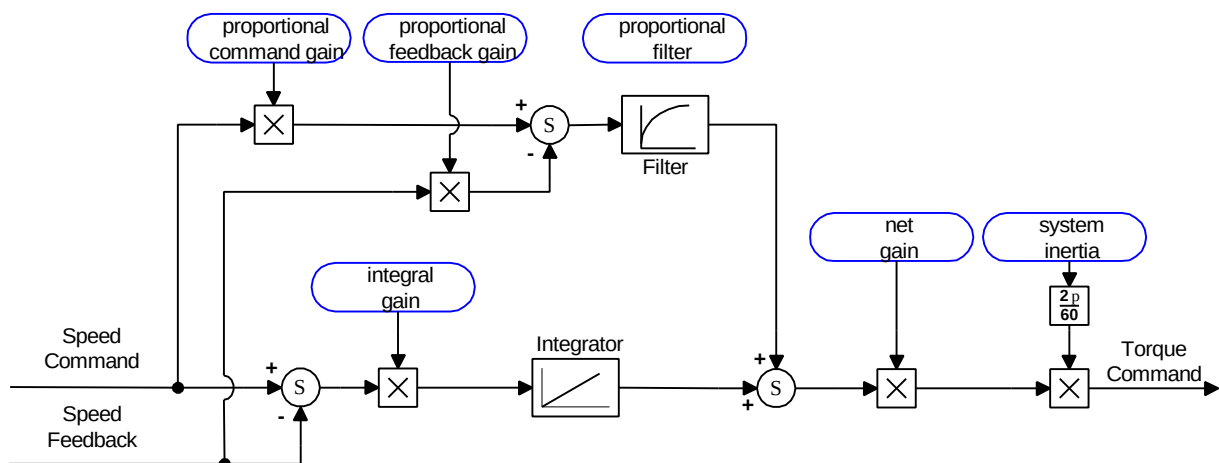
The *Simulator Setup* has reconfigured the drive with your selections.

---

# 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 1<sup>st</sup> and 2<sup>nd</sup> 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)

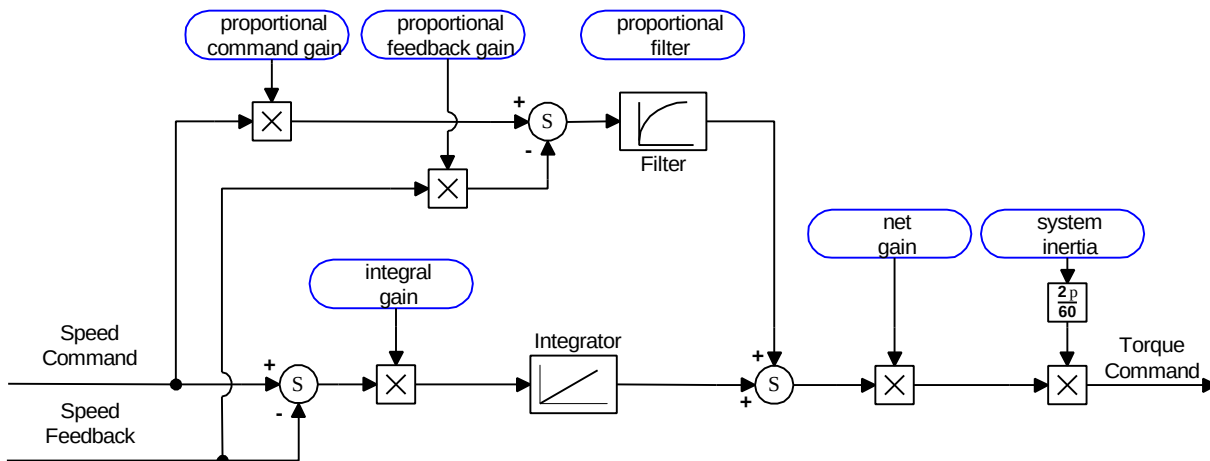
- If error “Problem With Torque for Rampup Test” occurs set At\_MeasJ\_Spd to 90% of the speed, in RPM, reached during test.
- If error “CoastDown Test Finished Prematurely” occurs set At\_MeasJ\_Spd to a value, in RPM, that would require the motor 1 sec to coast down.

## Speed Regulator Tuneup: Speed Regulator Mode

- Manually tune-up individual gains
- 1<sup>st</sup> order closed loop response
- 2<sup>nd</sup> order closed loop response
- 2<sup>nd</sup> order closed loop response with stiffness filter for load disturbances

## Speed Regulator Tuneup: Manual Regulator Tuneup

Enter the requested gains based on the following diagram:



System *Inertia* was previously measured or entered.

## Speed Regulator Tuneup: 1st Order Response

Calculate speed regulator gains based on 1<sup>st</sup> 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 2<sup>nd</sup> 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  $\pi/2$  to  $2\pi$ , where 0 is unused)

Note: If Tracking Bandwidth is equal to Regulator Bandwidth the speed regulator will give a 1<sup>st</sup> order response to a step input and a 2<sup>nd</sup> 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<sup>nd</sup> 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<sup>nd</sup> order response)
- Speed Regulator Tracking Bandwidth in radians/sec  
(bandwidth for coordinated section so reference errors are identical, practical limits are  $\pi/2$  to  $2\pi$ , where 0 is unused)

Note: If Tracking Bandwidth is equal to Regulator Bandwidth the speed regulator will give a 1<sup>st</sup> order response to a step input and a 2<sup>nd</sup> 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.

|                      |       |     |     |    |                    |
|----------------------|-------|-----|-----|----|--------------------|
| 2.0 KHz              |       |     |     |    | only               |
| 250 usec,<br>4.0 KHz | 250.0 | 4.0 | 266 | ?  | Evaluation<br>only |
| 200 usec,<br>2.5 KHz | 200.0 | 2.5 | 333 | ?  | Evaluation<br>only |
| 200 usec,<br>5.0 KHz | 200.0 | 5.0 | 333 | ?  | Evaluation<br>only |
| 166 usec,<br>3.0 KHz | 166.7 | 3.0 | 400 | 85 | No<br>Lan/ACLA     |
| 166 usec,<br>6.0 KHz | 166.7 | 6.0 | 400 | 65 | No<br>Lan/ACLA     |

## Max lineup output

Parameter *Max lineup output* specifies the maximum AC voltage that exists in the system containing the DC source, drive, and motors. The value of *Max lineup output* is determined in the following manner:

- If the DC source supplying power to the drive is a rectifier, then *Max lineup output* should be set to the line-line voltage input to the rectifier.
- If the DC source supplying power to the drive is a fully regenerative PWM source, and the line-line voltage input to the PWM source is greater than or equal to the line-line voltage rating of the motors powered by the drive, then *Max lineup output* should be set to the line-line voltage input to the PWM source.
- If the DC source supplying power to the drive is a fully regenerative PWM source, and the line-line voltage input to the PWM source is less than the line-line voltage rating of the motors powered by the drive, then *Max lineup output* should be set to the line-line voltage rating of the motors.

The type of DC source that supplies power to the drive is specified by parameter *Dc source*.

The value of *Max lineup output* for the drive should always match the value of *Max lineup output* for the source that supplies power to the drive.

*Max lineup output* is used to determine voltage protection levels for the drive. Its value should not be changed for the purpose of adjusting the protection levels.

## Units

- Presentation units: RMS volts
- Internal control units: RMS volts

### Functional use

- *DC Link Protection*
- *Power Dip Protection*

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

### 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:  $E-LN = \sqrt{3} \times E-PH$

Delta configuration:  $E-LN = E-PH$

## Preflux Forcing

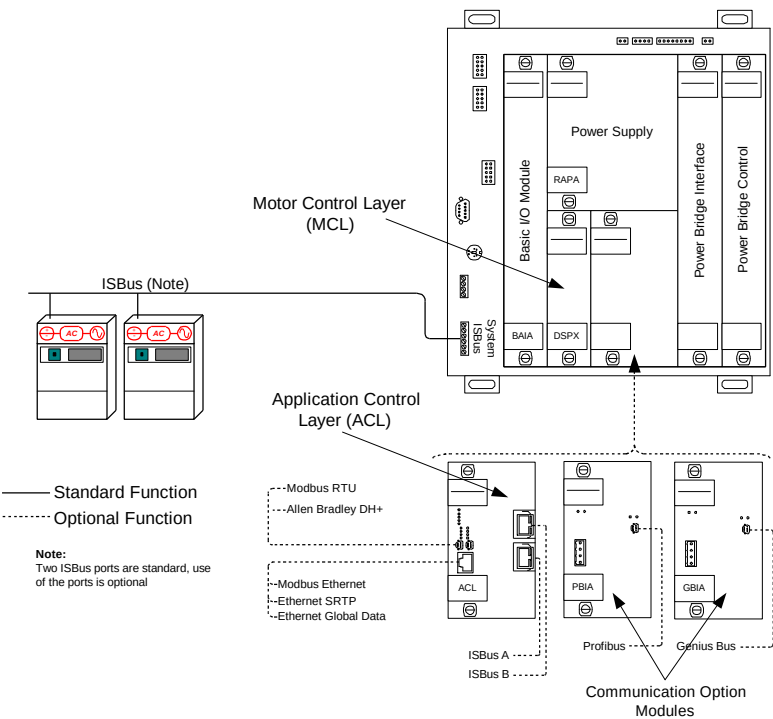
Parameter *Preflux Forcing* specifies the amount of peak current use to pre-flux the motor. The dimension is in per unit of motor nameplate amps. It is recommended to use 1.0 per unit field-forcing; however, in cases where motor rating is higher than inverter rating, the field-forcing Amps may have to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

# Chapter 4 Signal Mapping

## Introduction

| Section                                          | Page |
|--------------------------------------------------|------|
| Parameter Configuration for Signal Mapping ..... | 2    |
| Variable Mapping.....                            | 3    |
| Variable Maps .....                              | 5    |

Interfacing with the motor control layer (MCL) of the drive is done through I/O or a standard LAN (local area network) signal map. This chapter describes the standard LAN signal map which is used for several LAN interfaces (refer to the following figure and table).

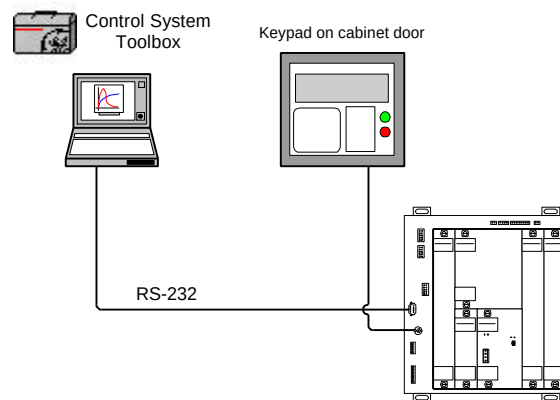


| Interface                       | Associated Module | Notes                                                                                                                                                                                                                                                         |
|---------------------------------|-------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Profibus-DP Slave               | IS215PBIA         | Freeze and sync mode supported<br>Support of 9.6Kb to 12Mb                                                                                                                                                                                                    |
| Genius                          | IS215GBIA         | LAN heartbeat supported                                                                                                                                                                                                                                       |
| ISBus Slave                     | IS215DSPX         | Supported from motor control layer, no additional modules required                                                                                                                                                                                            |
| Application Control Layer (ACL) | IS215ACLI         | From the ACL, other LANs are supported: <ul style="list-style-type: none"> <li>- Modbus RTU</li> <li>- Allen Bradley DH+</li> <li>- Modbus Ethernet</li> <li>- Ethernet SRTTP</li> <li>- Ethernet Global Data</li> </ul> Configuration is required in the ACL |

## 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.

Configuration of the 64 byte bi-directional signal map is done with either the keypad or Control System Toolbox.



Refer to the data sheets associated with these interface modules for a detailed description of the configuration.

| LAN Interface            | Description of Configuration                                        |
|--------------------------|---------------------------------------------------------------------|
| Genius Bus               | Auxiliary Genius Bus Interface Module IS215GBIAH_A__<br>GEI-100269  |
| Profibus-DP              | Auxiliary Profibus-DP Interface Module IS215PBIAH_A__<br>GEI-100419 |
| ISBus                    | GEH-6417                                                            |
| ACL based LAN Interfaces | GEI-100434                                                          |

---

## Variable Mapping

**Variables** are dynamic references for control of the drive or contain feedback on the status of the drive. For example, speed feedback and speed reference are two variables associated with the speed regulator function in the drive.

The variable map is defined in terms of paired reference and feedback pages.

| Page Type      | Direction of Data                                                   |
|----------------|---------------------------------------------------------------------|
| Reference Page | Sent from the controller to the drive (speed reference for example) |
| Feedback Page  | Sent from the drive to the controller (speed feedback for example)  |

**Signals** are LAN or I/O based variables that either control the drive or provide feedback data on the status of the drive. For example, an analog input signal provides the speed reference for the drive.

Each element in the map is assigned a data type. Standard assignments utilize the two data types, a 32-bit real and 1-bit Boolean.

| Data Type | Format                                                               |
|-----------|----------------------------------------------------------------------|
| Real      | IEEE 754 single format (23-bit mantissa, 8-bit exponent, 1-bit sign) |
| Boolean   | 1 bit per variable                                                   |

The following table specifies variables which indicate the LAN health and status for the LAN Configuration and Health function:

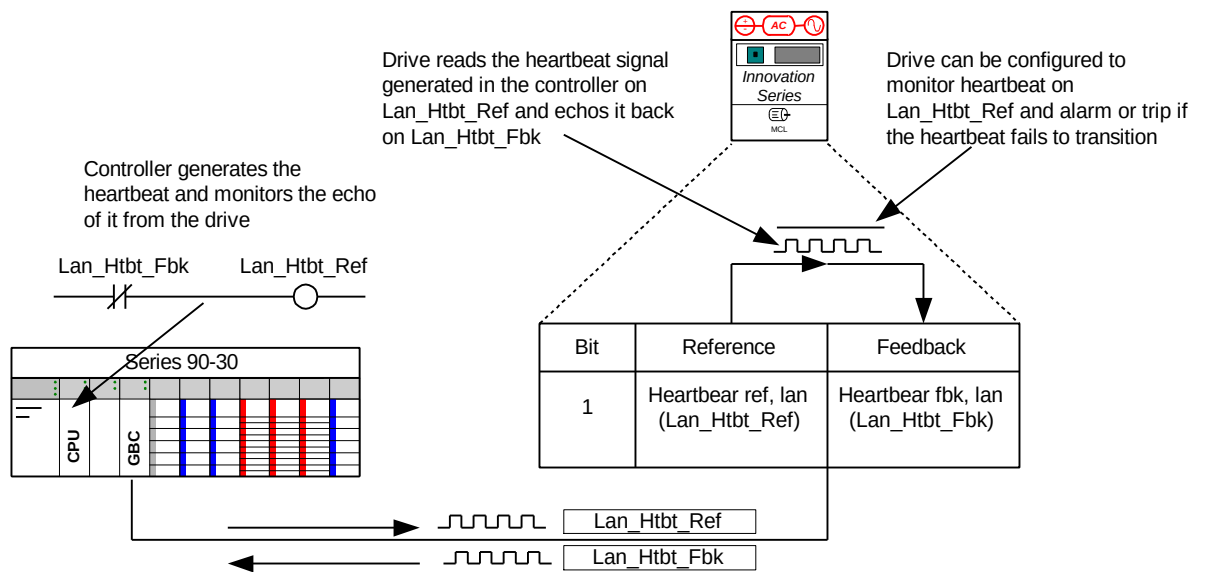
| Variable            | Description                                                                                                                                                                                                               |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LAN connection OK   | Indicates that the health of the LAN connection is good, so 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 variable 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 variable 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

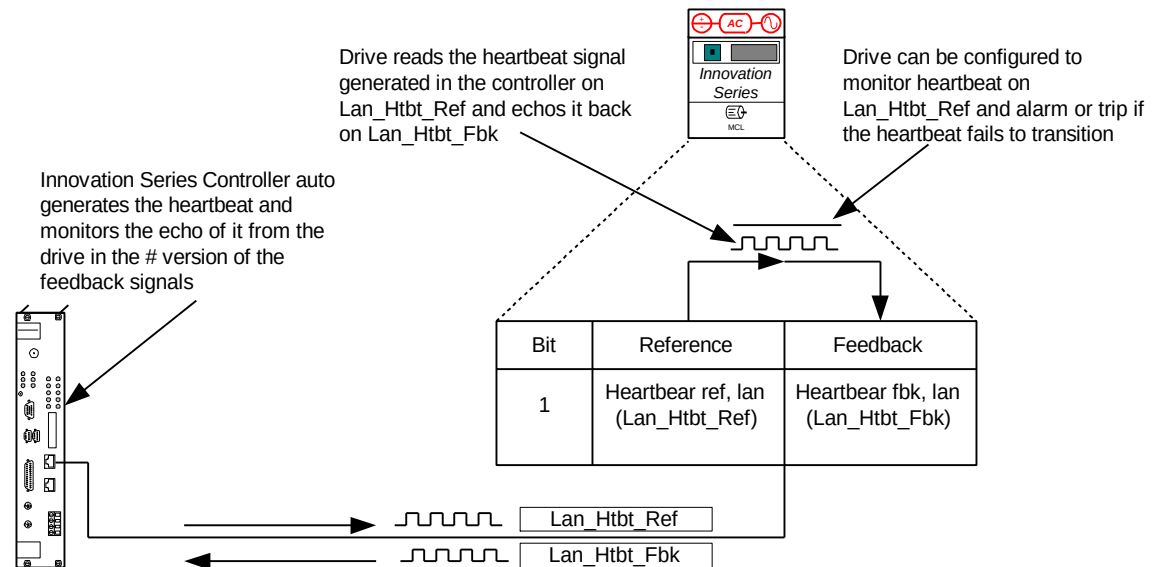
When controlling a drive over a LAN, both the controller and drive need to monitor and react to changes in the status of LAN health. The heartbeat echo feature in the drive provides a mechanism for this function.

The following illustrations of the heartbeat echo function indicate how the drive and controller obtain status on the integrity of the LAN 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, etc) operates asynchronous with the execution of control logic. Given this fact, 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 be 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" & "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 is provided by the ISBus.

## Variable Maps

This section defines the signal map for the ACDCF-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

| Byte  | Reference                                             |                                                     | Feedback                                             |                                                                                                        |
|-------|-------------------------------------------------------|-----------------------------------------------------|------------------------------------------------------|--------------------------------------------------------------------------------------------------------|
|       | Variable                                              | Functionality                                       | Variable                                             | Functionality                                                                                          |
| 1-4   | Request bits 1, lan<br>(Lan_Req1_Wrd)                 | multiple bits,<br>see table below                   | Feedback bits 1, lan<br>(Lan_Fbk1_Wrd)               | multiple bits,<br>see table below                                                                      |
| 5-8   | Auto speed ref, lan<br>(Lan_Spd_Ref)<br>SpeedRpm_Scl  | Auto analog ref sel<br>(Auto_Ref_Adr)<br>Behavior 2 | Fault number<br>(Lan_Flt_Code)<br><integer>          | number of the active fault<br>with<br>(1) highest severity<br>(trip/alarm) (2) earliest time-<br>stamp |
| 9-12  | Spd ref offset, lan<br>(Lan_Spd_Offs)<br>SpeedRpm_Scl | Speed loop sum sel<br>(Spd_Outr_Adr)<br>Behavior 2  | Speed feedback, lan<br>(Lan_Spd_Fbk)<br>SpeedRpm_Scl | =Avg[Spd_Fbk]<br>sequential averages                                                                   |
| 13-16 | Torque ref, lan<br>(Lan_Trq_Ref)<br>Torque_Scl        | Torque ref select<br>(Trq_Ref_Adr)<br>Behavior 2    | Motor torque, lan<br>(Lan_Trq_Fbk)<br>Torque_Scl     | =Avg[Trq_Cal_T2]<br>sequential averages                                                                |
| 17-20 | Not Used                                              |                                                     | Motor current, lan<br>(Lan_I_Mag)<br>“A rms”         | =Avg[I_Mag_T2 x Sqrt(1/2)]<br>sequential averages                                                      |
| 21-24 | Not Used                                              |                                                     | Not Used                                             |                                                                                                        |
| 25-28 | GP lan ref 1<br>(Lan_R01_Ref)                         | general purpose real<br>var                         | GP lan fbk reg 1<br>(Lan_R01_Fbk)                    | GP lan fb reg 1 sel<br>(Lan_R01_Adr)                                                                   |
| 29-32 | GP lan ref 2<br>(Lan_R02_Ref)                         | general purpose real<br>var                         | GP lan fbk reg 2<br>(Lan_R02_Fbk)                    | GP lan fb reg 2 sel<br>(Lan_R02_Adr)                                                                   |
| 33-36 | Torque fdfwd, lan<br>(Lan_Trq_Ffd)<br>Torque_Scl      | Torque feed fwd sel<br>(Trq_Ffd_Adr)<br>Behavior 2  | Motor power, lan<br>(Lan_Mtr_Pwr)<br>Power_Scl       | =Avg[Mtr_Pwr_T2]<br>sequential averages                                                                |
| 37-40 | Flux reference, lan<br>(Lan_Flx_Adj)<br><no units>    | Flux adjust select<br>(Flx_Adj_Adr)<br>Behavior 2   | Motor voltage, lan<br>(Lan_V_Mag)<br>“V rms”         | =Avg[V_Mag_T2 x Sqrt(3/2)]<br>sequential averages                                                      |
| 41-44 | Droop comp ref, lan<br>(Lan_Drp_Comp)<br><no units>   | Droop comp ref sel<br>(Drp_Comp_Adr)<br>Behavior 2  | Not Used                                             |                                                                                                        |
| 45-56 | Not Used                                              |                                                     | Not Used                                             |                                                                                                        |
| 57-60 | GP lan ref 3<br>(Lan_R03_Ref)                         | general purpose real<br>var                         | GP lan fbk reg 3<br>(Lan_R03_Fbk)                    | GP lan fb reg 3 sel<br>(Lan_R03_Adr)                                                                   |
| 61-64 | GP lan ref 4<br>(Lan_R04_Ref)                         | general purpose real<br>var                         | GP lan fbk reg 4<br>(Lan_R04_Fbk)                    | GP lan fb reg 4 sel<br>(Lan_R04_Adr)                                                                   |

## Boolean Variable Map

| Bit | Reference                             |                                                         | Feedback                                    |                                                                               |
|-----|---------------------------------------|---------------------------------------------------------|---------------------------------------------|-------------------------------------------------------------------------------|
|     | Variable                              | Functionality                                           | Variable                                    | Functionality                                                                 |
| 1   | Heartbeat ref, lan<br>(Lan_Htbt_Ref)  | Heartbeat function:<br>transitions expected             | Heartbeat fbk, lan<br>(Lan_Htbt_Fbk)        | Heartbeat function:<br>loopback Heartbeat ref,<br>lan                         |
| 2   | Fault reset req, lan<br>(Lan_Flt_Rst) | Fault reset select<br>(Flt_Rst_Adr)<br>Behavior 1, edge | No faults or alarms<br>(No_Flt)             | no active (uncleared)<br>faults,<br>"not (trip OR alarm)"                     |
| 3   | Trip request, lan<br>(Lan_Trp_Req)    | Fault.Lan trip request<br>(Lan_Trp)<br>Behavior 0       | Trip fault active<br>(Trip_Flt)             | active trip fault,<br>"trip"                                                  |
| 4   | Alarm request, lan<br>(Lan_Alm_Req)   | Fault.Lan<br>alarmrequest<br>(Lan_Alm)<br>Behavior 0    | Local fault string<br>(Loc_Flt)             | local hardware<br>perm issive; bridge<br>inhibited                            |
| 5   | Not Used                              |                                                         | System fault string<br>(Sys_Flt)            | system hardware<br>perm issive; bridge<br>inhibited                           |
| 6   | Not Used                              |                                                         | Ready to Run<br>(Run_Rdy)                   | device is ready & will<br>respond to run request                              |
| 7   | Not Used                              |                                                         | Bridge is on<br>(Brg_Pwr_Enb)               | bridge power enabled;<br>sequencer command                                    |
| 8   | Not Used                              |                                                         | Running<br>(Running)                        | Set, Clear:<br>Ref_Enb_Stat &<br>Sreg_Stat ,<br>/Ref_Enb_Stat &<br>/Sreg_Stat |
| 9   | Run request, lan<br>(Lan_Run_Req)     | Run request select<br>(Run_Req_Adr)<br>Behavior 1, edge | Run active<br>(Run_Act)                     | Running &<br>( Run_Req & /Jog_Req )                                           |
| 10  | Jog request, lan<br>(Lan_Jog_Req)     | Jog request select<br>(Jog_Req_Adr)<br>Behavior 1, edge | Jog active<br>(Jog_Act)                     | Running &<br>( Jog_Req )                                                      |
| 11  | X stop request, lan<br>(Lan_Xstp_Req) | X stop request sel<br>(X_Stp_Adr)<br>Behavior 1, level  | X stop active<br>(X_Stp_Cmd)                | result of Xstop requests                                                      |
| 12  | Full flux req, lan<br>(Lan_FFfx_Req)  | Full flux req sel<br>(Fflx_Req_Adr)<br>Behavior 1, edge | Full flux active<br>(Seq_Stat.Flx_Enb_Stat) | flux model indicates that<br>net commanded flux<br>is established             |
| 13  | Rev mode req, lan<br>(Lan_Rev_Req)    | Reverse select<br>(Rev_Req_Adr)<br>Behavior 2           | Reverse mode active<br>(Reverse)            | result of Rev mode<br>requests                                                |

| Bit   | Reference                                    |                                                     | Feedback                                      |                                                               |
|-------|----------------------------------------------|-----------------------------------------------------|-----------------------------------------------|---------------------------------------------------------------|
|       | Variable                                     | Functionality                                       | Variable                                      | Functionality                                                 |
| 14    | Torque mode req, lan<br>(Lan_Tref_Enb)       | Torque mode sel<br>(Tref_Enb_Adr)<br>Behavior 2     | Torque mode active<br>(Trq_Mode_Act)          | speed regulator function<br>is regulating torque              |
| 15    | Droop disab req, lan<br>(Lan_Drp_Inh)        | Droop disable select<br>(Drp_Inh_Adr)<br>Behavior 2 | Speed mode active<br>(Spd_Mode_Act)           | speed regulator function<br>is regulating speed               |
| 16    | Trq lim 2 req, lan<br>(Lan_Tlim_Sel)         | Torque lim 2 sel<br>(Tlim_Sel_Adr)<br>Behavior 2    | In cur or trq lim<br>(Trq_Lim_Act)            | Inner torque regulator in<br>limit=(Sreg_Frz_Pos  Neg)        |
| 17    | Ramp rate 2 req, lan<br>(Lan_Rmp_Sel)        | Ramp rate 2 select<br>(Rmp_Sel_Adr)<br>Behavior 2   | Not Used                                      |                                                               |
| 18    | <i>Ramp bypass req, lan</i><br>(Lan_Rmp_Byp) | <i>Bypass ramp</i><br>(Rmp_Bypass)                  | MA contactor closed<br>(Seq_Stat.MA_Enb_Stat) | sequencer task status;<br>real or modeled contactor<br>status |
| 19    | Auto mode req, lan<br>(Lan_Auto_Req)         | Auto mode select<br>(Auto_Adr)<br>Behavior 2        | Auto mode active<br>(Auto_Mode)               | result of Auto mode<br>requests                               |
| 20    | Not Used                                     |                                                     | Zero speed active<br>(Zero_Spd)               | speed feedback is below<br>zero speed (after delay)           |
| 21-24 | Not Used                                     |                                                     | Not Used                                      |                                                               |
| 25    | GP lan req bit 01<br>(Lan_B01_Req)           | general purpose bool<br>var                         | GP lan fbk bit 01<br>(Lan_B01_Fbk)            | GP lan fb bit 01 sel<br>(Lan_B01_Adr)                         |
| .     |                                              |                                                     |                                               |                                                               |
| .     |                                              |                                                     |                                               |                                                               |
| .     |                                              |                                                     |                                               |                                                               |
| 32    | GP lan req bit 08<br>(Lan_B08_Req)           | general purpose bool<br>var                         | GP lan fbk bit 08<br>(Lan_B08_Fbk)            | GP lan fb bit 08 sel<br>(Lan_B08_Adr)                         |

# Appendix A

---

## Introduction

**Parameters** are adjustable values within a function that allow you to configure and adjust the drive behavior. For example, some basic parameters and their associated units include Motor rated current (Amps), Motor rated freq (Hz), Motor rated voltage (Volts), and Regulator type.

Application firmware consists of coordinated blocks of code called **functions**. Each function performs a specific task in controlling the drive.

**Parameters** can be set and modified from the keypad and the optional configuration program, the Control System Toolbox.

The drawings in this section are function diagrams for a typical Innovation Series Low Voltage drive. Refer to Chapter 2 for more detailed description of these functions.



### Caution

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

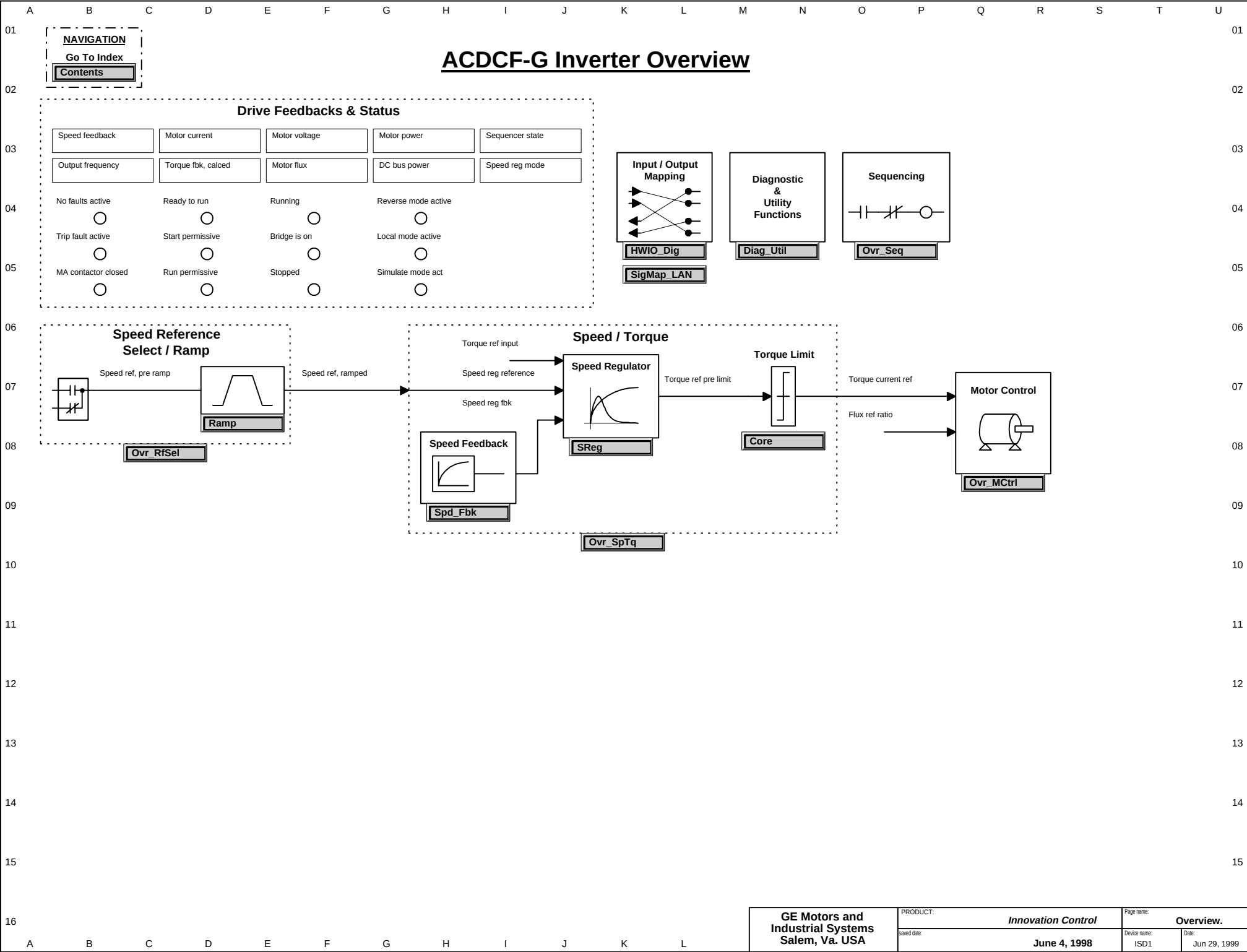
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**Note** These diagrams are available as navigable, online drawings in the optional Windows®-based drive configuration software, the GE Control System Toolbox.

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| <b>Diagram Title</b>                         | <b>Page Name</b> |
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| ACDCFG Inverter Index .....                  | Contents.        |
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| Sequencing overview .....                    | Ovr_Seq.         |

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# ACDCF-G Inverter Index

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Analog and Digital I/O Testing

HWIO\_Tst

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# Digital Inputs/Outputs & Mapping

## NAVIGATION

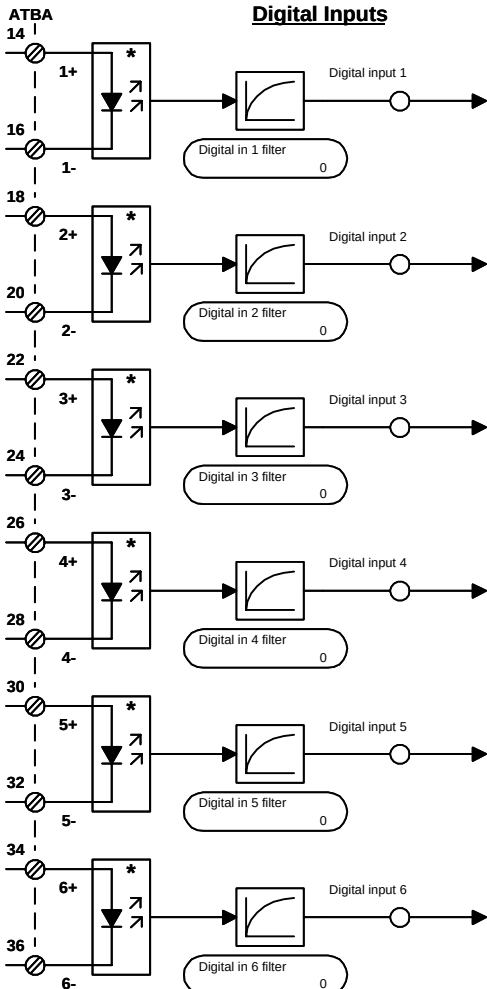
Overview

Analog I/O

Overview

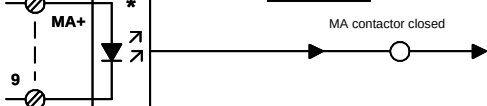
HWIO\_Ana

## Digital Inputs

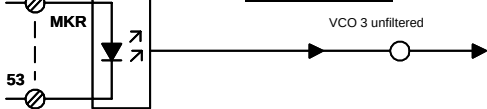


## Dedicated Digital Inputs

### MA Feedback



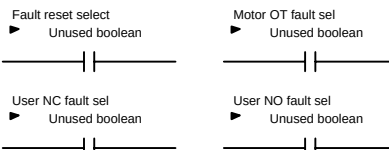
### Tachometer Marker



\* - 2-5ms HW Filtering

## Sequencing Selectors

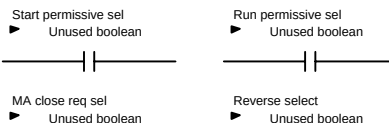
### Faults & Reset



### Stop Commands



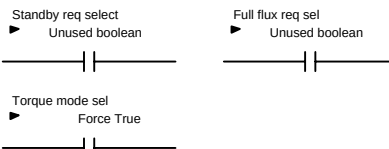
### Permissives



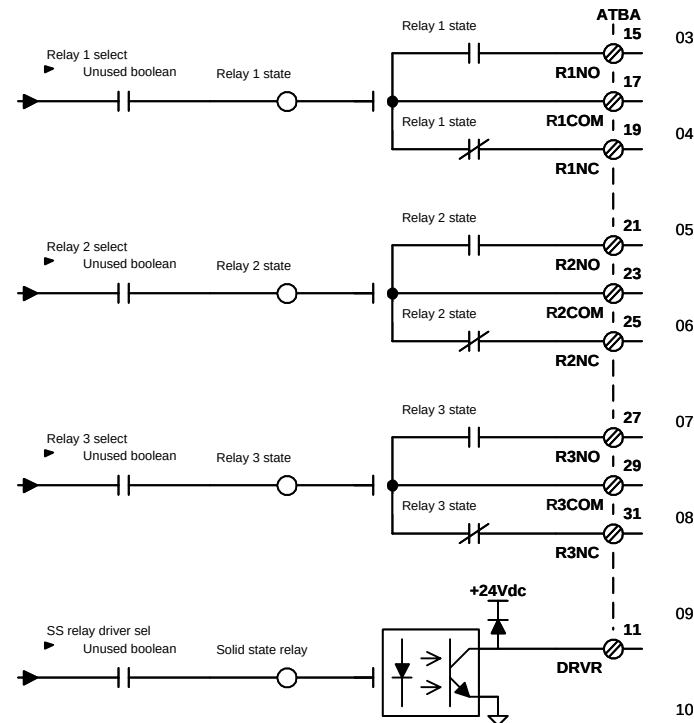
### Run / Jog Requests



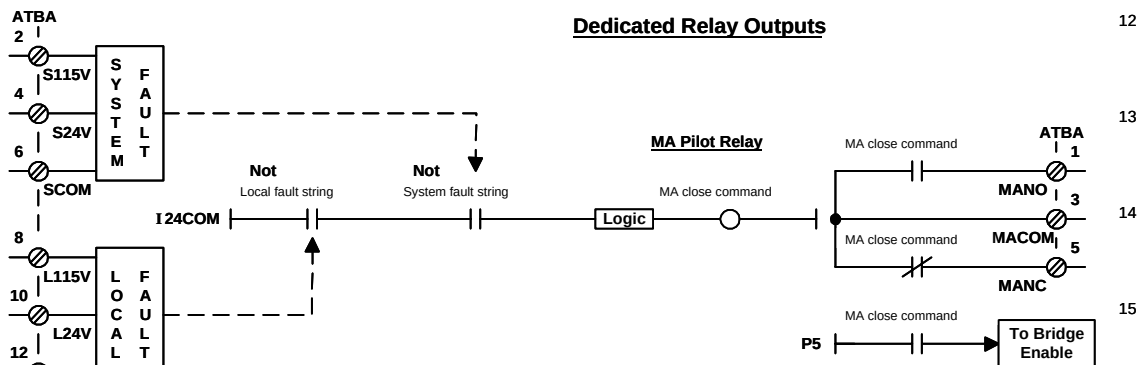
### Regulator Commands



## Relay Outputs



## Dedicated Relay Outputs



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# Analog Inputs/Outputs & Mapping

## NAVIGATION

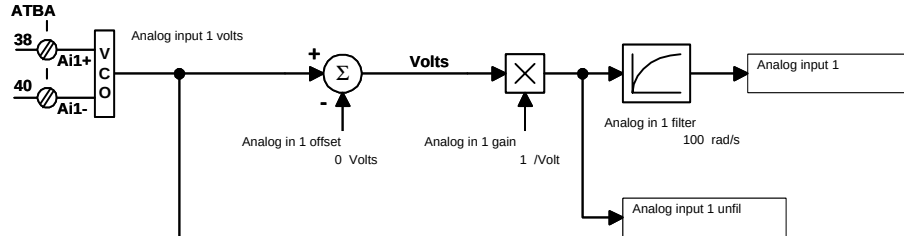
Overview

Digital I/O

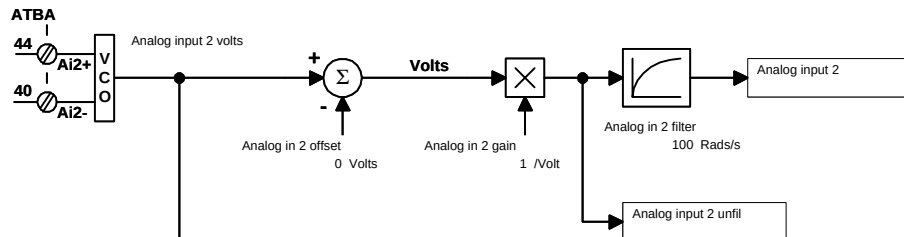
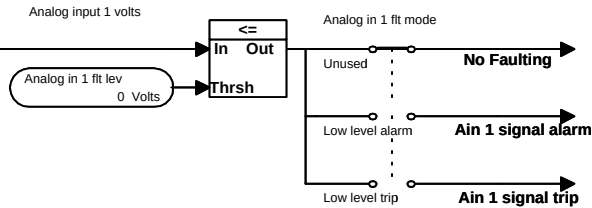
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HWIO\_Dig

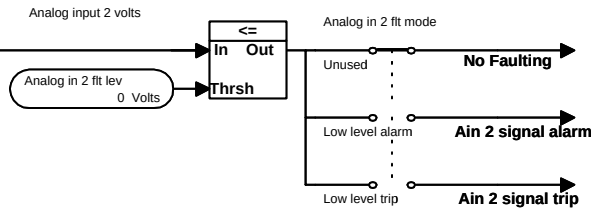
## Analog Inputs



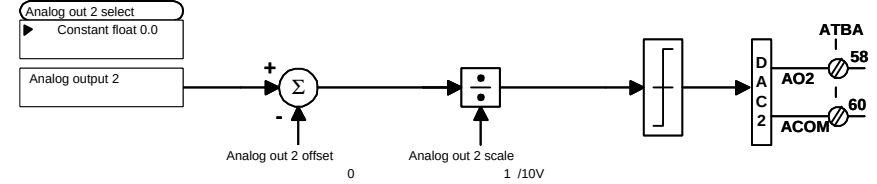
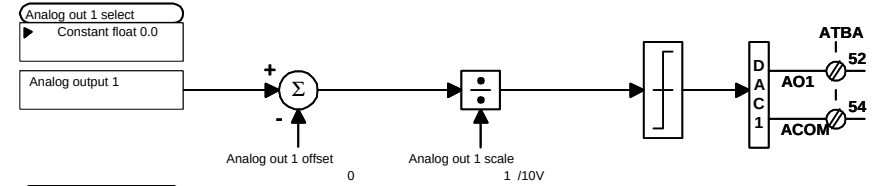
## Loss of 4-20mA Protection



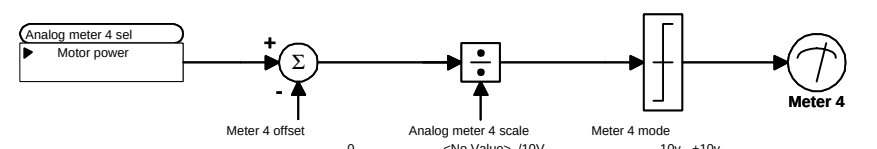
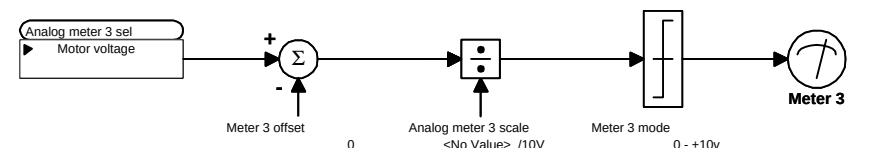
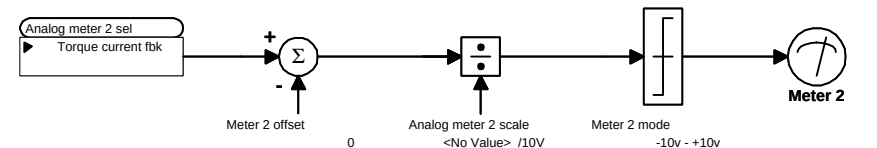
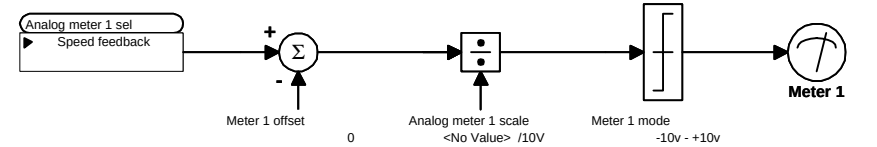
## Loss of 4-20mA Protection



## Analog Outputs



## Meter Outputs



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NAVIGATION

BackNext

OverviewSigMap\_Bit1

Configuration

Network interfaceNoneLan fbk avg time0 Sec

Sys ISBus node #-1LAN frame time1 ms Sec

Status

Lan connection okLan commands OK

Lan trips inhibitNoLan cmds inhibitNo

Drive Lan Signal Map

Page 1

| Reference            |                                           | Feedback             |                                                                        |
|----------------------|-------------------------------------------|----------------------|------------------------------------------------------------------------|
| Variable             | Functionality                             | Signal               | Functionality                                                          |
| 1Request bits 1, lan | (see table)<br>SigMap_Bit1                | Feedback bits 1, lan | (see table)<br>SigMap_Bit1                                             |
| 2Auto speed ref, lan | Auto analog ref sel<br>Constant float 0.0 | Fault number         | active fault number:<br>1) highest severity,<br>2) earliest time-stamp |
| 3Spd ref offset, lan | Speed loop sum sel<br>Constant float 0.0  | Speed feedback, lan  | averaged<br>Speed feedback                                             |
| 4Torque ref, lan     | Torque ref select<br>Constant float 0.0   | Motor torque, lan    | averaged<br>Torque fbk, calcd                                          |
| 5<spare>             |                                           | Motor current, lan   | averaged<br>Motor current                                              |
| 6<spare>             |                                           | <spare>              |                                                                        |
| 7GP lan ref 1        | general purpose<br>real var               | GP lan fbk reg 1     | GP lan fbk reg 1 sel<br>Unused float                                   |
| 8GP lan ref 2        | general purpose<br>real var               | GP lan fbk reg 2     | GP lan fbk reg 2 sel<br>Unused float                                   |

Page 2

| Reference            |                                           | Feedback           |                                      |
|----------------------|-------------------------------------------|--------------------|--------------------------------------|
| Variable             | Functionality                             | Signal             | Functionality                        |
| 1Torque fdfwd, lan   | Torque feed fwd sel<br>Constant float 0.0 | Motor power, lan   | averaged<br>Motor power              |
| 2Flux reference, lan | Flux adjust select<br>Unused float        | Motor voltage, lan | averaged<br>Motor voltage            |
| 3Droop comp ref, lan | Droop comp ref sel<br>Constant float 0.0  | <spare>            |                                      |
| 4<spare>             |                                           | <spare>            |                                      |
| 5<spare>             |                                           | <spare>            |                                      |
| 6<spare>             |                                           | <spare>            |                                      |
| 7GP lan ref 3        | general purpose<br>real var               | GP lan fbk reg 3   | GP lan fbk reg 3 sel<br>Unused float |
| 8GP lan ref 4        | general purpose<br>real var               | GP lan fbk reg 4   | GP lan fbk reg 4 sel<br>Unused float |

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|--|--|---------------------|--|-------------------------------------------------------------------------------|--|--------|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|--|
|  |  | NAVIGATION          |  | Drive Lan Boolean Signals (bits 0-15)                                         |  |        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | Back<br>SigMap_LAN  |  | Next<br>SigMap_Bit2                                                           |  | Status |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  |  | Back to<br>Overview |  | Lan connection ok<br>Lan commands OK<br>Lan trips inhibit<br>Lan cmds inhibit |  |        |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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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

Function

seq task status;  
real or modeled  
contactor status

result of Auto mode  
requests

speed feedback is  
below zero speed  
(after delay)

24

25

26

27

28

29

30

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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

GE Motors and  
Industrial Systems  
Salem, Va. USA

PRODUCT:

Innovation Control

saved date:

June 4, 1998

Page name:

SigMap\_Bit2.

Device name:

ISD1

Date:

Jun 29, 1999

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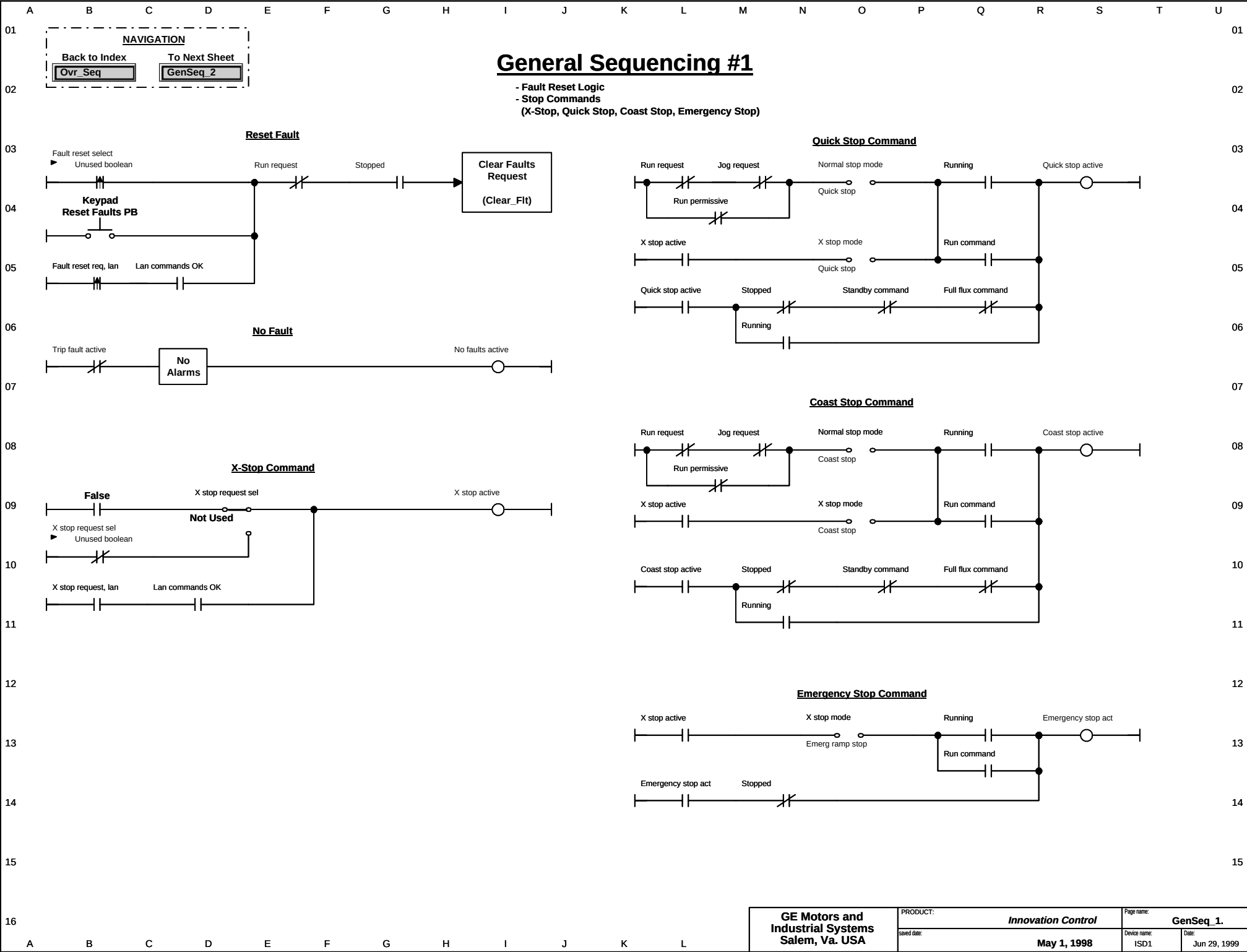
Run/Jog Requests & Run Command ..... ➡ GenSeq\_2

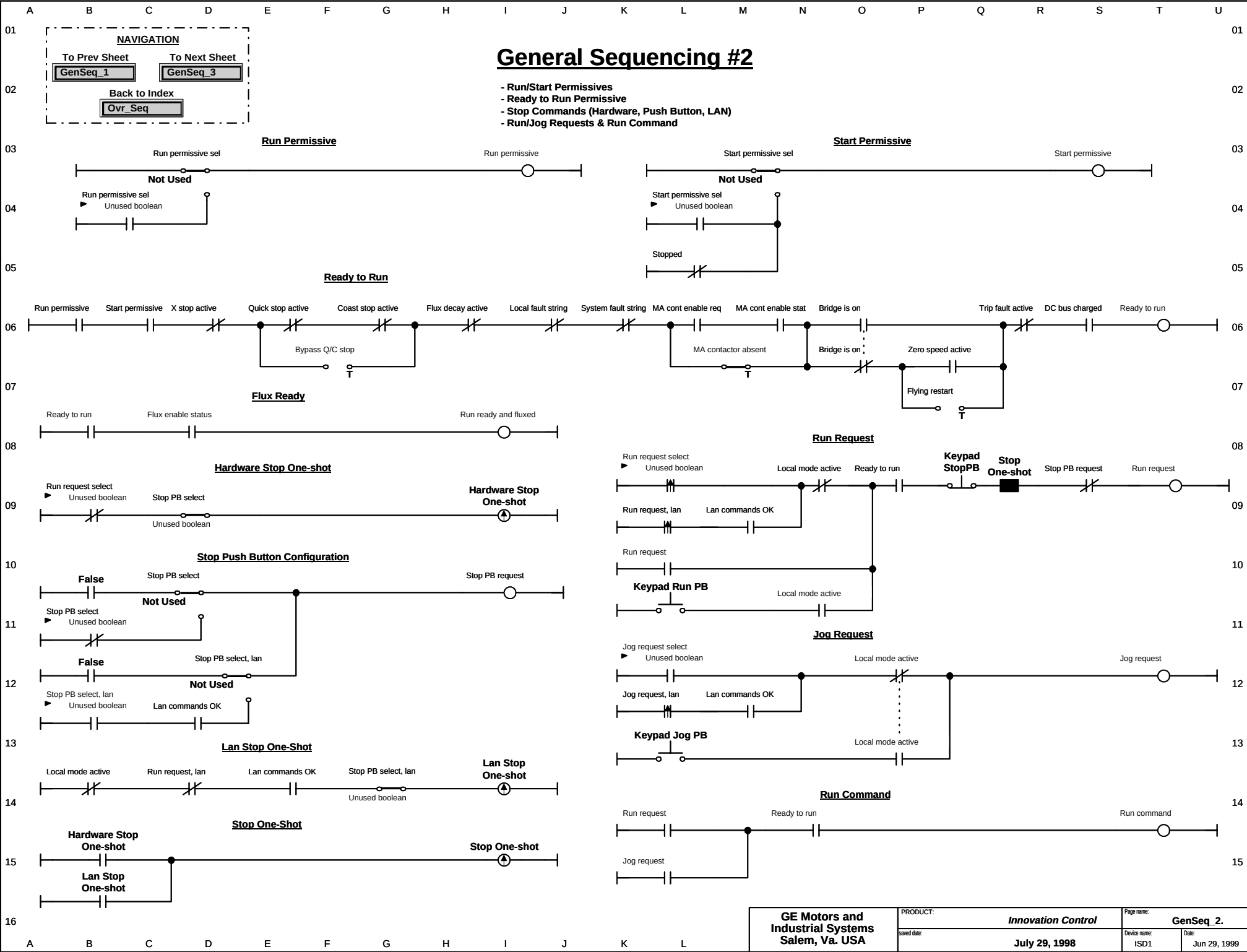
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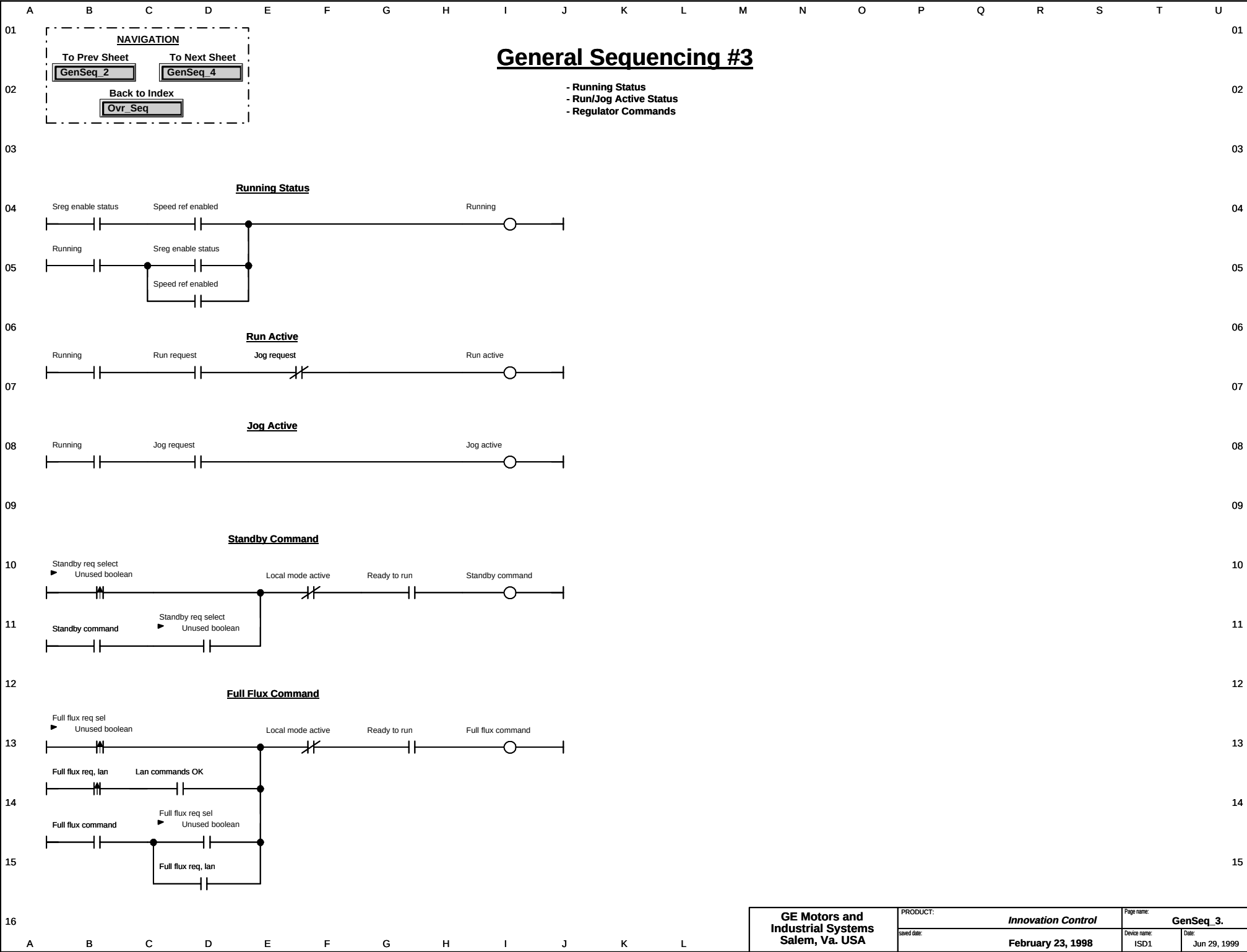
Regulator Commands ..... **GenSeq\_3**

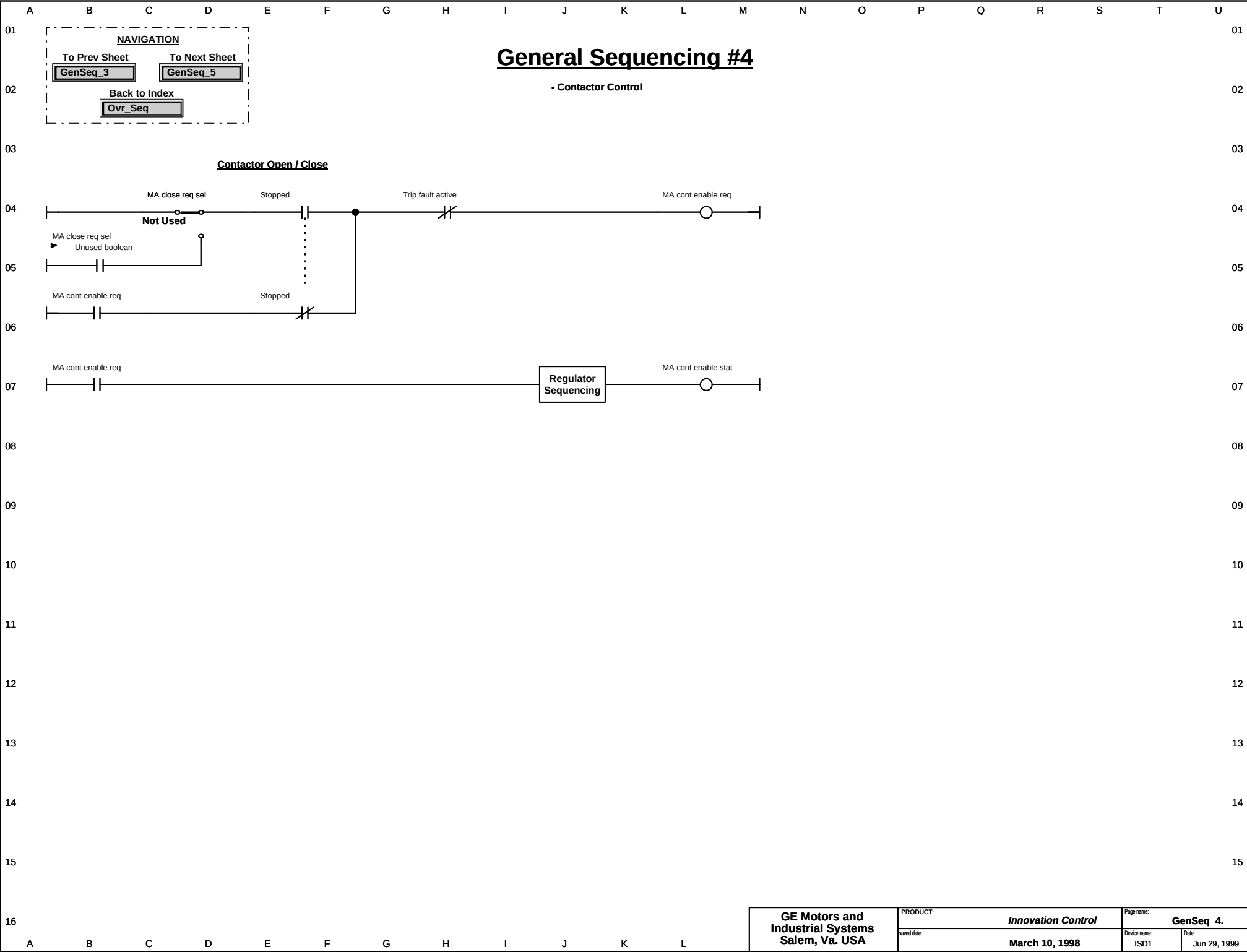
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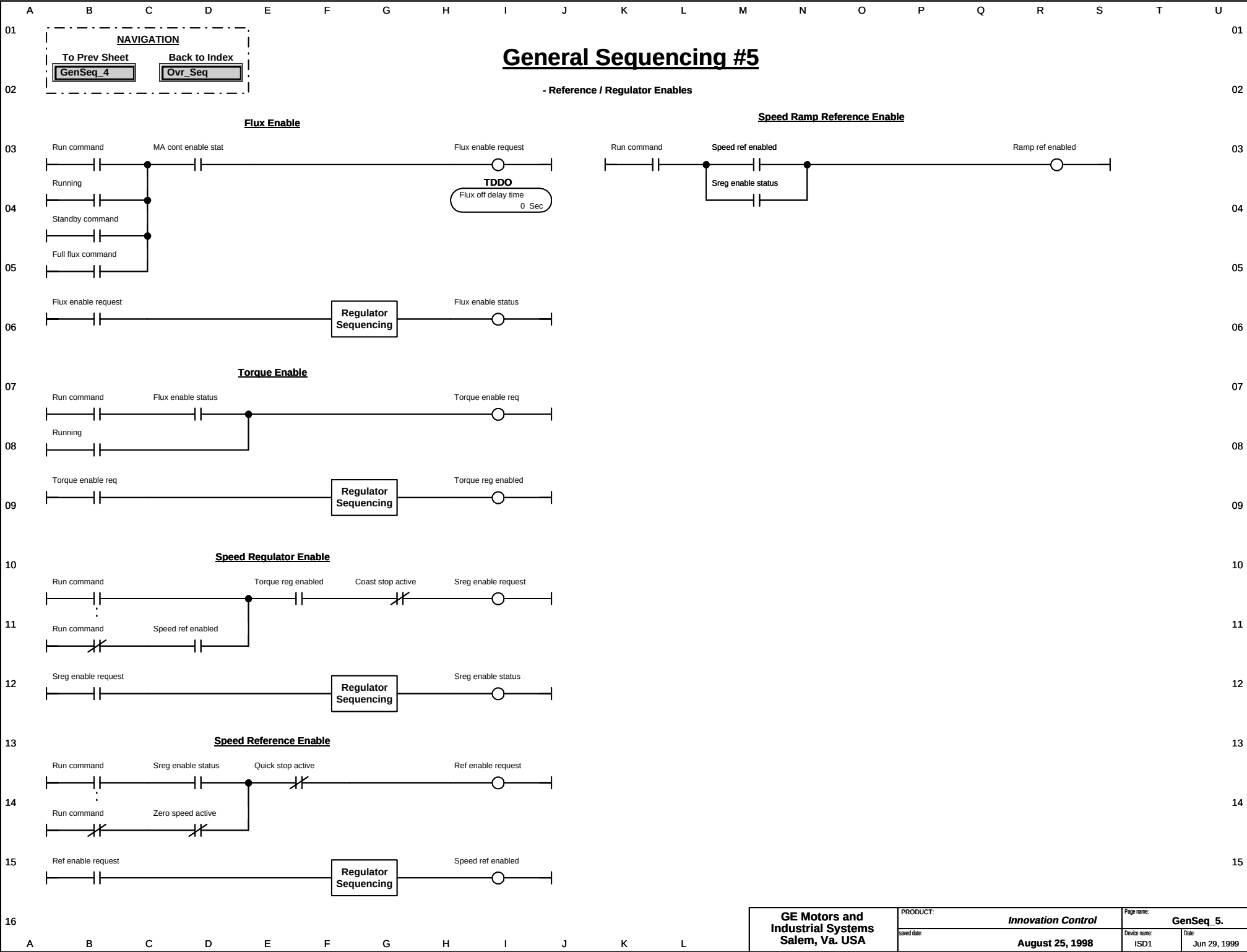
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# Speed Reference Generation

## NAVIGATION

Back to Overview

Overview

## Drive Diagnostic Reference

## Forward/Reverse

## Min Speed Limit

## Critical Speed Avoidance

CrSpdAvd

## Auto Reference

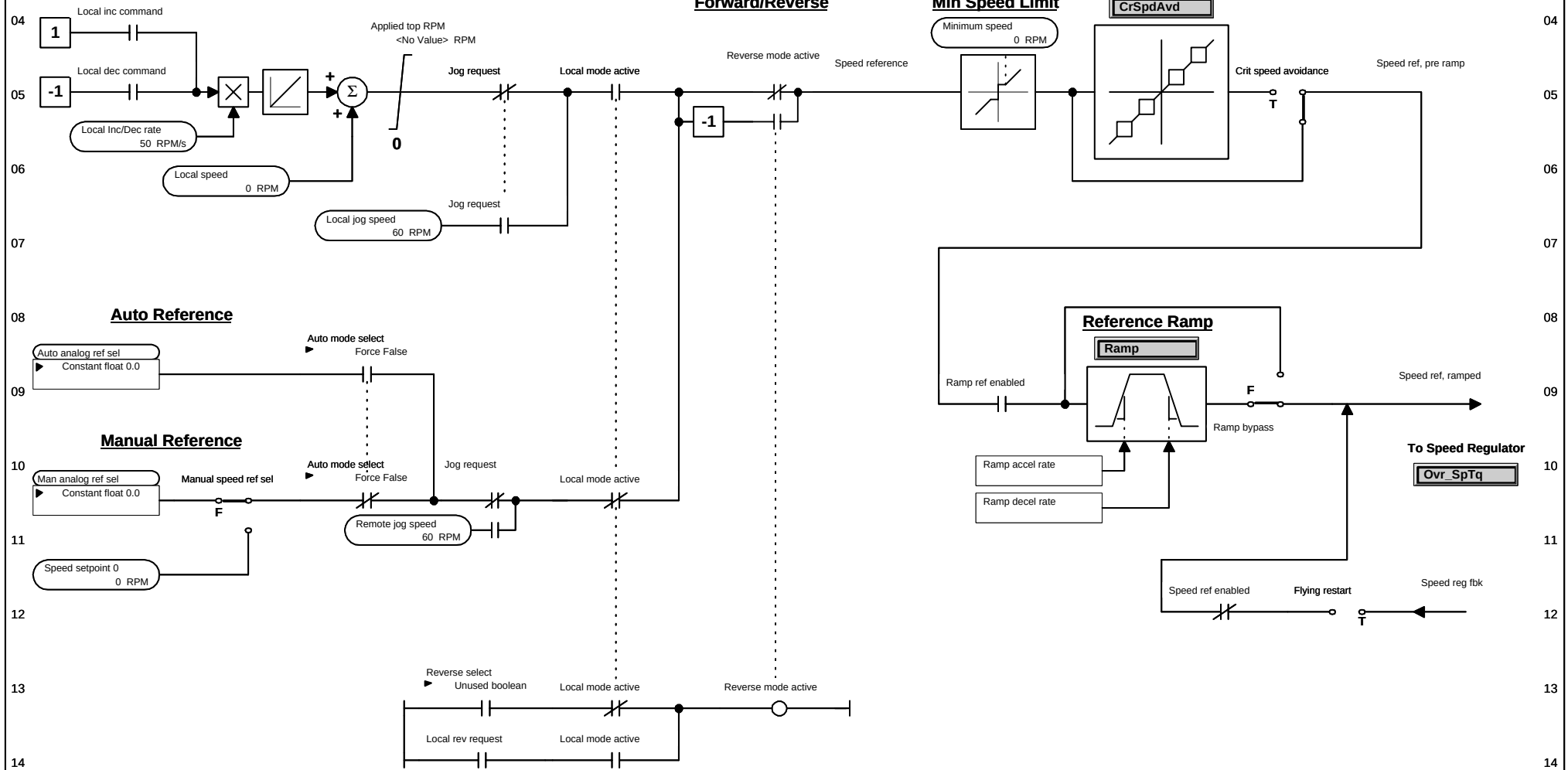
## Manual Reference

## Reference Ramp

Ramp

## To Speed Regulator

Ovr\_SpTq



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Industrial Systems  
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PRODUCT:

Innovation Control

Page name:

Ovr\_RfSel.

saved date:

March 10, 1998

Device name:

ISD1

Date:

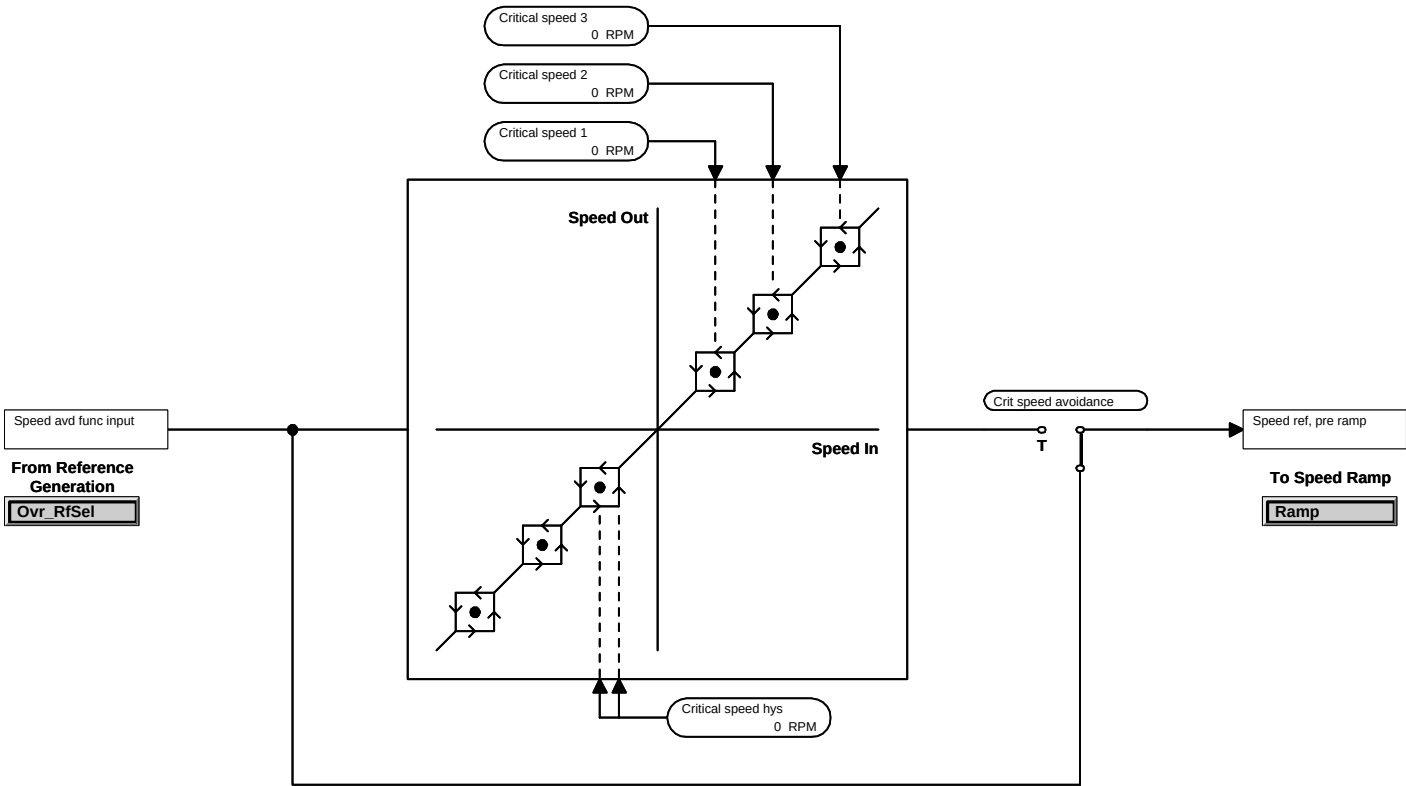
Jun 29, 1999

# Critical Speed Avoidance

NAVIGATION

Back

Ovr\_RfSel

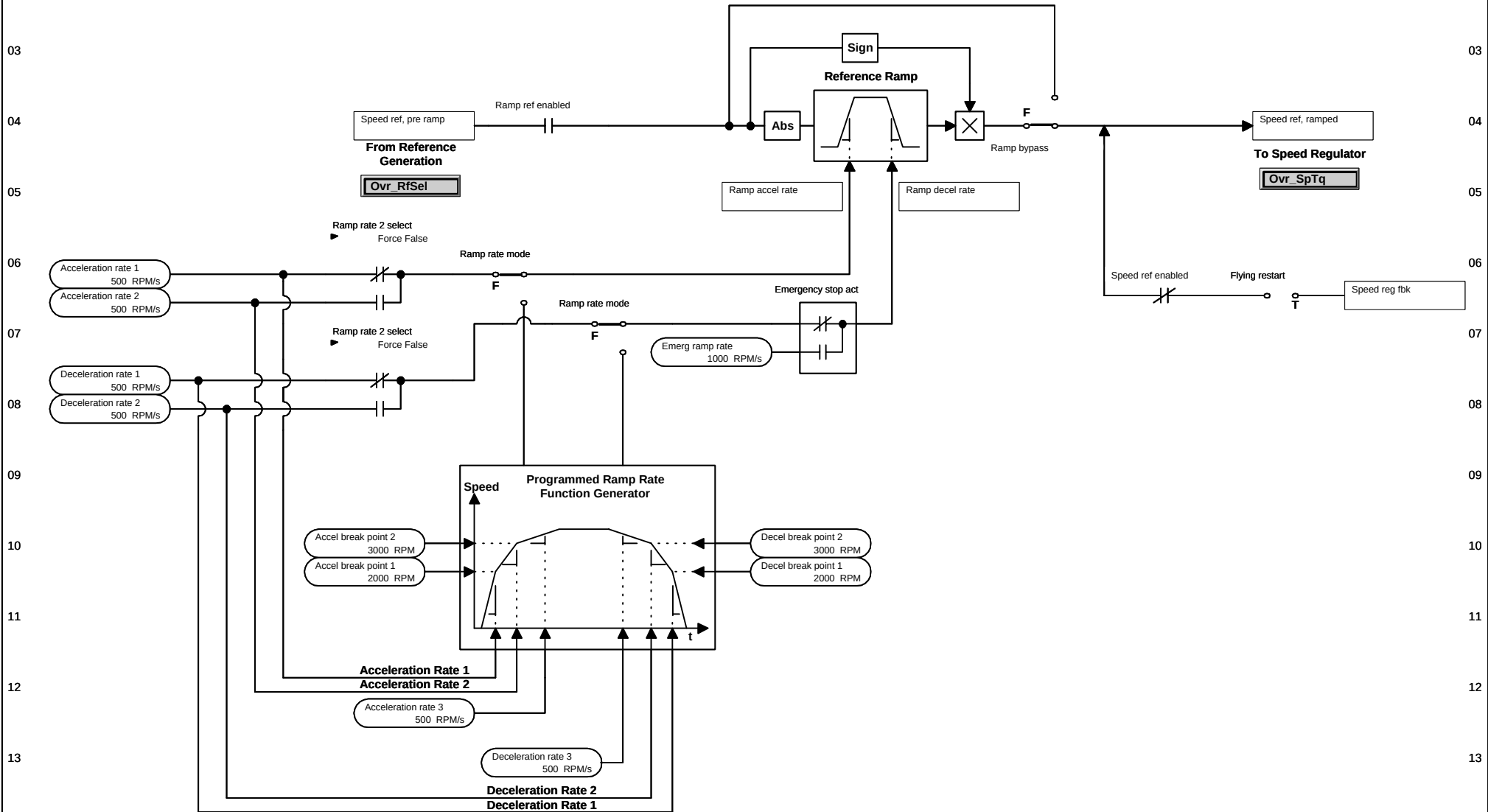


# Speed Reference Ramp

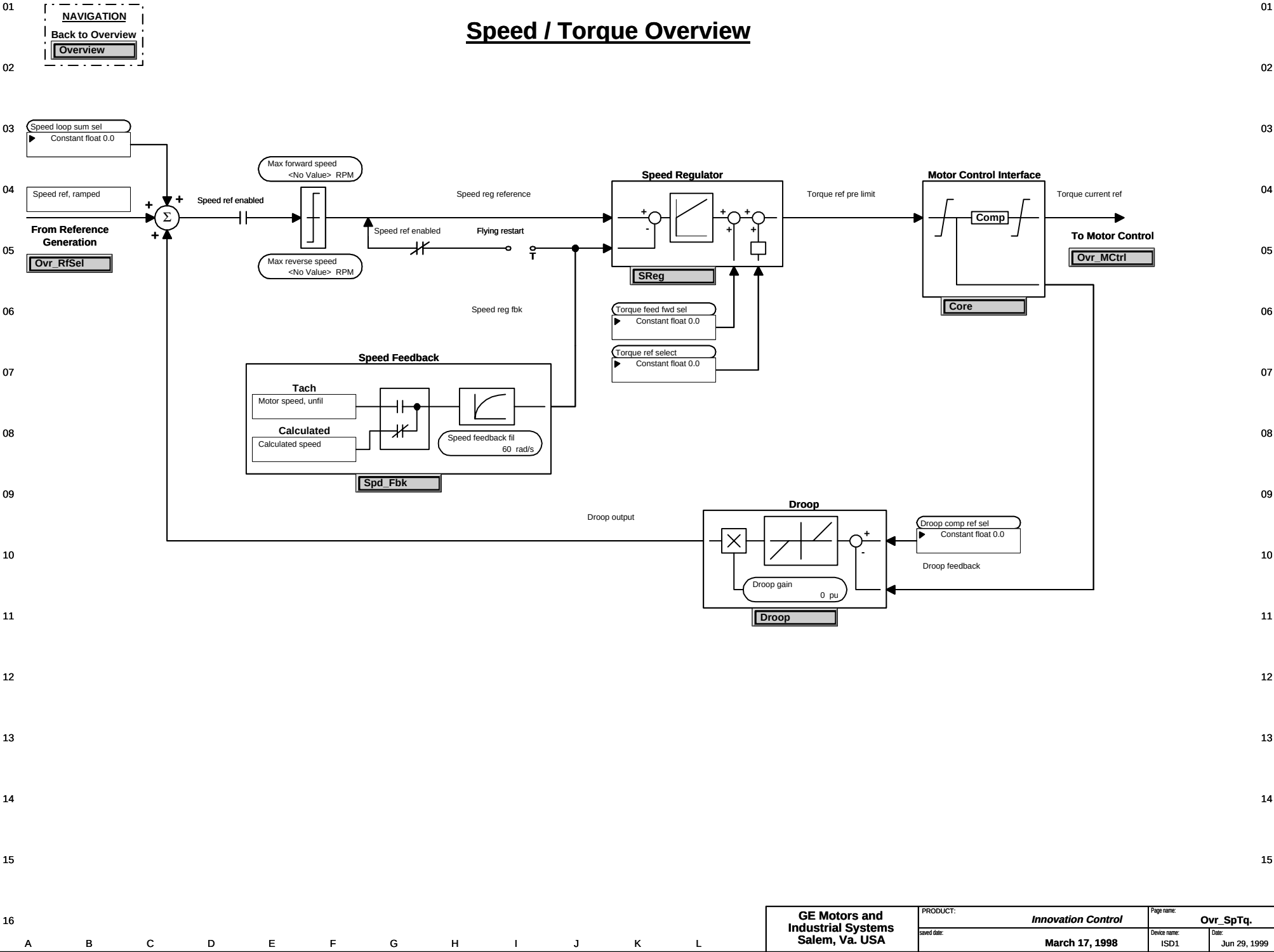
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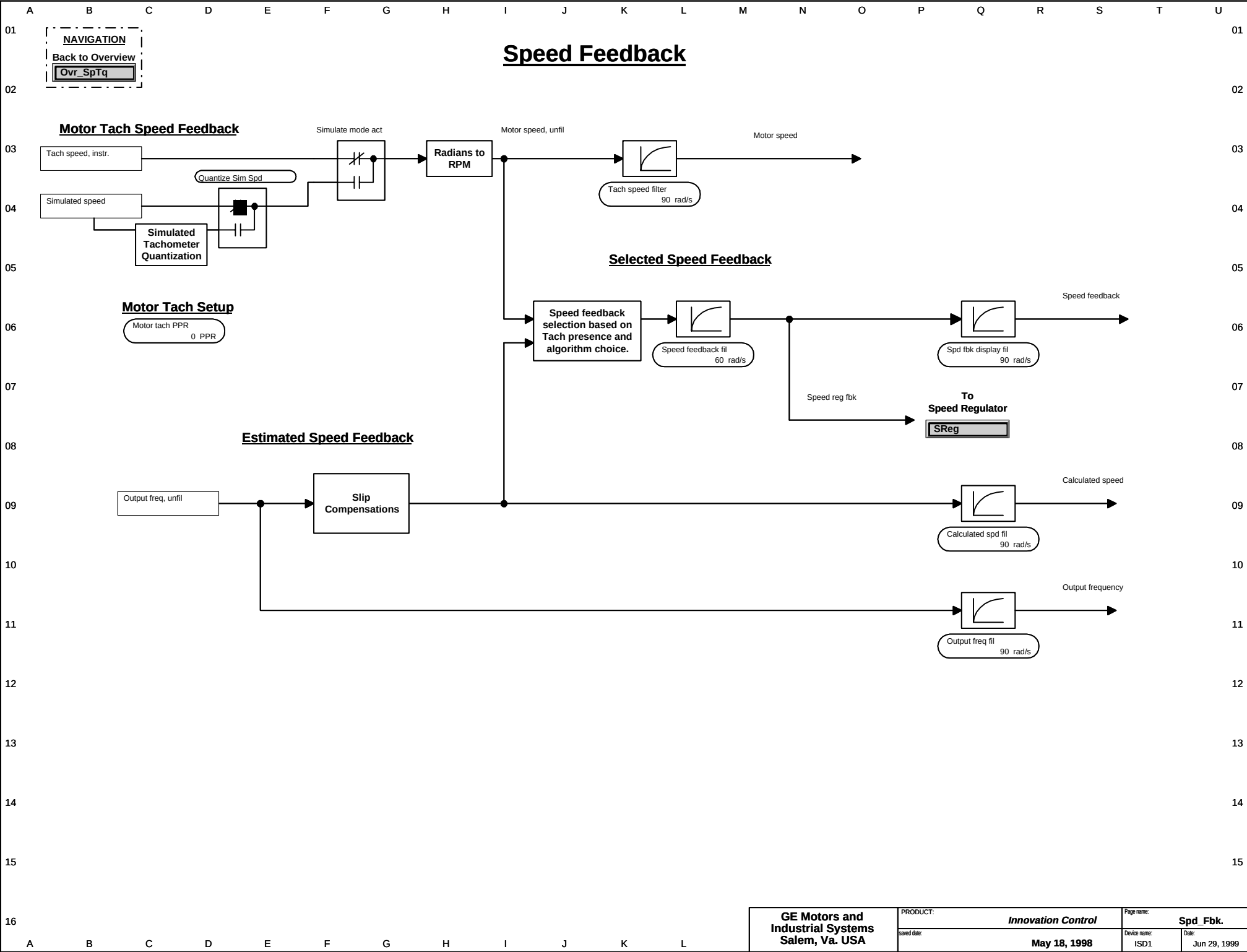
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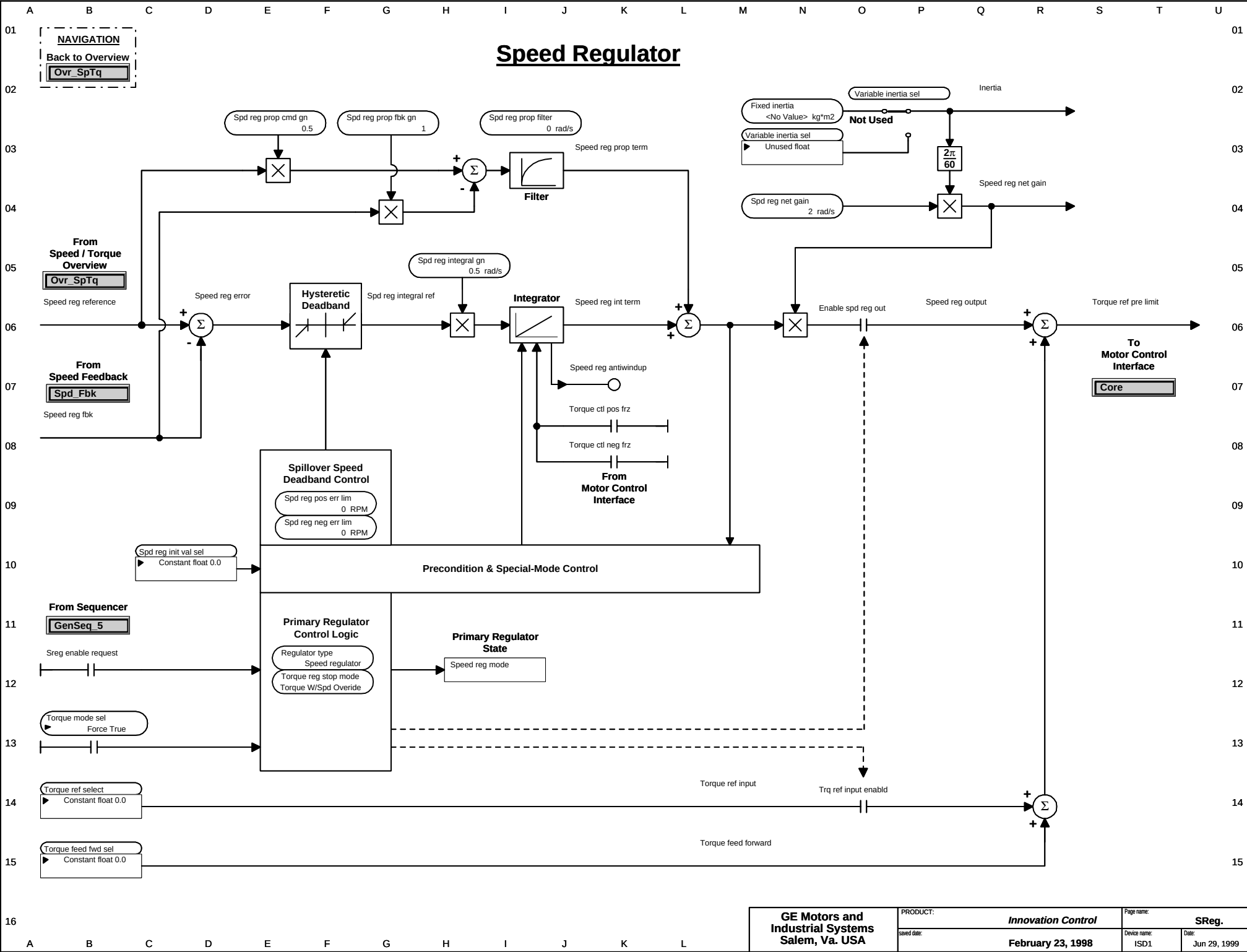
Ovr\_RfSel



# Speed / Torque Overview









# Motor Control Interface

## NAVIGATION

Back to Overview

Ovr\_SpTq

## Current Command

### Torque Command

Torque ref pre limit

Torque ref post lim

Torque enable req

Trq cur ref pre lim

Torque current ref

From Speed Regulator

SReg

To Droop Feedback

Droop

From Sequencer

GenSeq\_5

To Motor Control

Ovr\_MCtrl

Torque cmd pos limit

Torque cmd neg limit

Ix command pos limit

Ix command neg limit

### Motoring & Generating Torque Limit Select

Torque lim 2 sel

Force False

Adj mtr trq lim sel

Not Used

Motoring torque lim1

1 pu

Motoring torque lim2

1 pu

Adj mtr trq lim sel

Unused float

Motoring torque lim

100% Motor torque

Motoring & Generating Limit Steering Control

Torque lim 2 sel

Force False

Adj gen trq lim sel

Not Used

Regen torque lim 1

1 pu

Regen torque lim 2

1 pu

Adj gen trq lim sel

Unused float

Regen torque limit

DC Bus Regen Control can reduce Generating Limit

Motor rated power <No Value> KW

Motor rated rpm <No Value> RPM

Dc source Rectifier without DB

### Current Limit Select

Torque lim 2 sel

Force False

Adj cur lim ref sel

Not Used

Current limit 1

1 pu

Current limit 2

1 pu

Adj cur lim ref sel

Unused float

Current limit

Torque current limit

Motor rated current <No Value> Amps

Flux current, avg

Current Magnitude Limit

Pullout Limit Adjustment and Power-Dip Clamp Control

GE Motors and Industrial Systems  
Salem, Va. USA

PRODUCT:

Innovation Control

Page name:

Core.

saved date:

October 20, 1998

Device name:

ISD1

Date:

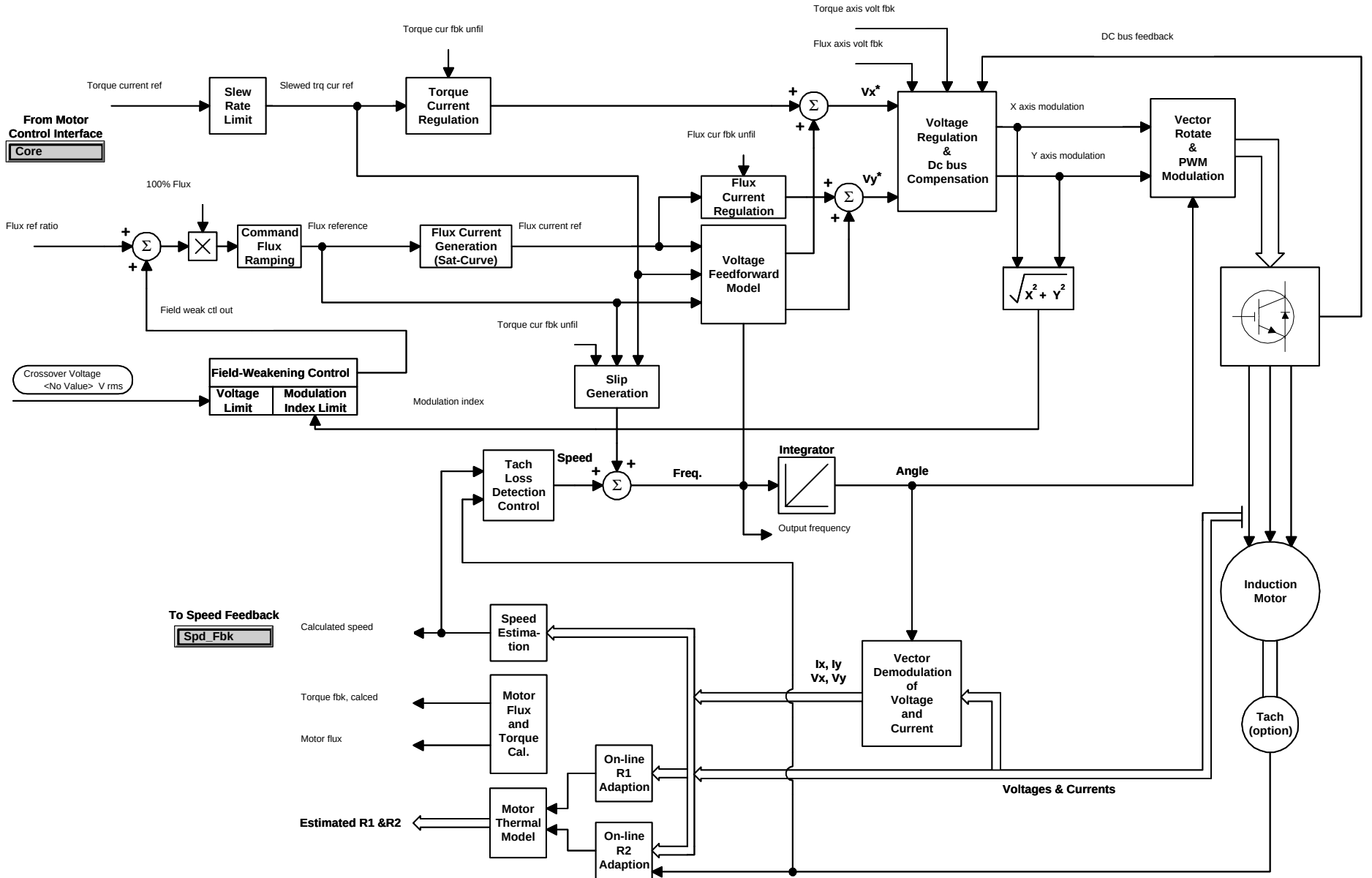
Jun 29, 1999

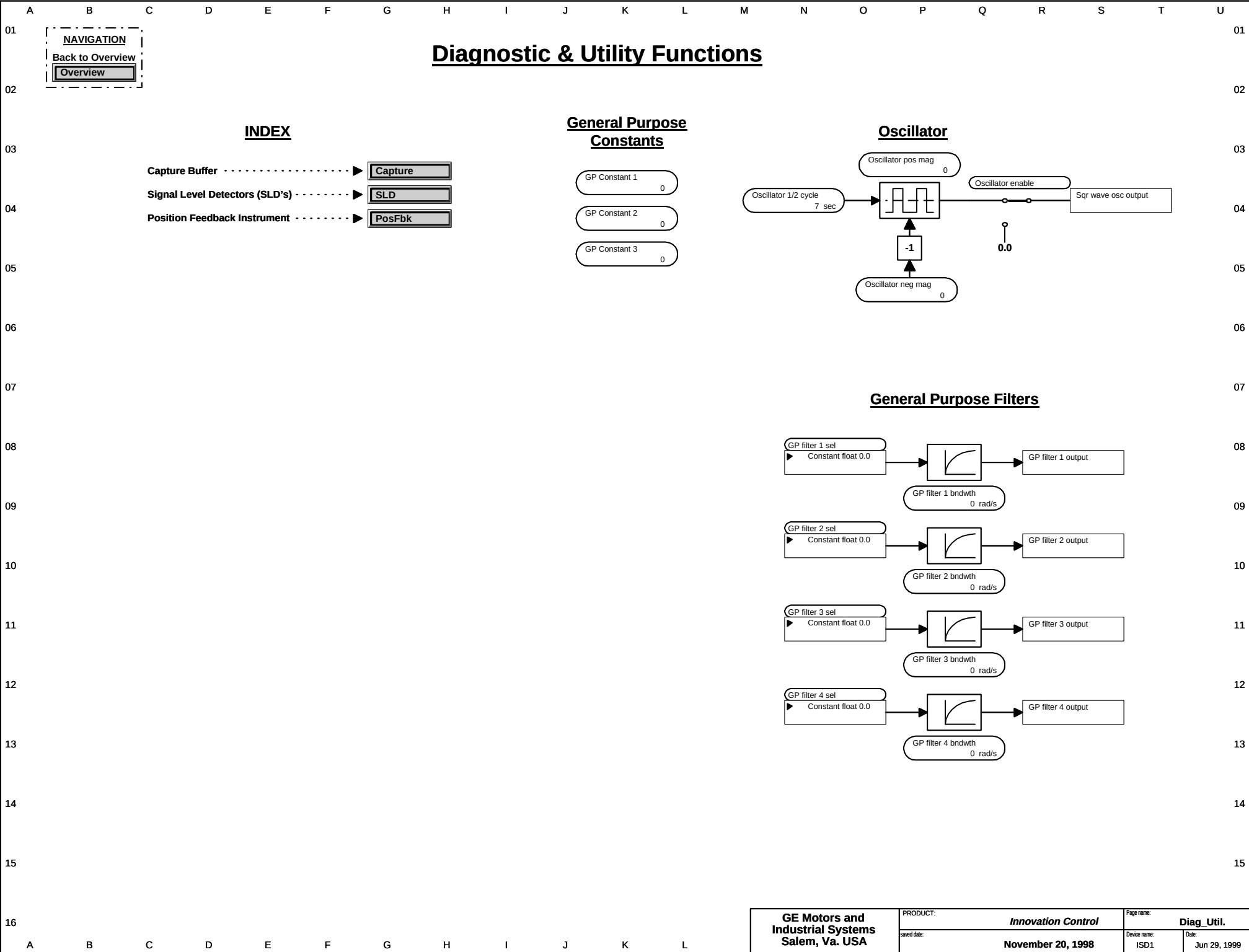
# Motor Control

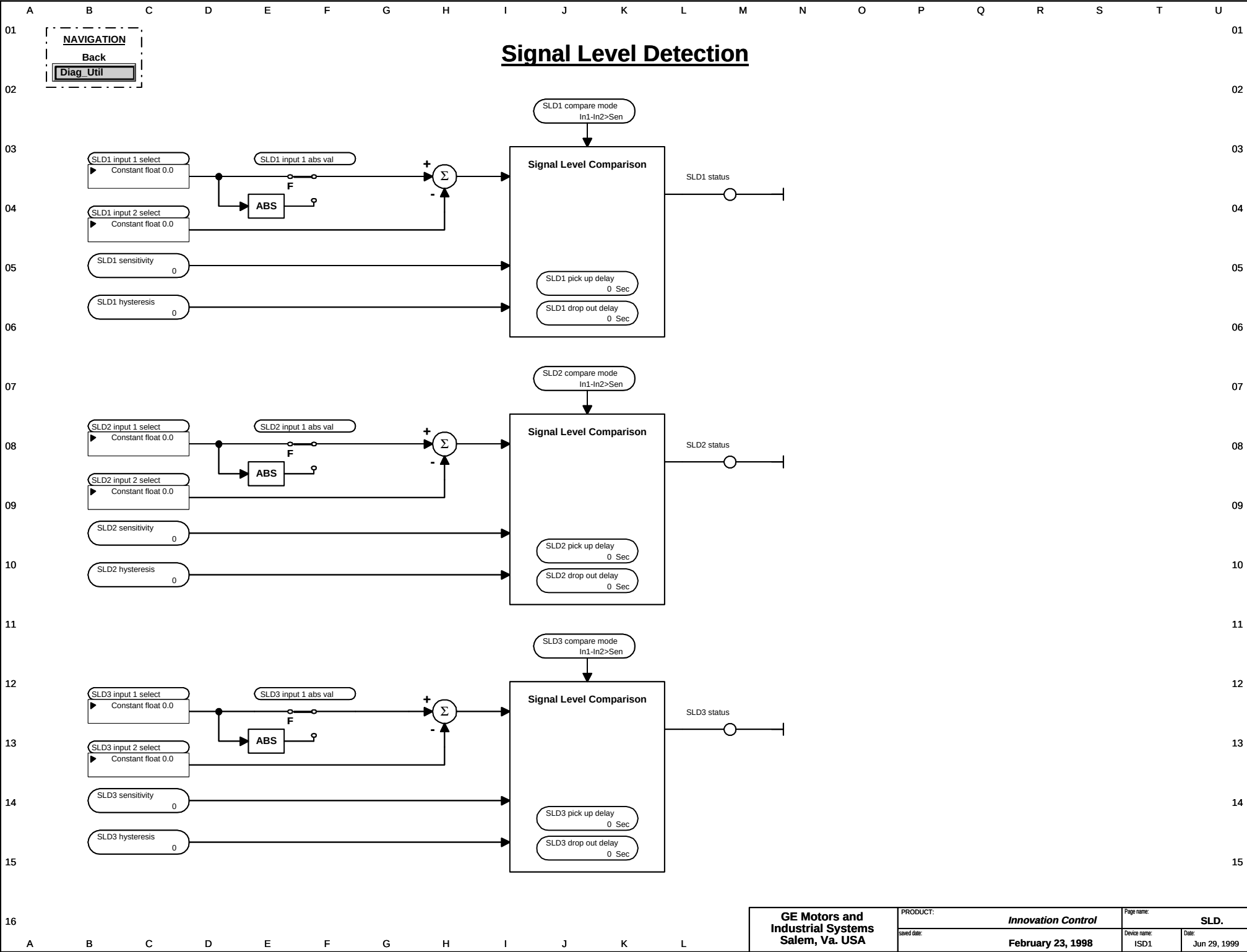
**NAVIGATION**

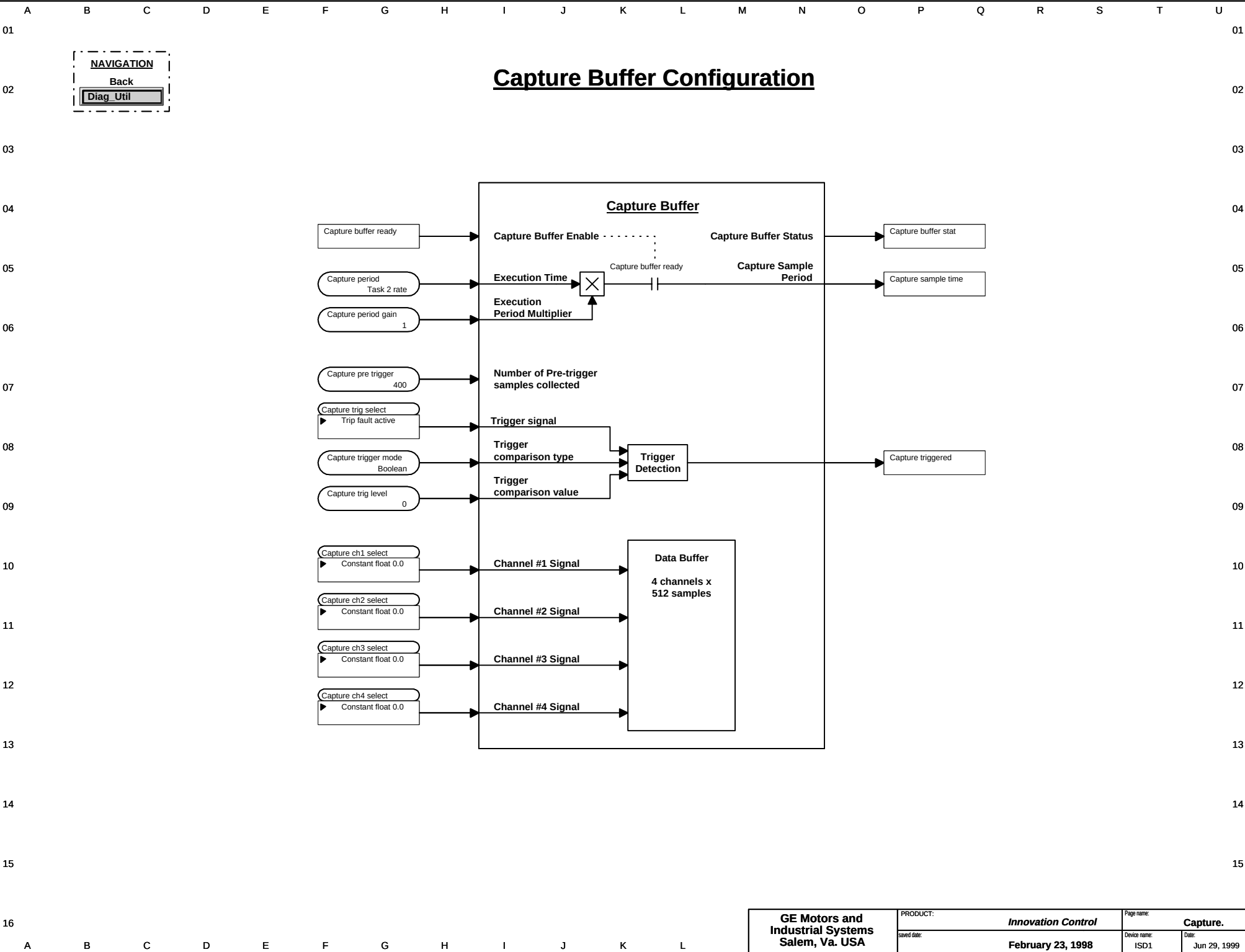
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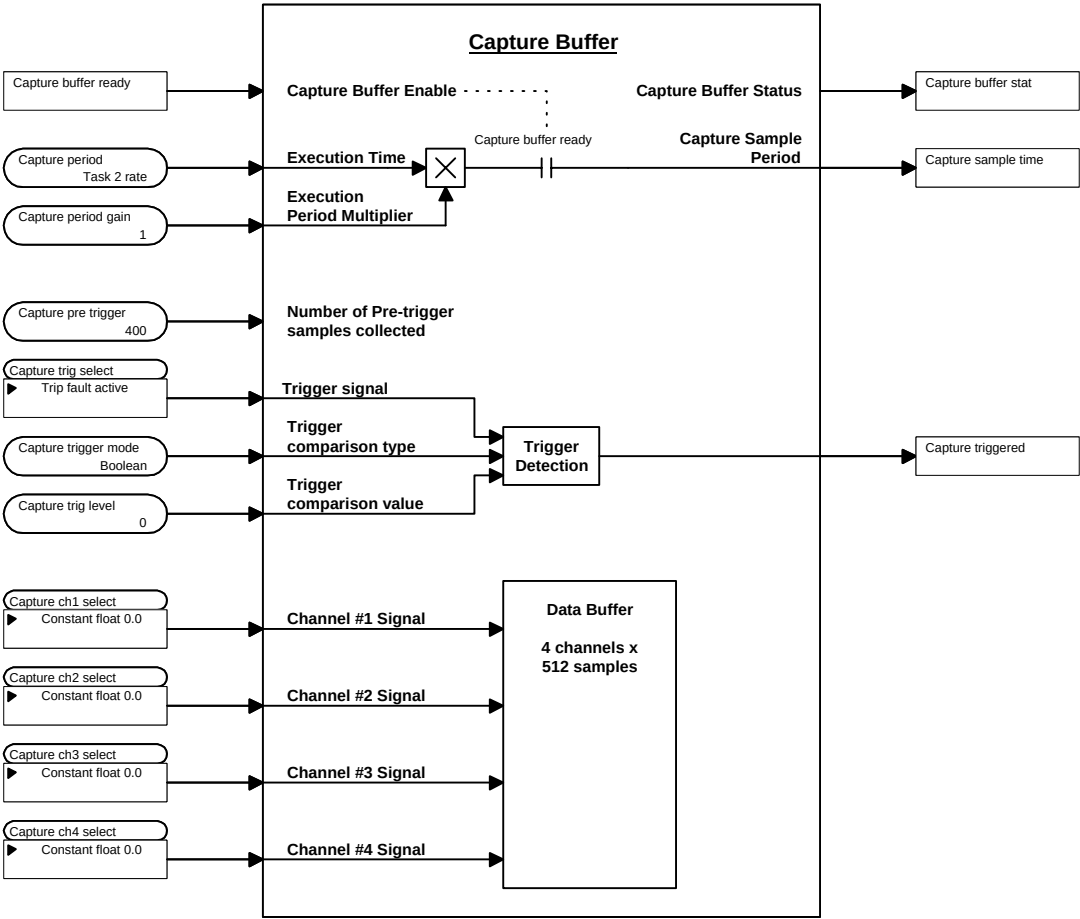


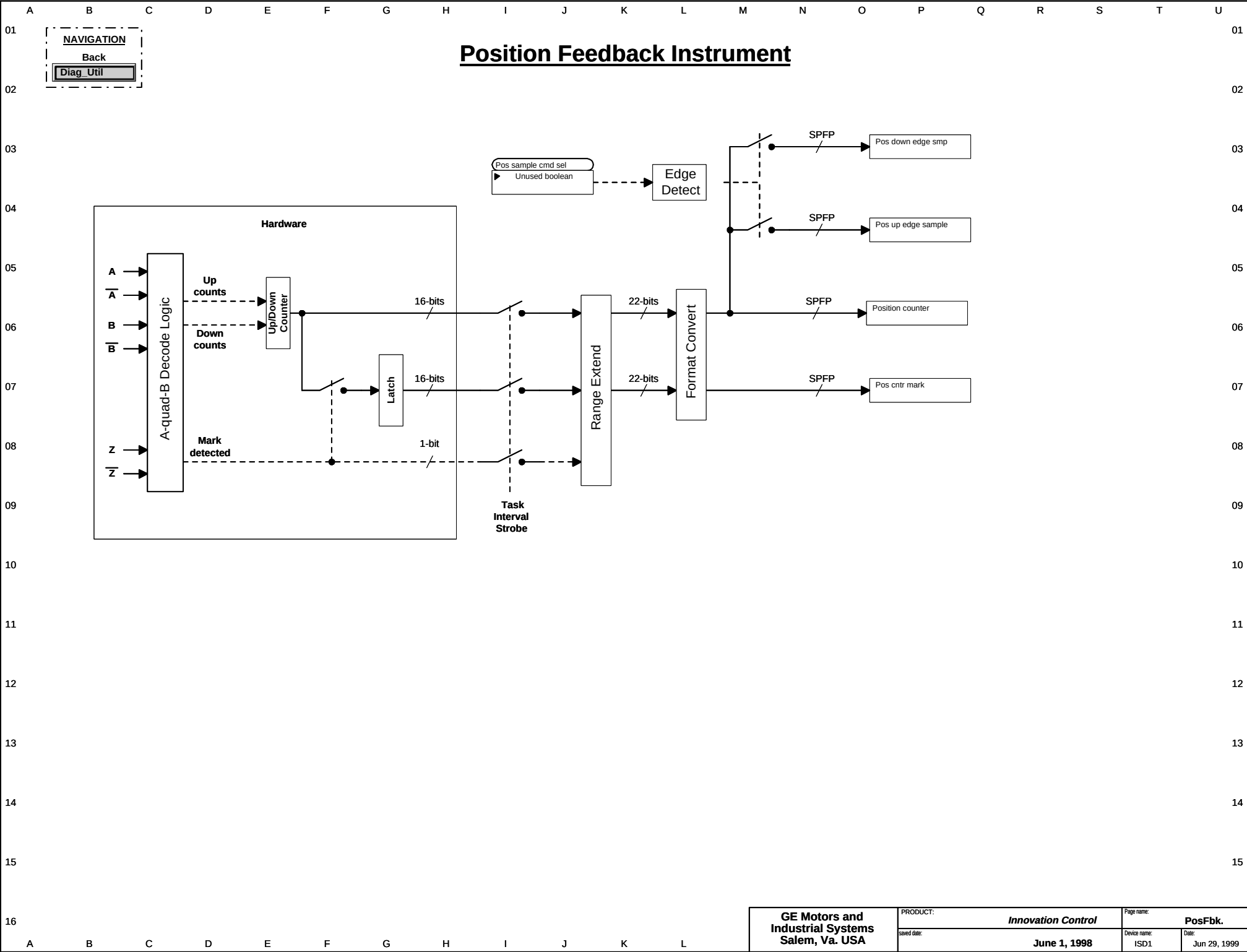






# Capture Buffer Configuration





# ***Glossary of Terms***

## ***ACCBN***

AC product, Common Bus Non-regenerative source. This source provides dc power to a dc fed, ac product (such as ACDCF), and is not capable of regenerating power to the ac line.

## ***ACCBR***

AC product, Common Bus Regenerative source. This source provides dc power to a dc fed, ac product (such as ACDCF), and is capable of regenerating power to the ac line.

## ***ACDCF***

AC product, DC Fed inverter. This inverter is powered from a source bridge (such as ACCBN, ACCBR).

## ***drive***

(Industrial.) The equipment used for converting available power into mechanical power suitable for operation of a machine.

## ***filter***

An electrical circuit that passes frequencies within a specified frequency band and attenuates signals that fall outside of that frequency band. (Also see line filter, ac.)

## ***frame***

Size of drive cabinet(s). Determined by hardware components required for power application.

## ***harmonic distortion***

Undesired harmonic frequencies that result from irregularities in a transmission line.

## ***layout drawing***

A diagram showing the components of a panel, and their location and connections.

## ***line filter***

A filter that connects from ac line to ac line at the input of a power converter. The filter consists of a series configuration of resistors and capacitors, which damps out high frequency oscillations on the ac power line.

## ***NEMA***

National Electrical Manufacturers Association. An organization that develops standards for the electrical manufacturing industry.

## ***Non-regenerative***

See regenerative.

## ***outline drawings***

A drawing or diagram that shows the dimensions and non-detailed layout of a device or equipment.

## ***parameters***

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.

## ***reactor***

A device (such as a coil, winding, or conductor of small resistance) used to introduce reactance into an alternating-current circuit.

## ***regenerative***

Ability of a drive to return power from the motor armature to the ac line. Creates a braking effect on the motor.

## ***signals***

Signals are LAN or I/O based variables that either control the drive or provide feedback data on the status of the drive. For example, an analog input signal provides the speed reference for the drive.

## ***variables***

Variables are dynamic references for control of the drive or contain feedback on the status of the drive. For example, speed feedback and speed reference are two variables associated with the speed regulator function in the drive.

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***General Electric Company***  
1501 Roanoke Blvd.  
Salem, VA 24153-6492 USA